BIOCAPITAL

The Constitution of Post-Genomic Life

by

Kaushik Sunder Rajan

M.Sc. Biochemistry
Oxford University, 1997

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BIOCAPITAL: The Constitution of Post-Genomic Life

by

Kaushik Sunder Rajan

Submitted to the Department of Science, Technology and Society in Partial Fulfillment for the Requirements for the Degree of Doctor of Philosophy in Science, Technology and Society

ABSTRACT

This thesis is concerned with tracking and theorizing the co-production of an emergent technoscientific regime — that of biotechnology in the context of drug development — with an emergent political economic regime that sees the increased prevalence of such research in corporate locales, with corporate agendas and practices. Hence biocapital, which asks questions of the implications for life sciences when performed in corporations, and for capitalism, when biotechnology becomes a key source of market value.

The methodology followed in this dissertation is multi-sited ethnography. I study a range of actors — including academic and industrial scientists, entrepreneurs, venture capitalists and policy makers — in two distinct national environments, the United States and India, as they shape and come to terms with these emergent technologies and emergent political economies.

I attempt, through such a study, to theorize biocapital, drawing primarily upon Marxian and Foucauldian understandings of life, labor and value, and upon literature in Science and Technology Studies, that has constantly drawn attention to the constructed, contingent and politically consequent nature of technoscientific activity. In the process, this thesis intervenes in social theoretical debates not simply around the nature and production of knowledge and value, but also around the place of larger belief-systems — relating to religion, nation and ethics — in such productive enterprises. It simultaneously intervenes in conceptual debates within cultural anthropology regarding methodological questions that surround the undertaking of comparative ethnographic projects of powerful sites of knowledge production and value generation in a globalized world.

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BIOGRAPHICAL NOTE

Kaushik Sunder Rajan obtained his Bachelors of Science (B.Sc.) degree in Human Biology (with a specialization in Biochemistry) from the All India Institute of Medical Sciences, New Delhi, India, in 1994, and a Masters of Science (M.Sc.) degree in Biochemistry from the University of Oxford, Oxford, UK in 1997. He was awarded the Radhakrishnan / British Chevening Scholarship, awarded by the University of Oxford and the British Foreign and Commonwealth Office, to undertake study at Oxford towards his Master's degree. His publications include "Modernity and the Nation-State in Regimes of Global Biotechnology" in Sudha Pandya and Prafulla Kar (eds), *Interdisciplinary Perspectives on Modernity,* 2001, 180-188 (Delhi: Pencraft International), and "Banking (on) Biologicals: Commodifying the Global Circulations of Human Genetic Material" in *The Sarai Reader, Volume 2: The Cities of Everyday Life*, 2002, 277-289 (Delhi: Sarai). He has worked as Editorial advisor (psephology) for TV Today, on the program *Aapka Faisla* (India Decides), which followed live on Indian public television the outcome of the 1998 general elections to the Indian parliament. He was also Research Associate to Lokniti, Institute of Comparative Democracy, Centre for the Study of Developing Societies, Delhi, India. This work involved analyzing survey data conducted around the general elections to the Indian parliament in 1996 and 1998. At MIT, he has been a teaching assistant for STS courses on topics such as the history of modern science, and ethical choices and political conflicts in American science. He has also taught his own undergraduate reading seminar, titled "Biomedicine: Law, Ethics and Practice".

For Thatha

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This dissertation could not have been attempted, let alone written, without the guidance, advice, encouragement and support of my committee, Mike Fischer, Joe Dumit, Sheila Jasanoff and Donna Haraway. Each has been a teacher in the most profound sense, and learning from each of them has been a privilege. My mother, Rajeswari Sunder Rajan, has virtually been a fifth committee member, and her own work has been a formative influence on my thinking and writing.

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Sections of this dissertation were presented at various conferences. Parts of Chapter 4 were presented at "Owning Up: Bodies, Selves and the New Genetic Property", organized by Sheila Jasanoff and Jenny Reardon at the Kennedy School of Government, Harvard University, and at a colloquium at the Department of Science and Technology Studies, Rensselaer Polytechnic Institute. Many thanks to Sheila and Jenny for inviting me to the former, and to Kim and Mike Fortun for organizing the latter. Parts of Chapter 5 were presented at "Wizards of OS –

2: Open Systems and Free Knowledge", at a panel organized by Chris Kelty. Parts of Chapter 8 were presented at an American Anthropology Association meeting panel on "Technology, Governmentality and Affect", and I thank Joao Biehl for organizing those conversations and inviting me to be a part of them. I have also benefited greatly from thinking about bioethics a two conference panels I co-organized with Chloe Silverman at the Society for the Social Studies of Science meetings in 2000 and 2001. Many thanks to the participants of these panels for sharing their thoughts with me. In addition, I have benefited greatly from three study groups / writing workshops that I have been a part of: at the MIT STS Department, made possible largely through the efforts of David Kaiser and Rachel Prentice; at the Kennedy School of Government, organized by Sheila Jasanoff and Jenny Reardon; and at the California Institute of Technology, organized by Marianne de Laet. Recently, reading theory at pubs with Joe Dumit, Mike Fischer, Andy Lakoff, Nate Greenslit, Orit Halpern and Clara Han at our "Hungry for Theory" reading group has been a wonderful way to spend Friday afternoons while getting food (and beer) for thought.

The STS Department has been a source of material support, intellectual sustenance and collegiality. I thank the department for funding parts of my dissertation research, which enabled me to do my fieldwork in Northern California and also spend a semester at the History of Consciousness Department at the University of California, Santa Cruz. Mike Fischer, in addition, funded portions of my fieldwork from his own grant money, for which I am grateful. Further thanks to MIT's Kelly-Douglas Fund and the MIT Graduate Student Council, who funded my conference and fieldwork travel on a number of occasions. I am also grateful to the organizers of the Cold Spring Harbor genome meetings, and to the Cambridge Healthtech Institute, for making it possible for me to attend their conferences by waiving their fees. In addition, the constant help and cheerful presence of Chris Bates, Nancy Boyce, Ben Brophy, Shirin Fozi, Paul George, Kris Kipp, Debbie Meinbresse, Judy Spitzer, Diane St. Laurent and LeRoy Stafford at STS

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TABLE OF CONTENTS

Prologue: Discovery and Revolution..... 10

Chapter 1: Theory and Critique..... 21

1.1. Overview of thesis and significance 21

1.2. Theory 25

1.3. Outline of dissertation 38

Chapter 2: Ethnography and Praxis..... 44

2.1. Thick description 45

2.2. Multi-sited ethnography 49

2.3. Field-sites and reflections on fieldwork 57

Chapter 3: Biotech and Pharma..... 89

Chapter 4: Speed and Information..... 137

4.1. A Brief History of Genomics: Stories and Polemics 137

4.2. Genomic Capital 163

4.3. Labor 197

Chapter 5: Ownership and Ethics..... 230

5.1. Banking (on) Biologicals 230

5.2. Ethics in Post-Colonial Context 253

5.3. Ethical Plateaux as Political Terrains 271

Chapter 6: Vision and Hype..... 286

6.1. Future Perfect, Present Tense 286

6.2. Entrepreneurial and Investor Envisioning 316

Chapter 7: Nation and Salvation..... 340

7.1. The Born-Again Ethic and the Spirit of Venture Capitalism? 340

7.2. Envisioning India Inc. 355

Chapter 8: Risk and Subjectivity..... 405

8.1. From Promise to Fetish 406

8.2. Genomic Fetishism and Polymorphic Subjects 440

8.3. Consumptive Power 460

Appendices..... 474

References..... 485

PROLOGUE: DISCOVERY AND REVOLUTION

Deciphering the code of existence requires a special set of tools.

Affymetrix. Discover more.[1]

I met a traveller from an antique land
Who said: Two vast and trunkless legs of stone
Stand in the desert. Near them, on the sand,
Half sunk, a shattered visage lies, whose frown,
And wrinkled lip, and sneer of cold command,
Tell that its sculptor well those passions read
Which yet survive, stamped on these lifeless things,
The hand that mocked them, and the heart that fed;
And on the pedestal these words appear:
"My name is Ozymandias, king of kings:
Look on my works, ye Mighty, and despair!"
Nothing beside remains. Round the decay
Of that colossal wreck, boundless and bare
The lone and level sands stretch far away.[2]

Affymetrix, a Santa Clara, CA based biotechnology company, is the inventor and manufacturer of DNA chips, what they call GeneChip® arrays. A DNA chip is a 1 cm x 1 cm silicon wafer substrate, that has genes tagged to it, on which hybridizations can be performed to compare two sets, and "states", of genetic samples, to see which genes are selectively up- or down-regulated in response to certain events, or predispositions to events (these events usually

[1] From an advertisement for Affymetrix, Inc., a Santa Clara, CA based biotechnology company.
[2] Shelley (1818).

being diseases). It is an actant in the sense that Bruno Latour uses the term (Latour 1987). Essentially a machine, DNA chips are also an experimental site, an entire laboratory on a single silicon wafer,[3] and a bearer of scientific fact, as it is a tool in providing not just a profile of gene expression across whole clusters of genes (conceivably across whole genomes), but also therefore enables us to know our predispositions to various traits, once those gene expression profiles are adequately correlated with those different traits.

The DNA chip epitomizes both many of the features of biocapital that I see as its distinctive markers (just as the chip itself shows distinctive markers of traits, even as it disavows cause-effect relationships between those markers and their corresponding traits). In the ad in Figure 1, the DNA chip is also shown to embody and reflect some of the contradictory discourses and tensions that I want to show as constitutive of biocapital.

Firstly, the DNA chip, both as it is represented in this ad and in its everyday existence as a key material-semiotic object of the genomics revolution, embodies a promise, the promise of understanding as leading to discovery. It is a promise that is couched in the secular terms of cryptography and computer code. Yet that much more emphatically Christian premise, of the human genome as the Book of Life (Kay 2000) and the Holy Grail, is barely hidden. The DNA chip is the first of many salvationary objects provided to us by the biotechnology – genomics revolution. It offers us the first step on the route to knowledge that will ultimately, in this narrative, lead to the generation of new therapies for diseases without adequate cures.[4]

But secondly, the DNA chip is also a signifier that we are both always already predisposed to a whole range of diseases and, therefore, just one of many variable living entities, not "pathological" (see Canguilhem 1989 [1966]) in our multiple disease predispositions.

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[3] Indeed, another company that makes chips for biomedical applications, Caliper Technologies (based in Mountain View, CA) explicitly calls their products labs-on-a-chip (or LabChip®).

[4] It is already clear that the greatest promises of genomics lie in cancer research.

Therefore, the DNA chip hastens to tell us of our (potential) imperfections even as it tells us that it is the fact of having these imperfections in the first place that makes us "normal".

Figure 1: Affymetrix advertisement for DNA Chip

What is immediately promised, by the ad and by the chip, is not a therapeutic, but a diagnostic; not a drug, but knowledge. At once modest, yet extremely profound, the DNA chip is a tool to decipher code, where deciphering code itself is a tool for profoundly revolutionary and scale-making practices of getting better *through* an understanding of "life itself".[5] The chip is at once salvationary and secular-utopian, the salvation mediated by the rational accrual and use of the "ultimate" knowledge of human existence.[6] One's "agreeing" or "disagreeing" with the type of knowledge doesn't preclude this knowledge from functioning in all the ways mentioned above, as supremely authoritative, as fact, but also as fact that is somehow fundamental and originary, as fact *about existence*, fact that will lead us to *discover more.* About what, or to what end, is not a part of this script.

Thirdly, the DNA chip is a commodity, but only a commodity that is also already an experimental system and knowledge, all in one. It interpellates us, as both patients- and consumers-in-waiting, as subjects of a knowledge-producing enterprise that is one of the most capital intensive and profitable enterprises there is.

The DNA chip is quite literally a hybridization of informatics and life, as DNA samples are *hybridized* onto a silicon chip in order to create the DNA chip. Both a commodity and an object of knowledge production, it has within it the mysticism and authority associated with each. What it does is standardize, providing a neutral (as in scientific) playing-field for such vexed analyses as comparisons of populations for predispositions to disease or drug response – the

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[5] For an extremely insightful use of Michel Foucault's term "life itself" as it pertains to the revolutionary imaginaries of contemporary biotechnology, see Franklin (2000).

[6] I think here of Douglas Adams (1995) on "life, the universe and everything", in which he shows through deftly excessive humor how the answers to profoundly revolutionary questions are often apparently banal and unintelligible, but nonetheless lead, in their very quest, to scale-making projects that are both extremely productive and extremely dangerous, violent and potentially destructive. Also central to Adams' implicit philosophy is that such questions also lead, in the attempted elucidation of their answers, to extremely interesting stories, biographies and enactments, whose narration is of as much importance as the "ultimate" diagnosis of outcomes.

latter, pharmacogenomics, being one of the most immediately realizable outcomes of the genomics revolution.

The DNA chip also has tied into it histories that point directly to the strategic terrains of ownership through intellectual property protection that serve as yet another diagnostic marker of the biocapitalist era that the chip signifies. Patent disputes around DNA chip technology are bewilderingly numerous as well as complex, because it is very difficult to determine exactly what a particular patent covers, and what specific licensing agreements have covered. Patents are taken out not just on the DNA chip, but on the hardware and software associated with the chip, the applications of the chip for different research / therapeutic / diagnostic purposes, the fundamental principles on which the chip operates, and so on. Patent disputes over research tools can span different "components" of the tool (underlying principle versus method of manufacture versus specific application), previous licensing agreements and different national legal regimes, and are further complicated by the fact that the companies involved themselves often postdate the initial fundamental patents that get argued about. Some patent disputes are between competitors, such as the case between Affymetrix and Hyseq Inc.[7] Others are between "collaborators", for example the dispute between Incyte and Affymetrix. These two companies had entered into an alliance in 1996 to develop and commercialize novel and disease-specific gene expression databases and services,[8] a partnership that combined Affymetrix's GeneChip® technology with Incyte's LifeSeq™ genomic database. Affymetrix's suit was against chip developer Synteni, which had just been bought by Incyte.[9] Incyte wasn't averse to taking their own adversaries to court over such technologies (which can generically be referred to as microarray technology), taking Gene

[7] See http://www.affymetrix.com/press/pr980818.html for Affymetrix's press release on this matter.
[8] http://www.recap.com/alliance.nsf/1a23c592b103546f88256480005a7e33.
[9] See http://www.signalsmag.com/signalsmag.nsf/657b06742b5748e888256570005cba01/.

Logic to court alleging infringement of three of its patents which all cover microarray and gene expression technologies.[10]

Meanwhile, the fact that hybridization was developed as a technology in the first place by Edward Southern led to another series of patent disputes. In 1995, Southern founded a company co-owned by Oxford University called Oxford Gene Technology Ltd. (OGT) in order to develop and commercialize services using microarray technology. On 13 December 1999, they signed a licensing agreement with Incyte covering each other's microarray and gene expression technology portfolios, under which OGT provided Incyte with access to the basic array technology, and in turn got access to the downstream technologies associated with the production and use of the microarrays.

While OGT was building bonds with Incyte, they were taking Incyte's ex-buddy Affymetrix to court to revoke two of their UK patents relating to microarrays. Justifying this, Southern said, "Affymetrix did not invent the array. Yet they appear to be attempting to patent all arrays and achieve a monopoly over all arrays. This conduct may hinder the emergence of competitive array technologies, such as the computer-controlled printing techniques disclosed in our original filing. If not checked this could ultimately drive people away from arrays altogether. It would be a catastrophe not to make full use of such a powerful analytical tool."[11]

Therefore, on the one hand, there are intellectual property disputes over what *is* uniquely coverable by patents relating to the chip. On the other hand, there have been disputes that have stemmed from the fact that less sophisticated versions of the chip are easy to "home-manufacture". Affymetrix, after spending lots of money in aggressively (and not always successfully) protecting its intellectual property on the chip, is now "open-sourcing" it: a dramatic

[10] For Incyte's press release on this, see http://www.incyte.com/news/1999/genelogic.html.
[11] Quoted in OGT's press release, http://www.ogt.co.uk/ogt02.html. Earlier, OGT had brought proceedings against Affymetrix to US and UK courts for infringements. In defence, Affymetrix resorted to stating licensing agreements made previously between other corporations / incarnations of the two parties, pointing

example of the ways in which contradictions built into the supra-commodification of biological objects leads to tensions that force decommodification; but also an example of the ways in which forced decommodifications get articulated as magnanimous acts of "gifting" naturally ownable property to the public domain.[12] "Open-sourcing" is through what is called the NetAffx™ Analysis Center, which enables researchers to correlate their GeneChip® array results with array design and annotation information.

Both the DNA chip itself, and the advertisement for it that I show at the start of this work, provide windows onto each of the five sets of theoretical issues I explore in the dissertation: speed and information, ownership and ethics, vision and hype, nation and salvation, and risk and subjectivity. In order to understand a little bit more about why I think this tool, and the way this ad represents this tool, are such useful segues into my larger arguments regarding biocapital, it is perhaps useful to start by explaining exactly what sort of tool the DNA chip might be in drug development.

The ad, interestingly, does *not* make explicit at any point that this tool is about, or for, drug development at all. The message here is about deciphering, almost as an end in itself rather than necessarily as a prelude to therapeutic development. Before the genomics "revolution" (and I purposely for the time being put this in quotes), the end point of what might broadly be called a "pharmaceutical" enterprise was precisely the development of therapeutics. One of the many things genomics promises us – and I explore this in detail in Chapter 8 – is the possibility of diagnostic development without the concomitant development of therapeutics. In itself, the DNA

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to a license granted by Isis Innovation, Oxford University's technology transfer company to Beckman Instruments (now Beckman Coulter, plc) in 1991.

[12] I asked one of the division managers at Affymetrix where the company would realize value if they "open-sourced" the chip. Her response was that the quality of Affymetrix chips is so high that people will still buy the chip rather than reverse-engineer their own based on the information Affymetrix has open-sourced. In other words, by early 2002, Affymetrix has moved to a situation where it relies on brand loyalty rather than intellectual property protection to retain market monopoly. While branding can never provide the type of complete monopoly that IP can, the belief in the company is that what is lost in terms of absolute protection is compensated for by the symbolic capital that can accrue from releasing chip information into the public domain.

chip *is* a decoding device, one that will allow association between gene expression and disease predisposition and therefore one that will be a useful prelude to the development of diagnostic tests, and some of its most promising, and potentially profitable, uses stem from that fact.

But the importance of having tools to "decipher the code of human existence" also underlies what has been an attempted paradigm shift in therapeutic development over the past number of years, towards what is called "rational" drug design. Traditionally, drug development occurred through medicinal chemistry by trying to determine the therapeutic properties of candidate natural products and seeing if those therapeutic properties exceeded the toxicity of the products concerned sufficiently to enable it be used as a drug. The two problems that became manifest with what was for decades a very successful strategy of natural product chemistry for drug development were, firstly, that this strategy involved a completely random screening of possible leads, with all the attendant risk and uncertainty that comes from an inability to predictably prioritize promising lead compounds; and secondly, that it has recently come to be suspected that most of the "low-hanging fruit" in terms of therapeutic natural products have already been picked.

There are two broad approaches possible to rational drug design. The first is to "rationalize" the chemistry, by creating combinatorial libraries of chemical compounds from which therapeutic molecules can be derived. I do not talk specifically about this in this dissertation (though see Barry Werth's fascinating book *The Billion Dollar Molecule* for a history of Vertex Pharmaceuticals, one of the first biotech companies to aggressively move into rational drug design in the early 1990s), though in terms of the scientific-corporate implosion into venture science, in terms of hype, vision, promise and a certain contingent, unpredictable and far from complete fulfillment of that promise, combinatorial chemistry prefigures many of the current happenings in genomics.

The second approach is to rationalize drug development by identifying molecular targets within the cell by elucidating biological mechanisms at the molecular level. This really is the outcome of the recombinant DNA revolution. Genomics – by "deciphering code" – becomes one means to such realization.

The Affymetrix DNA chip is precisely a tool that enables the earliest stages of such a rationalization, by helping to look for gene candidates that might be therapeutic targets (though as argued in Chapter 8, the sorts of information provided by the chip are a very very early stage in the possible development of any therapeutic actually based on such information), and by looking for gene markers that could be used in the development of diagnostic tests (a much easier proposition). Further, the DNA chip allows not just rationalization, but *high-throughput* rationalization: massively parallel analysis of whole genomes or parts of genomes that can increase the speed of analysis manifold.[13] These – information and speed – really are the defining facets of genomics.

The story of the DNA chip is one about speed, but also one, as outlined above, about commodification, and therefore about speedbumps inherent to a system that makes such speed possible (this is the theme I elaborate while talking about speed and information in Chapter 4). The story of the chip is also a story full of promise, it is a tool of the future. And yet the ad shows the chip embedded, quite literally, in the past, not just in post-Christ-ian history, but in pre-history; the code of human existence as depicted in this ad is not computer code, but a hieroglyph; not the Book of Life, but before the Book.

It is these sets of complex symbolisms in the ad that go beyond and undo the normal teleological frontier assumptions of unbounded and inescapable progress that typifies much corporate technoscientific discourse. The "pre"-historical embeddedness, quite literally, of the chip as depicted in the ad signifies a denial of the ahistoricity that pervades much corporate

biotechnology discourse, while reinstantiating it in a different form, by conveying a sense of timelessness, of eternity. One is forced to think of Ozymandias – Shelley's Egyptian king, whose grandeur, eventually, is eroded into unmemorable rubble – to remember how, even in the absence of specific historical memory, it is possible to superimpose civilizational scale-making projects in ways that deny history not by ignoring it, but by encompassing it. The DNA chip is hardly figured in this ad as emanating in any progressive manner from the glories of Egyptian civilization; it does, rather, suggest that the chip co-habits the same sort of civilizational imaginary that the great ancient civilizations conjure up for us.[14]

Therefore, the ad in Figure 1 also asks the question of revolution. While the ad might invoke history in an originary sense, rather than as flowing out of a progressive linear narrative of technoscientific progress, there is no question that the ad does suggest that an invention like the DNA chip is world-historical, a defining moment in civilization and humankind. This ad indicates not the endless frontier that epitomizes the myth of much American technoscientific progress (where the frontier signifies geography without end, but also therefore denies historical antecedents, the concern with the frontier myth being what exists at the crest of the wave and beyond rather than what has come before it), but origin in a Biblical sense, revolution in a Marxian sense, discontinuity in the sense of Foucault and Canguilhem. It *therefore* asks the fundamental question that must be asked: what *kind* of a history is a history of genomics? It is

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[13] At the time of writing, May 2002, Affymetrix has managed to put the entire human genome on two chips.

[14] This difference is of some significance in sites, such as India, where understanding the role of "pre"-history in figuring contemporary greatness is a matter of extremely vexed political debate, with very high stakes. This is because the ruling Bharatiya Janata Party (BJP), and its ideological wing, the Rashtriya Swayamsevak Sangh (RSS), are extremely invested precisely in the sort of history – distinct from that suggested by the Affymetrix ad – that suggests that contemporary Western technoscience was perfectly anticipated by (even if it did not emanate from) the glories of Vedic science (especially mathematics). The glory of "India", through moves that take recourse to "history" while remaining perversely ahistorical, then gets figured as originating, in a deeply civilizational sense, from mathematicians such as Aryabhatta. It is equally of note that the complicated city-building projects of the Indus Valley Civilization, which pre-dated the suspected Aryan "invasion" that led to the Vedic period and eventually pre-figured Hinduism as it is now understood, are not accorded a similarly glorious place in such civilizational history. I make this point both to suggest that the figuration of historical imaginaries is hugely consequential, and also as a prelude to sections of the dissertation that deal with genomics, drug development and biocapitalism in India, which

precisely the difficulty that one encounters in parsing out these various suggestions, that genomics is originary / revolutionary / an epistemic shift, when encountering genomic imaginaries such as they are conveyed through ads like Affymetrix's that pushes me *not* to attempt either a Foucauldian history / archaeology *of* genomics, or a classic science studies constructivist account, but rather a more Marxian political economic analysis of biocapital, in which genomics serves as a central diagnostic marker rather than as the subject itself of historical analysis.

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are emerging in the context of a BJP-run coalition government, a context that is of some importance in understanding the sorts of technoscientific emergences occurring in India today.

CHAPTER 1: THEORY AND CRITIQUE

1.1. Overview of thesis and significance

The title of this dissertation is "Biocapital: The Constitution of Post-Genomic Life". I use biocapital here as an explanatory framework for contemporary capitalism in its emergent and shifting topological manifestations and conundrums of value generation and market logic that come out of the bio-informatic (disciplinary and corporate) mergers of the genome sequencing revolution. As new disciplines such as bioinformatics, functional genomics and structural genomics emerge within the life sciences, so too does the practice of life science research move towards corporate locales, with corporate agendas and practices. I am interested in the features and consequences of this corporatization of the life sciences, and well as in asking what it means for specifically the *life* sciences to undergo such corporatization.

In this project, I use "constitution" in all its meanings. Firstly, as a noun, constitution refers to a set of institutionalized codes, both legal and normative, that get sacralized and held up as defining prescribed codes of action and governance. The working draft sequence of the human genome, announced in June 2000, is a revolutionary moment not just for biology, but for society and its perspectival vantage points writ large. The sequence itself was during its generation referred to as the "Holy Grail" of life itself, and within the life sciences, it is seen as constitutional of the way in which research agendas will be structured, both conceptually and institutionally. In other words, genomic information is becoming a reference point against which the intellectual quality of life science research gets constantly validated, and genomics is emerging as *the* attractive area of research in order to grab institutional attention and get money, whether from public sources or private investors. Genomics as research agenda is further being co-produced in a larger technoscientific environment that Joseph Dumit calls "venture science", in which the corporatization of the life sciences is deemed not just desirable but natural.

Secondly, constitution as verb refers to the act of constituting, of putting in place. Work in Science and Technology Studies (STS) has for years insisted upon the constructed and contingent nature of production of scientific fact. Recent literature on co-production has further emphasized how scientific fact is neither produced in isolation, nor does it precede or follow institutional (legal / corporate / governmental) productions in any causal manner (see for example Jasanoff 1995, 1996). Rather, emergent science and technology gets constituted along with emergent institutional structures and emergent individual and collective identities. This constitution requires active work by various actors, whose goals are by no means identical or even co-terminous. Tracing the acts of constitution that create post-genomic life across multiple locales and in multiple institutional settings is an integral part of any larger project that seeks to make sense of and historically situate emergent life-worlds.[15]

Thirdly, constitution refers to health, to the body and its overall well being. And indeed, genomics is about health, the body, life and hope, as it shapes and gets shaped by a society that is increasingly a therapeutic one. This therapeutic society, like any other, has a political economy embedded within it. And yet, theorists of the information economy, such as David Harvey (1990) with his sector economy approach, have tended to emphasize how such emergent economies intersect Work (the classical Marxian formulation) without enough attentiveness as to how they intersect Life. The co-production of new political economies with and *as* biopower (Foucault 1990 [1976]), biosociality (Rabinow 1992) and new "forms of life" (Fischer 1999) is the third broad organizing theoretical problematic of my work.

Using multi-sited ethnography as my methodology, I have studied the constitution of genomics and / as biocapital from a series of situated vantage points in the United States and India. The actors I have followed include corporate biotech entrepreneurs, venture capitalists,

[15] In this regard, I see STS as what Michael Fischer calls a "canary discipline", as in "the canaries that miners take into the mines to sniff out deadly gases, thereby showing where the mines need to be vented or reworked" (Fischer 2000).

public researchers, policy makers and founders of patient advocacy groups. Rather than simply write *about* each of these sets of actors, as an anthropologist conventionally might, I have rather written *from* the locales that each of them inhabit as they engage and come to terms with an evolving global scientific-corporate-legal regime that biocapital co-produces. Further, multi-sited ethnography is necessarily *fragmentary* rather than comparative in any complete sense, and this fragmentary nature is inherent to a politics of partial perspective that acts against and resists the fetishistic maneuver of passing off any necessarily fragmentary piece of knowledge as somehow "whole".

I have thus explored the importance of *speed* and *information* as the organizing material - rhetorical principles that make genomics a constitutional moment; analyzed the debates and politics around ownership and intellectual property in the United States and India that get thrown up because of the possibilities of obtaining patent rights on biological material; traced the importance of hype and other forms of strategic visionary articulation in creating a biocapitalist political economy; and argued for the need to create new theories about the operation of risk and risk discourse in order to understand how biocapital and genomic information operating as scientific fact create new individual subjectivities and social identities.

The sequencing of the human genome is revolutionizing the life sciences and creating new sorts of knowledge about life, which is increasingly viewed as information that can be obtained, analyzed and decoded. The commodification of the information that produces these ways of understanding is increasingly perceived as legally justifiable and strategically natural. This project partakes in the contemporary intellectual endeavors to identify, name, and explore the implications of these new developments in science and the concomitant new epistemology. It undertakes an extensive mapping of the global terrain of post-genomic biotechnology, generates a methodological apparatus for the study of this new phenomenon, and develops the outlines of a theory.

Theorizing global phenomena leads to questions about the boundaries of one's research. As I will elaborate while describing my field sites, the strictly "ethnographic" component of this research has been undertaken at a number of sites in the United States and India, from periods ranging from a day to a few months. Therefore, what this work offers at the outset is a comparative view of genomics research and the politics surrounding it in two distinct national environments, each with its own institutional, political and cultural contexts, but both always already over-determined by a globalizing market rationale. And yet, as again I will elaborate upon subsequently, ethnography is itself undergoing what Marcus and Fischer (1986) call an "experimental moment", and field sites and the narrative structures emanating from writing "about" them need to be retheorized (see also Gupta and Ferguson 1997). While I write "about" genomics in certain specific sites in the US and India, I also write *from* these sites, sites that are to varying degrees invested in one another, but also in other locations and the unlocatable "global". This means that this project is both bounded and not. My attempt is not to create a theory as totalizing as the processes of globalization I set out to critique appear to be, but it is impossible to artificially circumscribe one's pronouncements to a specific set of locations, because they themselves are crossing boundaries of many sorts while trying simultaneously to instantiate some of those very boundaries.

It is hoped that this project will have an impact in a number of areas. It aims to contribute specific knowledge about science and technology changes in the US and India; to extend the methodological frameworks in STS and anthropology; and to feed into broader interdisciplinary debates over the nature of globalization and the impact of biotechnology. A propos the last: much of the public response to biotechnology has been of a reactive anti-science variety, as seen in the Seattle (and subsequent) demonstrations against the World Trade Organization, or the Boston demonstrations against the Biotechnology Industry Organization. Such tendentious responses have marked much academic writing about biotech as well, especially in India (see for instance

Visvanathan 1997). This project offers instead a strategic and reflexive *critique* with a view to facilitating a genuinely dialogic understanding of the issues and the compulsions at stake for the various actors involved.

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1.2. Theory

Emergent Forms of Life

This thesis is concerned with tracking and making sense of emergent forms of life, in an era in which there is "a pervasive claim asserted by practitioners in many contemporary arenas such as law, the sciences and political economy that life is outrunning the pedagogies in which we were trained" (Fischer 1999). In other words, I am concerned with a thick description of what Michael Fischer refers to as an *ethnographic datum*.

"Emergent forms of life" as a heuristic is particularly resonant in understanding what I shall outline as biocapital, precisely because of the multiple meanings that can be attributed to both "forms" and "life". Fischer, drawing upon Raymond Williams, Ludwig Wittgenstein and Emmanuel Levinas, uses forms of life to refer to socialities of action. Biotechnology, however, brings with it the possibilities not just of new forms of life as in modes of living, but equally forms of life as in, quite literally, living beings. Genetically modified organisms and cloned animals are only the most colourful and controversial of such forms of life. "Forms of life" could also refer to a combination of the above two definitions, especially as it applies to humans. As Donna Haraway and Sherry Turkle have both shown in different ways, "forms of life" could be forms that life -- as both object and instrument -- takes as humans relate to emergent technologies in ways that question the form of life that the human is, and the forms of lives that humans lead (see, for instance, Haraway 1991, 1997; Turkle 1984, 1995).

In Haraway's articulation, this form of life is cyborg, a conceptualization that has spawned a whole generation of what is often referred to as "cyborg anthropology" (for a representative collection of such "cyborg anthropology", see Downey and Dumit 1998). According to Haraway, there are three boundary breakdowns in the late 20th century that make cyborg imaginings possible (Haraway 1991: 149-181). The first is that between human and animal; the second between the (animal-human) organism and machine; and the third between the physical and the non-physical. A tracing of emergent forms of life, then, is very much an exercise in cyborg politics, as it tracks these (intensely productive) breakdowns in order to track the possibilities: utopian, dystopian, liberatory, repressive, necessary and contingent: that flow from them. This thesis, from the outset, adheres to the politics that Haraway argues for in her "Cyborg Manifesto", politics that stem from the reality and the realization of emergent cyborg worlds: first, that "universal, totalizing theory is a major mistake that misses most of reality, probably always, but certainly now" (181); and second, that an anti-science demonization of these emergences is not a viable strategic response to dealing with their very realities.

If *life* can refer to both object and instrument, then, equally, *form* functions as both noun and verb. As noun, it refers both to external structure and to the essential nature of a thing. But further, "form" carries within itself notions of normativity, of established methods of proceeding: a form of life *could* refer to ungrounded socialities of action (as Fischer argues), but equally could imply emergent prescriptions for action, formulae, customs, etiquette. Form then refers both to substance (outer / morphological and inner / essential) and to style. Fourthly, a form is a document that classifies, that makes sense of and puts order into the world by parsing it in ways that have consequences, for life and for lives (see, for example, Bowker and Star 1998). Indeed, forms refer to orderly methods of arrangement, to patterns. As verb, form is a process of shaping or molding, of modeling by instruction and discipline, a process of normalizing unruly and chaotic -- indeed emergent -- material-semiotic actants. It is an act of fashioning and constructing.

Understanding emergent forms of life, therefore, involves tracking objects and subjectivities, both as things and as processes, and requires an attentiveness to tactics and strategies. Both actors and actions have to be simultaneously traced and located.

Understanding biocapital obviously requires as a starting point an understanding of what has variously been referred to as contemporary / late / postmodern capitalism, whose features have been most comprehensively outlined by Harvey (1990) and Jameson (1991). There is much understanding to be gained of the ways biocapital functions from the understanding of the information economy that these authors, Harvey in particular, provide. But such theorizing still locates forms of life primarily (merely?) as socialities of action. The question that *bio*capital begs is how these socialities of action can be understood in a context of a technology that literally creates new forms of life-as-objects. In other words, how does the creation of new forms of beings (including but not just human) affect new forms of being? How do productive (and re-productive) biotechnologies interdigitate with socialities of action?

These are not new questions, and have been asked most forcefully in science studies by scholars such as Paul Rabinow (1992) in his articulation of biosociality. The question Rabinow fails to ask however is how biosocial articulations get manifested in a social framework that is always-already overdetermined by capitalist relations of production.

This thesis offers a number of theoretical propositions about the life sciences and the institutional contexts within which scientific knowledge is produced, and traces the consequences following from them. These relate to the generation of new forms of ownership, new conceptualizations of property, and new forms of subjectivity, which at various levels or registers are themselves constantly relating to each other. There is a need to explore the relationships between ideology and state or corporate activity and between information and materiality, since at each of these levels one sees a back-and-forth between abstraction / conceptualization on the one hand and the site where it might be materialized on the other. Outlined below are some of the

major bodies of work that will be drawn upon here, in order to make theoretical sense of these relationships.

There are three strands of social theory that are relevant to engage with in such a project. The attempt to understand the political economy of an innovative technoscientific marketplace, especially when placed in global contexts, is primarily an engagement with Marxian theorizations of political economy, labor, value, the meaning and magic associated with the commodity-form and an industrial economy that depended upon colonialism. This project engages these key Marxian concepts in a context in which many of them demand retheorization. For instance, value is increasingly being realized in the realm of symbolic capital, the biological emerges as (more than just) a form of commodity and global relationships are more complicated and mutually implicated than they were during the phase of industrial colonial expropriation.

This thesis argues that we are in the midst of an inaugural moment brought about by the life sciences' constructing and articulating different forms of meaning and value, by looking both at commodification *and* subjectivity, when knowledge about living beings – selves – becomes increasingly naturalized as marketable. Patenting DNA sequences and other biologicals has become increasingly commonplace, governments encourage industrial bioscience research with payoffs and there is a tighter integration of biological research with biotech companies and pharmaceutical results. There is an ease and persistence with which biotechnology, bioinformatics and bioscience have entered our vocabulary, testifying to a profound shift in the nature of "nature" and also therefore of labor and value. This creates a need to understand the politics of production, circulation and consumption of both knowledge and the market frameworks in which it is embedded.

The second strand of social theory that this project predominantly engages relates to the notion of biopower (Foucault 1990 [1976]), which articulates how modernity has put knowledge about life into the realm of explicit political calculation. This in turn owes much to Georges

Canguilhem's explanations of how knowledge in-forms subjectivity by producing certain legitimized forms of normativity (Canguilhem 1989 [1966]). Subsequently Foucault's analyses of the intimate relationships between knowledge about life and power over it have been forcefully developed by such theorists as Paul Rabinow, who has developed the notion of biosociality as a conceptual framework with which to understand how biological knowledge co-produces social relationships (Rabinow 1992). There is now a body of work that focuses on this relationship between technology, governmentality and affect (see for examples Petryna 1999, Sunder Rajan 2001, Biehl 2001, Biehl et al 2001, Fischer 2001).

My attempt, to begin with, is to bring together these two complementary strands of social theory. In their respective evolutions into "schools of thought", they have by virtue of excessive faithfulness to their progenitors carried with them analytic lacunae that get further reified as the objects of study emerge in ways that outrun the theoretical formulations proposed to make sense of them. If one were to locate biocapital as simply as "case" of Marxian political economy, then what would most glaringly get left out, as mentioned earlier, is that economies intersect Life just as they intersect Work. Marxian political economists, while insisting on the value of human labor against the reifying efforts of the capitalist machinery to value human labor merely as a relatively expensive, dispensable, and interchangeable input, have paid little attention to the Foucauldian emphasis on the production of life as a calculable unit of political policy. Similarly, imagining biocapital to be the next theoretical step in a genealogy starting with Foucault's notion of biopower (Foucault 1990), and its extension and incorporation as Rabinow's biosociality, misses the number of points at which Foucault's theory diverges markedly from a Marxian theoretical understanding. In other words, biocapital as a theoretical notion doesn't simply complement or "fill in" biopower and biosocial theorization by including corporate ethnography or explicitly situating these notions in capitalist (theoretical and empirical) frameworks. Rather, it acknowledges the need to understand the modes of abstraction that give a certain constitutional

moment (which also happens to be constitutive of a global regime) its meaning and magic through theoretical categories such as ideology and fetishism that Foucault explicitly rejected.

The challenge in tracing biocapital is to place theoretical reflections such as these along with thick ethnographic observations into the emergent and hardly stable frameworks of political economy. An ethnographic tracing of forms of life would initially encounter them as ways of life, and describe and interrogate the different cultural formations that emerge in a world of scientific practice that is increasingly corporatized. It would then encounter "inner lives", the biographies of the various individual actors involved. Incorporated, quite literally, into these forms of life are emergent forms of ethics, both as individual commitments (and the lack thereof) and as collective normative practices. Therefore, the purpose of ethnography here is to map the various registers of meaning – articulated as everyday social and institutional practices, discursive strategies and inner belief-systems – that constitute a larger life-world that demands theorization.

The third strand of social theory draws upon various notions of what Ulrich Beck calls "Risk Society" (Beck 1986). Beck is attentive to the central place that the politics of science and technology, centering around health and environment, has in defining emergent social and institutional orders and political economies. While Beck views risk society within a Habermasian sphere of rational communication (Habermas 1985), other theorists of risk adopt more Marxian or Foucauldian approaches. Francois Ewald, for example, sees risk as a form of capital in his analysis of the insurance industry, an understanding that is extremely pertinent to theorizing the high-risk environment of speculative capital and intensive R & D investment that marks the start-up world and big pharmaceutical business models respectively. Robert Castel theorizes risk in a more Canguilhemian mode as he discusses how calculations of risk of disease lead to the creation of certain types of subjectivities that are molded by risk profiling.[16] Amongst STS authors, Sheila Jasanoff and Brian Wynne have extensively documented the ways in which risk assessment is

[16] See Burchell et al 1991: 281-298, for both Ewald's and Castel's arguments.

used in environmental controversies by various expert bodies in political and legal arenas, thereby showing how risk analysis as "science" is co-produced with risk analysis as a regime of expertise and a set of legal and institutional codes (Smith and Wynne 1989, Jasanoff 1994, 1995, Lash et al 1996, Jasanoff and Wynne 1998).

The challenge theoretically, then, is to weave from / with these three normally distinct strands a whole political economy and a whole system of knowledge about life that both embeds within and shapes such a political economy. Therefore, the overarching co-production that this project is trying to map is that of an epistemic regime as / with an economic one. This isn't just choreography within an immutable theoretical framework (such as political economy or biopower) that is already given. A political economic analysis of biotechnology cannot simply slot biotechnology into a pre-existing political economic framework. Rather, it must be an exercise in coming to terms with an entire epistemic framework that attempts to explain how money, capital and knowledge together mediate and in-form the way people live the lives they do in an emergent and inaugural moment. The project will try to conclude what is at stake – in lives as well as in political economies – in a biocapitalist society.

The sociological or ethnographic mapping of technoscientific processes in the work of the early STS mappers such as Latour (1986, 1987) and Knorr-Cetina (1981) or schools such as the Social Construction of Technology (SCOT), were primarily concerned with the construction of scientific knowledge and technological artifacts. But there are aspects and implications to genomics that call for further theoretical understandings. Firstly, there are cultural transformations that accompany and co-produce the redefinition of "life itself", making such maps extremely complicated to generate, with very few fixed points of reference. Secondly, a complete commodification of "science itself" leads to a very quick internalization and acceptance of these processes as natural. Thirdly, the global integration of these processes requires an attention not just to the co-production of science, politics and culture, but to such co-productions

across multiple relational locales, adding a further level of complexity to the analysis. Put simply, the object of bioscience, the practice of bioscience and the locations of bioscience have all changed. These changes call for an STS / anthropology of science approach that will combine political economic, business and bioscience analysis and ethnography. Some recent pioneering works in STS (Haraway 1997, M. Fortun 1999, Kelty 1999, Fischer 2000, K. Fortun 2001, Dumit forthcoming) and in the related field of medical anthropology (Farmer 1993, Rabinow 1997, 1999, Petryna 1999, Cohen 2000, Biehl 2001) have begun to chart such a terrain. Also of relevance are models of other ethnographic work sensitive to the relationship between global political economic processes and local practices, knowledges and value systems provided by authors such as Taussig (1980, 1987), Appadurai (1996), Gupta (1998) and Scott (1987, 1999).

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New theorization is always a form of critique, and critique, of course, is a political exercise. It would therefore be worthwhile to elaborate upon the politics of an intervention such as this dissertation. At its most simplistic, mine is a politics that is similar in inspiration to that which underlies much of the enterprise of STS scholarship, in its attempts to mix up extant boundaries. It stems from my formative and ethnographic experiences, and comes from a political engagement as an Indian who is deeply concerned about global scientific inequity, about articulations of nationalism and the preservation of a secular, anti-imperialist nationalist ethic and about democratic participation in and access to decisions about and developments in technologies that deeply affect our lives: that indeed, as Michael Fischer (1999) poignantly points out, have consequences for who lives, and who dies. I believe there are four broad political "themes" that underlie this dissertation.

The first has to do with situatedness. Biotechnology and genomics are not just about science or business, but are about life itself. This is not just because they are "life sciences", but because they structure to a great extent the ideological and institutional terrain and imaginary of

the emergent new millennium. This is a banal point, but one that is overlooked with surprising ease even by those works on biotech that serve as public relations manuals for the enterprise: they claim to talk about how biotechnology is changing the way we live, but end up often talking about scientific developments or business models as if they can indeed be talked of in isolation from ethics, politics or subjectivity (see for a representative example Robbins-Roth 2000).

This is part of a purificatory impulse, rejected by STS authors such as Donna Haraway, Sheila Jasanoff and Bruno Latour, that often forms a basis for an oppositional politics towards biotechnology as well. I argue that such purifying moves are not just politically fraught, but are also epistemologically unfounded. Not only does it assume a transcendental view-from-nowhere space from which critique can be made (and it is precisely the impossibility of making such an assumption that I imply in the point above, that biotechnology does impact all of our lives: every critic of biotechnology is always already a situated observer, not because the politics of situated perspectives is in any way "better" or more strategic than one that pretends to be "outside" the murkiness of the objects of one's critique, but because everyone *is* situated in worlds that have the life sciences as a central organizing regime), it also plays into precisely such ahistorical and racially motivated discourses of the "pure" that those broadly on the left generally (ought to) oppose. There might be many reasons to oppose regimes that produce transgenics, and to feel uncomfortable about the thus produced transgenic objects themselves, but their emergence as novel and therefore "unnatural" entities is not one of them. It is not just critics on the far right or left of the ideological spectrum who take up cudgels against the "unnatural" products of the biotech revolution: such critiques are often the basis of institutionalized bioethical critiques, that operate not from the fringe (with the attendant skepticism accorded to what gets perceived as a fringe critique), but as normative expert discourses that legitimately mediate in and adjudicate upon biotechnologies and their consequences. Without ever explicitly exploring institutionalized bioethics with an ethnographic gaze (that is undeniably an important project, and one that is being

attempted in interesting ways by a host of people in anthropology, science studies and the history of science),[17] I do critique it at various points in the dissertation.

The second political "theme", related to the first, is that a situated perspective necessarily involves being suspicious of both unreflexively realist and exuberantly relativist positions. On the one hand, I am suspicious, based again on the strength of ethnographic observations, of the type of linear accounts of biotechnical (and therefore necessarily societal) progress that biotech enthusiasts like Robbins-Roth propound (while knowing, surely, that such accounts are simply not born out by historical fact). I am also aware of the erasures that get effected through such frontier discourses of technoscientific progress, that at the end of the day, even when they are "true", do end up targeting diseases selectively (those that have huge Western markets), do cater selectively to those patient populations that can afford to pay for expensive high-end therapeutics, do take resources and attention away from basic primary health problems and approaches to solving them, and do involve more exploitative labor practices than one fathoms from reading accounts (including this disseration) that invariably focus on the excitement of *managing* biotechnological workplaces. On the other hand, I also see the hopes that get pinned on biotechnology, not just as a means of making lots of money, but as a means of saving lives that otherwise would not be saved – and these are not hopes that can simply be dismissed by cynical attributions of "hype". Yes, biotechnology operates on hype – and yes, hype is not reality, but hype is also not the binary opposite of reality. Biotechnology has many complex affective dimensions to it for those who are invested in it in many different ways. Further, technoscience,

[17] I have co-organized two conference panels at the Society for the Social Studies of Science (4S) meetings that explore and critique the role of institutionalized bioethics, sometimes in head-on ethnographic and political engagement, sometimes more obliquely through related objects and subjects of critique, in 2000 and 2001. Participants in these panels are all engaging with the challenges that get thrown up in critical engagement with biotechnologies in a discursive field that is powerfully configured by the "expert" meditations of institutionalized bioethicists. The participants on these panels are therefore all in their own work and their own ways concerned precisely with the political implications of formal "ethical" interventions in biotechnologies. Many thanks to all of them: Stefan Beck, Joao Biehl, Joseph Dumit, Michael Fischer, Kim Fortun, Michael Fortun, Linda Hogle, Kristin Peterson, Adriana Petryna, Jenny

even when high tech, virtual and not addressed to more primary needs, is an important vehicle for development in Third World countries, both for the tangible material benefits it promises (and sometimes provides), and for the epistemic interventions it makes in polities such as India where anti-scientism is not just the privilege of vanguard intellectuals who expose the violence of technoscience (see for instance Visvanathan 1997), but is also the preferred position of many on the Hindu Right who are at present in the position of formulating science policy. Their choices have serious implications for what gets learnt as "scientific", "true" and "rational", from the school level onwards.

At the level of epistemological critique, while I am surprised by the reification of science as something whose authority solely derives from the "truths" it propounds, I do hold on to a residual Marxian belief that scientific facts *do* matter: the job of the critic is not to *undermine* science as much as it is to *make it better*. I am not willing to admit that a belief in technoscientific progress is merely false consciousness. At the level of material practices, this means that I do think India should invest in genomics, and I myself am invested in seeing such investment bear fruit, even if I am uncomfortable at priorities that pit such expensive technoscience against primary health concerns, and am uncomfortable at priorities *within* Indian genome agendas that might end up reifying genetically determinist notions of race, caste and ethnicity while setting up the (manipulated and studied) genetic material of the Indian people as "naturally" the intellectual property of the Indian state.

The third political "theme" involves rethinking corporatization and property. I believe that one of the central structural – and strategic – issues in biotechnology has to do with intellectual property, and I recognize the huge amount of ambivalence that must go into structuring one's political positions vis-à-vis intellectual property regimes. On the one hand, I am firmly in agreement with a host of actors ranging from many public scientists in the US to critical

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Reardon, Chloe Silverman, Jeanette Simmonds, Jenny Smith, Stefan Sperling, Karen-Sue Taussig and

legal theorists like James Boyle (see, for instance, Boyle 1997) regarding the importance of preserving the intellectual commons, and not barricading it completely through what are often ludicrous intellectual property claims that still nonetheless get granted (and I think the argument that obtaining patents on gene sequences is one such ludicrous claim has considerable merit). On the other hand, I feel uncomfortable that an overly pre-meditated opposition to intellectual property on simply logical grounds might serve to effect *strategic* erasures, since intellectual property protection does get used by otherwise disenfranchised groups to stake claims not just to monetary rewards but also to control over research agendas. The debate on the desirability of gene patents often looks very different, and much more complicated, than an unreflexive politics for the preservation of the public domain might anticipate. We are forced to reflect again when the major *proponents* of an IP regime are members of a patient advocacy group (for example, PXE International) who are struggling to get just enough control over biotech research agendas so as to push biotech companies into researching a rare disease that would otherwise get no attention, and its major *opponents* are big multinational pharmaceutical companies, for whom gene sequence information isn't the primary locus of value, and whose desire to do away with gene patents has no impact whatsoever on their position regarding drug patents. These latter ultimately are the form of intellectual property that most directly translates into unaffordable drug prices for a majority of the world's population.

A major institutional feature that deserves political response – and that arguably *defines* venture science – is the issue of the increased cohabitation of academic and industrial technoscience worlds. On the one hand, again, I feel extremely uncomfortable about the easy naturalization of the corporatization of academic research, that is especially marked in a place like MIT, which sometimes seems to me to frame itself as existing solely *in order to* provide the space for enabling discoveries that then get transferred to private companies rather than

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Charles Weiner: for helping me think through issues relating to bioethics.

remaining accessible through the public domain. I also believe that it is important for academic centers to do science that doesn't have a corporate agenda, if only because that is the only way such enabling discoveries for subsequent market development can keep happening. On the other hand, I am also suspicious of an ivory tower academic mentality that disdains industrial science as somehow corrupting and necessarily corrupt, not just because such an attitude smacks of arrogance and ignorance, but because it is also reflective of a discomfort with inter-disciplinarity and boundary crossing, fostering both of which are central to the epistemological and political agenda of inter-disciplines like STS, and both of which have, it must be admitted, been attempted with much greater imagination by industry than by academe.

The fourth political "theme" has to do with reinventing democracy and notions of accountability through role models. What politically ought to be the task of broadly "left" oriented critical thinkers is not just to make science better, but to make it more democratic and publicly accountable. As suggested above, this is one of the scariest and most tangible potential dangers of over-corporatization: not just a loss of material or information or property from the public domain, but the loss of certain forms of *discourse*, of the sorts of dialogic polyphony that shouldn't always have to translate into consensus for it to be productive of better science and better civic society. Excessive corporatization of the academic environment does, as Sheldon Krimsky says, lead to a loss of capacity for social criticism.

There are role models to look for, who might provide alternative ways of doing and thinking science, and finding such role models could be an exciting consequence of ethnographic investigation. Such role models, when they are found, are necessarily imperfect, agenda driven people who might have politics or values that the ethnographer feels deeply uncomfortable with, or ambivalent about. Certainly, I ascribe no perfection, in any sense, to the two actors in my dissertation, Sunil Maulik and S.K. Brahmachari, who I do think provide certain types of role models in my eyes. I think they are important because they think venture science in alternative

ways. They are both invested in the corporate world, invested in money and fame, and, to varying degrees subscribe to genetically determinist views of the world, they are also powerful and by no means subaltern voices. But by contributing to the dialogic polyphony that I yearn for, they do open up the possibilities for new forms of representation, for new inter-disciplinary spaces that involve crossing boundaries, for the *de*naturalization of venture science as something that is always already a given. People like these two open up new political terrains as they open up new scientific possibilities, and I think my last political theme in essence is also reflective of a question of ethnographic ethics: namely, that it is impossible to generate truly sustained and meaningful critique through ethnography without being genuinely (though not blindly or unreflexively) respectful of the subjects of one's study, even if they do occupy what might politically seem adversarial positions to the ethnographer's own.

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1.3. Outline of dissertation

As Marx always implied, understanding capitalism involves understanding its science (political economy / information economy), its religion (a Weberian Protestant ethic, but also the modes by which a certain scientific-economic formulation becomes legitimately authoritative) and its magic (surplus value / the generation of emergent forms of life). As already noted, I contend in this dissertation, through each of my chapters, with five key sets of theoretical issues: speed and information; ownership and ethics; vision and hype; nation and salvation; and risk and subjectivity.

The first question to ask when tracing any emergent phenomenon is: what's really new here? The first thing that is new is that life-as-information is transformed through genomics into commodifiable, material reality. The second is the *speed* at which the science is being done and information produced. Indeed, many of the changes that genomics brings about are not new conceptually. However, their realization is made possible because of technological advancements.

The key here is *automation* and *high-throughputness*, as biology becomes an *industrialized, process-driven* science.

Speed is of both material and rhetorical value. A blockbuster drug can generate revenues for a pharmaceutical company of $3-4 billion a year. Therefore, goes the rhetoric, a delay in bringing a possible blockbuster drug to market (and of course, any drug that is being brought to market, it is hoped, will be a blockbuster drug) costs the pharmaceutical company potential revenues of about a million dollars a *day*. This is the material justification made for constant speed within the industry, where daily delays are calculated as huge possible losses in an endeavor that usually takes up to 15 years from initial R & D to market launch. But speed is also a rhetorical fulcrum, integral to the operation of hype and the making secondary of ethical issues and considerations, to lever the government, venture capitalists and the public to further invest themselves in biotech.

Therefore, speed is dictated by "market logic". However, market logic also propounds ownership as desirable, legitimate and logical. My argument is Chapter 4 traces the speed bumps predictably encountered in biocapitalism because of the speedy trajectories of genomics being tempered by a market system that allows things to be owned. There are contradictions in the capitalist system that lead to a frictioned process, a friction which isn't just obstructive but intensely productive, of new ways of doing things, strategic ways to deal with ownership and so on. In other words, the very constituents of capitalist dynamics, such as market logic, operate to some degree in countervalence to one another.

Chapter 5 on ownership goes more deeply into the host of intellectual property issues that arise all the way through genomic drug development, but focuses most specifically on the ownership of genomic material and information, and the relationship between these two sets of genomic "things" that have related but distinct social lives and ownership politics. I specifically talk about the contested commodity status of these various genomic things as they undertake

travels that are invariably global, and outline some of the strategic and policy initiatives that the Indian government, in particular, is considering in regulating the flow of genetic material from its territory. In the process, questions come up not just around property, but also around the nation-state: its jurisdiction, its boundaries and its assumption of being the representative of its peoples' genetic material. This is, of course, set in a larger context of globalization and economic liberalization, which sees the Indian state framing itself in ways very different from the way the anti-imperialist Indian nation-state framed itself in relation to the West for much of India's post-Independence history until the 1990s.

Chapter 6 theorizes vision and hype. Genomics, as I have mentioned, is venture science, through which a certain form of corporatization is not just effected, but also very quickly naturalized and legitimated. My argument in this chapter is that biotechnology is a game which is constantly played in the future in order to generate a present that enables one to go into that future. It is not dissimilar, in this regard, from the dot com economy, but this dynamic has marked the biotech industry since its inception in the late 1970s. By definition, biotech companies can only operate on promise, because of the time scales of drug development and the capital intensivity of the process.

But vision is also a part of the symbolic capital of biotech, which is in the business of, to quote Monsanto's logo, Food, Health and Hope (™). I argue in Chapter 7 that the promises of biocapital are intensely messianic. What interests me here is to trace how vision gets articulated through different underlying belief-systems in the US and India that drive the vision in different ways. In the US, as mentioned above, this vision is theological and messianic, and is the subject of my section titled "The Born-Again Ethic and the Spirit of Venture Capitalism?".

On the one hand, the performativity of futuristic discourse around biotech in the US takes on messianic overtones. On the other, there are embodied perspectives on biotech as visionary practice, that I explore in particular through my story of Patrick Terry and the patient advocacy

group that he has founded, PXE International. For people like Terry, who is himself a devout Christian, the promises of biotech are not utopian in some general sense of being the route to the realization of health, wealth and happiness; biotech contains salvationary hopes that are intensely subjective, and that have everything to do with his own family, his own children. Indeed, Terry's trust in Randy Scott, with whom he has co-founded a biotech company, stems from Scott's own devout Christian values, which again are embodied in the suffering of people Scott himself knows rather than in some abstract notion that therapeutic development is a good thing and a virtuous business.

In India, on the other hand, nationalism is the predominant underlying visionary belief-system, in the context of a larger transformation of nationalist consciousness away from Nehruvian secular nationalism towards the ruling Bharatiya Janata Party (BJP)'s Hindu cultural nationalism. Once again, nationalist technoscientific vision gets articulated in a number of ways. The first is at a policy level, where a major Hindutva ideologue, Murli Manohar Joshi, is India's Minister for Science and Technology. He is in the process of drafting India's first science policy document since 1958, which was written by Nehru himself with the famous atomic physicist Homi Bhabha. Much of the genesis of the present policy document is taking place at the Centre for Biochemical Technology (CBT), Delhi, India's flagship public sector genome laboratory, and I will draw upon my fieldwork there to talk about it. It is not coincidental, of course, that the 1958 document was largely authored by an atomic physicist, while the 2002 document is largely authored by a genome scientist.[18]

Secondly, this nationalist vision nicely articulates the tension between a New World Order definition of "national" prowess as being indicated by global competetiveness (the successful mimesis of the West as being the ultimate signifier of the "Third World" country's

[18] One is reminded here of Donna Haraway's diagnostic epigraph "Transuranic elements: Transgenic organisms :: Cold War: New World Order" (Haraway 1997: 52-63), which dutifully plays out in India as well.

national worth) and an anti-imperialist rendering of "national" interests as being the protection of "Indian" genetic material from Western expropriation. This tension perfectly mirrors that within the Hindu Right, which wants to be an aggressive global free market player while protecting what is "essentially" Indian.

Thirdly, this vision portrays personal nationalism and patriotism among scientists, for whom such sentiments are a part of a personal and scientific identity that is marked by a decision to either stay back in India or return after doing research in the West. It is very much more common for the best biological scientists to move to and settle down in the West after initial training in India (usually at the expense of the state).

In my final chapter, I talk about personalized medicine, which in many ways is the "ultimate" aim of genomics. Personalized medicine is the ability to make therapeutics that are ideally tailored to each individual. The hype that surrounds personalized medicine suggests that one can find genes responsible for diseases, find molecules that can target the gene when diseased, and fix it. This is not just a popular perception: this is the view of companies with a certain type of business model that is based on genetic target identification. Therefore, this articulation of genomics fits well for them, because they are in the business of finding targets to tinker with and "fix".

I trace the construction of the promise of personalized medicine through the hype surrounding it, and through its co-production with a variety of upstream business models to show how in reality what "personalized medicine" is becoming, as a consequence of genomics being venture science, is a combination of pharmacogenomics (tailoring drugs that already exist for optimal response in different patients) and predictive diagnostic testing, rather than a novel means of individually targeted *de novo* therapeutic development. I finally suggest how, in a post-genomic world with many diagnostic capabilities and many fewer corresponding therapeutic availabilities, genomic information translates into scientific fact to constitute the subjectivity of

consumers – as patients-in-waiting, and patients as consumers-in-waiting. In the process, I theorize the emergence of *risk* as the defining heuristic around which biocapital as a value-generating enterprise interpellates individuals as polymorphic subjects (themselves always already at risk of future illness) along with the fetishization of genomic information *as* scientific fact. This is, ultimately, an attempt to theorize the modes of abstraction of biocapital, and to understand how the magic of biocapital operates.

CHAPTER 2: ETHNOGRAPHY AND PRAXIS

The challenge of understanding political economic structures through ethnographic methods is one that has been highlighted by George Marcus and Michael Fischer as being central to anthropology's current "experimental moment" (Marcus and Fischer 1986). I explore some of these challenges as encountered in this project by considering multi-sited ethnography as a conceptual topology for exploring stratified political economic emergences, and explaining my choice of field-sites through such a conceptual lens. I do so, initially, through multiple re-readings of Clifford Geertz's *Interpretation of Cultures* (Geertz 1973) , a necessary starting point because of his call for thick description as the method through which to realize a program of interpretive anthropology, but equally a productive starting point because he has not himself dealt with some of the contradictions flowing from following through his own program.

Some of the issues that I highlight through a critique of Geertz that become central to my own ethnographic and narrative practice are as follows. Firstly, there is Geertz's positivism with respect to science in his reading of religion that STS as a discipline has taken avoided as fundamental to its practice of knowledge production. Secondly, there is the importance, in projects such as mine, of polyphony, which is subsumed in Geertz's "thickness", which ultimately seems to represent a synoptic cultural view. Thirdly, there are questions of ethnographic complicity and heterogenous collaborations, leading to vexed politics of access. These transactional relationships with the subjects of one's research are never adequately problematized in Geertz. Fourthly, for Geertz, the question of critique doesn't arise in the way it does for me, because his synoptic view presented through thick description is a re-presentation (as in portrait of the culture under study). In projects such as mine, the politics of representation is very much more in the sense of representation as proxy (for the necessity of staying attentive to the distinction between these two forms of re(-)presentation, *vertreten* versus *darstellen* in Marx, for any form of critique that claims to "speak for" others, see Spivak 1988). This latter sense of

representation is necessarily an intervention, and it is representation that is necessarily incomplete. The challenge of such representation is to retain the ability to be judgemental without falling prey to the tendency to pre-judge.

It therefore becomes difficult to talk about methodology in ethnography without blurring the boundaries between theory and method. To the extent that I talk about the sets of methodologies that I have employed in this project, I attempt to do so as theoretical interventions.

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2.1. Thick Description

Thick description was a mode of ethnography famously articulated by Clifford Geertz (1973). Particularly useful to an analysis of biocapital is the way Geertz applies it to an analysis of religion as a cultural system. I use Geertz's analysis of religion as a cultural system as a methodological guide with the help of which one can interpret other belief structures, like science (and indeed also as a narrative guide when one is confronted with the task of writing about these structures). These are belief structures that function in the world as common-sense, and that engage both authority and ritual. Geertz's reification of the *scientific* as a somehow distinct and unquestioningly Baconian form of common-sense in opposition to the religious may be challenged: we could productively argue instead that religious common-sense and scientific common-sense operate in the same objective or social spaces. This is not to equate science and religion, but rather to say, firstly, that both science and religion depend upon certain ritualized performances (which in the case of the former, gets operationalized and reified as "scientific method") and ideological conceptions of legitimacy in order to be authoritative. Belief systems of all kinds have this in common: they are neither seamlessly self-confirming, nor are they totalizing, and they require careful mapping if they are to be made sense of in situated fashion. This is where Geertz's methodological lessons become even more important rather than less. What a thick description of biocapital is called upon to be, if it is to follow these lessons, is a

careful tracing of the multiplicities of rituals and reliances upon authorities and institutional structures (which include markets, legal regimes such as those codified in intellectual property law, the state, conventions of scientific bodies, and so on).

Geertz's own definition of religion is: "*(1) A system of symbols which acts to (2) establish powerful, pervasive, and long-lasting moods and motivations in men by (3) formulating conceptions of a general order of existence and (4) clothing these conceptions with such an aura of factuality that (5) the moods and motivations seem uniquely realistic*" (Geertz 1973: 90, emphasis in original). The methodological utility of such a mode of description is that it manages to be descriptive without being definitive or exclusionary.

The question that comes out of this definition is that of religious belief. Belief, which is fundamentally a question of the modes of transformation of consciousness, remains as fundamental to a contemporary globalizing knowledge regime as it was for an understanding of class formation in the nineteenth century. Geertz's answer is that "it is best to begin any approach to this issue with frank recognition that religious belief involves not a Baconian induction from everyday experience -- for then we should all be agnostics -- but rather a prior acceptance of authority which transforms that experience" (Geertz 1973: 109). The first step then is tracing belief to a pre-existing authority. But the question that remains is how that authority became authoritative. In trying to understand what is widely called "the religious perspective", one comes up against two questions:

1. What *is* the religious perspective, as distinct from other perspectives (common-sense, scientific, aesthetic)?

2. How do human beings come to adopt it?

As we shall see, this is a form of questioning that can be of great relevance in understanding the formation of subjectivities by and through scientific fact.

The essence of religion is complex symbolism combined with authority that is generated *in ritual*. It is in ritual that "the world as lived and the world as imagined, fused under the agency of a single set of symbolic forms, turn out to be the same world, producing thus that idiosyncratic transformation in one's sense of reality" (Geertz 1973: 112). The most important and effective rituals operate as full-blown cultural performances.

Geertz himself tends to reify and make static the "scientific perspective", which marks an interesting blind-spot in an interpreter of cultures. Nonetheless, methodologically, Geertz calls into focus the importance of understanding any form of production, including (indeed, necessarily) scientific production, not just in institutionalized and demarcated laboratory spaces and settings (though understanding the functioning of authority that emanates from such demarcation is undoubtedly vital), but as a part of the totality of everyday social experience, and also as something that is produced through ritualized modes of *performance*. (In my investigation of biocapital, such performances will be enacted at sites like journal articles, conferences, investor presentations and press releases). Says Geertz: "The acceptance of authority that underlies the religious perspective that the ritual embodies thus flows from the enactment of the ritual itself" (Geertz 1973: 118).

Geertz thus talks about the becoming of religious common-sense: "this placing of proximate acts in ultimate contexts...makes religion, frequently at least, socially so powerful. It alters, often radically, the whole landscape presented to common sense, alters it in such a way that the moods and motivations induced by religious practice seem themselves supremely practical, the only sensible ones to adopt given the way things 'really' are" (Geertz 1973: 122).

What Geertz achieves is a location of religion as simultaneously a common-sensical *knowledge* of social life and as a set of practices that mark this knowledge as supremely authoritative. It is an imbrication of the inherent and essential force of a form of life with a set of ritualized or strategic (but always dynamic) practices that leads to the creation of subjectivities, if

subjectivities can be explained as expressions of consciousness of selves. Subjectivities are created by the internalization that certain knowledge - belief systems are authoritative / true / legitimate / natural / desirable. In addition, capitalism requires the internalization of the authoritative / true / legitimate / natural / desirable nature of commodification. Biocapital emerges at the articulations of the knowledge - belief systems of biology (operating as a scientific, and therefore legitimate, knowledge - belief system) and capitalism, each in turn being affected in its own emergence by the contingencies imposed by the other. The mechanisms of internalization of both knowledge - belief systems involve both ritualized performance and tactical improvization, acts in the world that constantly destabilize each other's authority / truth / legitimacy / naturality / desirability as much as they instantiate and reify them. It is this tension, marked by contingency though certainly not by indeterminacy, that marks an emergent moment as distinct from the bounded and fixed culture that serves as the subject of anthropological enquiry even, ultimately, for Geertz.

There is a second reason, beyond the methodological, why I refer to the particular essay of religion as a cultural system. I will flag this second reason here, and return to it in detail in Chapter 7. This is that science and capitalism, especially their co-production of venture science, partake significantly of a Christian, or broadly theological, discourse. We see this in two aspects of their formation. First, there is Weber's description of Protestantism as one of the causes for early industrial capitalist investment, and for the work ethic of the labor force at particular points in the stratification system (Weber 2001 [1930]); this is the understanding to which I quite obviously owe the title of section 6.1, "The Born-Again Ethic and the Spirit of Venture Capitalism?". And second, there is the similarity of the belief-systems constituted by science, religion and capitalism. While these may be at odds in the *content* of the belief they impart, they are eerily similar in the *form* of belief they depend upon and bring about.

Of course, there is a difficulty in reducing religion to either Weberian or Geertzian formulations, because religion isn't one thing, and has many definitions and manifestations. The visionary nature of venture science, which I talk about in Chapter 6, is, especially as it applies to biotech, entirely messianic. For instance, strong resonances may be found between my work on biotech entrepreneurs, especially in the United States, and Susan Harding's on born-again Christians (Harding 2000). I will therefore return in the body of my thesis to "Religion as a Cultural System" in more ways than the simply methodological.

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2.2. Multi-sited ethnography

The immediate assumption that many contemporary "experimental" ethnographies challenge is the assumption of locality. George Marcus and Michael Fischer have argued for the necessity of multi-sited ethnography as a conceptual topology through which to track an increasingly mobile and inter-connected globalized emergent world (Marcus and Fischer 1986). A common misreading of multi-sited ethnography is the literalist one of assuming that it is simply a quantitative multiple of single-sited ethnography, now performed at many places. Such an understanding assumes that multi-sited ethnography perforce asks the same questions of the known and demarcated locality that traditional ethnography disciplinarily based itself on. Multi-sited ethnography can certainly ask the same questions, but it cannot ask them in the same way, a way that assumes an exact correspondence between the *place* being described and the sets of "objects" issuing therefrom that are being written about.

The issue, in other words, is that the questions "*where* am I writing about?" and "*what* am I writing about?" have ceased to remain the same question. This is not simply the consequence of a fashionably "postmodern" or "experimental" ethnographic style: it is a necessary consequence of tracking processes of globalization, of which after all biotechnology is one example.

To talk about the politics of using multi-sited ethnography to study a globalizing phenomenon, let me turn to Michael Fischer's analyses of religion, that remain faithful to Geertz while moving Geertzian parameters, conceptually, methodologically and politically.

Debating Muslims (Fischer and Abedi 1990) explicitly embodies some of the key features of *Anthropology as Cultural Critique*: firstly, an attentiveness to different *genres* of storytelling and the relationship between them; and secondly, the use made of cultural idioms, concepts, tropes and discourse, not just as objects to be studied but as epistemological guides. This is where Fischer expounds the term critical hermeneutics, which is not just a hermeneutics of suspicion, but is, importantly, *dialogic*.

There is, again, a politics to emphasize in an endeavor that seeks to understand religion in a dialogic fashion rather than through monolog(ic writing). This politics is not just a Derridean politics of suspicion of the violence of writing, but is equally a Bakhtinian politics of polyphony rather than a single authoritative voice. This is a politics that opens up spaces for articulation and transgression rather than closing them down: therefore, the particular salience of the word *debating*, in the title and to the project.

What lessons, then, do multi-sited works such as *Debating Muslims* have, for devising methodology and for intervening in politically reflexive and strategic ways *as* anthropologists?

Firstly, these works teach us that "multi-sitedness", as mentioned earlier, is a topology and not a literalist dictum. This means that the multiplicity of sites could be temporal as much as spatial, and there is a decentering of the authenticity of the physically present source during the anthropologist's encounter with the culture under study. Storytelling and different narrative forms become crucial informants, but it is always important to stay attentive to the genres that these narratives inhabit and the way they relate to each other in order to understand the stories they tell.

Secondly, Fischer inverts Geertz's problematic understanding of cultures as texts awaiting interpretation by using texts as particular symbols of cultural expression.

Thirdly, the anthropologist's own presence is much more uncertain, fragmented and unstable – and therefore demanding of reflexive theorization – than for Geertz, who successfully "penetrates" Balinese culture in his famous flight from the police when they raid a cockfight (Geertz 1973: 412-417). Fischer's locational politics are poignantly highlighted by post-revolution Iran, where physical travel itself gets authoritatively circumscribed in ways beyond the anthropologist's control.

Fourthly, religion for Fischer ultimately is a polyphony, whereas in Geertz, it crystallizes into the moment of the ritual, as described in his colorful portrayal of the Rangda-Barong ritual (Geertz 1973: 114-118).

This dissertation reflects challenges analogous to the ones Fischer faces and highlights. Doing ethnographies in corporate environments quite literally involves negotiating a minefield of access issues, and an anthropologist's travels are seriously and constantly circumscribed by her informants (or their lawyers). Physical presence is always already further decentered in online ethnographic contexts, where conversations often occur much beyond the "ethnographic encounter", and where informants themselves are hugely mobile – which means that it might actually be easier to meet with the CEO of a San Francisco based company in Boston than in San Francisco. Written sources are a terrific source of information, especially regarding sites where physical access if difficult or impossible, but constant attention needs to be paid to the "origin stories" of these sources, that are often significantly crafted or influenced by corporate public relations apparati (whether they be annual reports, press releases or even "objective" journalistic accounts). Finally, while technoscience, like religion, operates in supremely authoritative and legitimate ways, one of the values of ethnography is to highlight its polyphony: corporate technoscience is neither the seamless embodiment of progress that its official discourse would

suggest, but nor is it a supremely cynical, money-grubbing exercise at the expense of "higher" norms or values, as many academics and activists on what might broadly be termed the left are quite ready to believe. (En)countering corporate technoscience requires respect for the multiple, often contradictory, voices that go into its creation and sustenance.

I have visited a number of sites in the course of this thesis, and I document and talk about them in a subsequent section. I use one, however, as an emblematic ethnographic site through which to locate the broader sets of theoretical issues concerning biocapital that I talk about in this thesis. This might be a controversial choice, and certainly there are perhaps other sites that could have served this function just as well; maybe even better, or more "authentically", for the start-up I write about is not even a biotech start-up. Certainly the perspective that I provide from this company is very much a situated perspective, and is only one situated perspective of many that I have in this thesis. I think, however, that it might be the most important.

Situated perspectives serve a political function, as Donna Haraway has forcefully argued (Haraway 1989). In anthropology, even more so, and the importance of reflexively situating the perspective that one is writing from and about (which may or may not be the same thing) is increasingly obvious. This is accentuated by the fact that in this thesis I choose to investigate the systems of techno-capitalism from the inside: trying to get into the belly of the corporate beast that I have politically often thought about adversarially. The ethnographic challenge here is to be able to narrate my multiple (usually corporate) subjects' perspectives with respect and understanding without abandoning the right, or the ability, to be critical. It's hard.

GeneEd, one of the sites I chose for a slightly longer-term, targeted period of participant observation, provides situated perspectives on the drug development marketplace, on Silicon Valley, on entrepreneurship and on Indian diasporic trajectories. My stories of these can be read as a supplement to the main "body" of the thesis, independent of it, or not at all. It is meant to be one running commentary on the worlds that I explore in this work, but is not intended as a distraction.

GeneEd is an e-learning start-up that provides online genomics and biology courses to biotech and pharmceutical companies. A start-up is an emergent form of life in both senses of the term as I have outlined above: it is both an emergent entity, and an emergent sociality of action. The question of corporate identity -- what, or who, or who all, constitute(s) a corporation -- troubles me throughout this thesis. A start-up allows some insights into a definition. Start-ups, literally, are emergent entities: every day that they survive is a triumph, often against odds; their days are numbered, quite literally, by the amount of cash they have left in the bank.

GeneEd was conceived in the early 1990s, to the extent that its co-founder Sunil Maulik conceived, even before the existence of the world wide web, of the possibilities of using the computer to teach science. Born in Bombay, Maulik grew up in England, where he studied biology before moving to Brandeis University for a PhD. After his degree, he moved in the late 1980s to Silicon Valley to join a company called Intelligenetics. Intelligenetics was a "bioinformatics" company before bioinformatics existed. His contemporaries at Brandeis thought he was crazy. It was still relatively unusual to leave academics to do research in a company at that time; but more than that, who would ever do biology in a company that only had computers? From Intelligenetics, Maulik moved through a series of other companies, before ending up at Pangea Systems (later Doubletwist).

It was during this time that Maulik met Salil Patel. Of Indian descent, Patel spent his early childhood in Uganda, before his family became one of the many Ugandan Indian refugee families who moved to England because of their persecution at the hands of Idi Amin. In England, Patel grew up with many other refugee families in Greenham Common, the site of a United States Air Force base made famous by anti-nuclear demonstrators through the 1980s. Patel did a Ph.D. at Stanford and a post-doc at Caltech, before joining a biotech firm to do research on angiogenesis in order to develop gene therapy.

In his spare time, Maulik used to teach seminars on bioinformatics, often at evening colleges and University extension schools, and once they became friends Patel would occasionally stand in for him. They both shared and developed together a love for teaching, that blossomed into Maulik's mind as a corporate

opportunity. Bioinformatics was just becoming big; it would be the future. Why not start a company to teach bioinformatics? And why not teach it on the web, in order to reach a really wide audience?

It was easy for Maulik to think of leaving a job to start his own company. He typified the Silicon Valley entrepreneur. Divorced, he did have a child to support, but not a traditional nuclear family structure to seriously disrupt by the manic commitment and insane risk that any entrepreneurial activity entails. In any case, Maulik, again fitting the Silicon Valley stereotype made famous by Jim Clark (the founder of Netscape), was someone who dared to think differently. A friend and GeneEd investor, when asked why he invested in GeneEd, was very clear that it was Maulik's personality -- epitomized for him by his memorable (and invariably bare-chested) presence at parties -- that gave him the confidence that his money was being soundly wagered. Maulik is extroverted and fun-loving, and he loves talking about his ideas for a company -- precisely the sort of person financial communities in any other place and at any other time in history would have most immediately run away from. In Silicon Valley, he was perfect CEO material.

It was a lot harder for Patel to leave his job and jump into the world of entrepreneurial unknowns. In addition to the commitments of marriage, he had grown up being a scientist: relatively shy, passionately committed to his research, and not, in his own mind, at all an entrepreneur. Only his friendship with Maulik and his love of teaching made him even seriously consider jumping ship. GeneEd, therefore, was founded and incorporated as far back as 1997, but really remained in a state of purgatory for the next couple of years, as Maulik and Patel balanced their new company with their existing jobs. During this time, in Maulik's terms, GeneEd lacked the "activation energy" to function as a real company doing real business on its own.

Starting a company is such an insane business that it usually requires some form of crisis to make the risk worthwhile. For Patel, it was a progressive disenchantment with his current employer, a disenchantment that really stemmed from the type of scientist that he was. Patel has a firm belief in science -- in the truths it provides, and in the ways it must be performed -- that harkens back to an era of positivism and Mertonian normativity, an ethos that seems strangely out of place in today's postmodern venture science environment that thrives on the ability to be cynical. Patel's almost myopic principle that science is

about the quest for truth encountered considerable friction from the everyday activities of an aggressive biotech company. The difference in value-systems between Mertonian academic science (such as it exists) and corporate venture science, as I will assert again later in the thesis, is that the onus shifts away from truth and towards credibility in the latter: corporate biotechnology research becomes almost inseparably intertwined with corporate PR.

Patel in any case was not terribly happy with the way his company was managed, an unhappiness that clearly proved to be a learning experience as he moved to become a manager of a company himself. He was involved in gene therapy work that was constructed as the flagship project of the company, and yet he was given meager resources and only four researchers under him. After a year of working on his project, his team reported generally negative results, which he took to the management, advising them to drop the project altogether. The next day, the company put out a press release announcing the stunning advances they had made towards gene therapy, using as examples the sorts of seriously troubled projects such as Patel's that the company was actually pursuing (or considering to not pursue further). Their public relations stunt got them the desired publicity and allowed their stock prices to shoot through the roof at a time when stock markets were highly responsive to the slightest hint of promise. In Patel's belief system, however, this piece of what in many circles might be admired as clever marketing was nothing other than scientific fraud. His disenchantment, increasingly, was not just with the way the company was being managed, it was with the form of life that the company stood for. Maulik's entreaties to join him were looking more and more attractive. What finally gave him the courage to make the jump was the support of his wife Tejal, who insisted that he should do what gave him satisfaction, rather than simply what brought home the proverbial bacon.

Maulik, meanwhile, was running GeneEd by John Couch, the CEO of Pangea, where he was now in charge of business development, and was generally getting Couch's blessings. As far as Couch was concerned, anyone who could go out and educate other biotech / pharmaceutical executives about bioinformatics was in effect creating informed customers for companies like Pangea. By December 22,

1999, the company incorporated two years previously had slowly gathered enough momentum to appear ready to go on the road. Maulik had been promised money by venture capitalists, and had made eight job offers. On this day, he threw a party for the new employees, to celebrate the "beginning" of GeneEd.

The real beginning, according to both Maulik and Patel, happened neither when GeneEd was incorporated, nor when they made these initial hires, but on the day after that party, on December 23, when Maulik, in the midst of a hangover, was informed by the venture capitalists who had promised him funding that they had decided, after all, not to give it to him. This was the crisis that provided Maulik with the activation energy to really get GeneEd started, as he was faced with no money and eight employees as a single parent who had maxed out four credit cards. The option remained to return to Pangea and resume his job there; but the withdrawal of the VCs' commitment, more than ever, made Maulik determined to convert what he was by now convinced was a very good idea into reality.

Over the next few weeks, Maulik went into money raising frenzy. He called up a couple of his friends who had struck gold in the dot com boom and who were toying with the idea of doing some angel investing (this being a particular form of "benevolent" investing that is contrasted to venture capitalism in the generally smaller amounts invested, with the generally lower expectations on the part of the investors of incredibly high returns on their investments. Venture capitalists, ideally, like a 60-70% return on their investment, and usually take over a significant chunk of the company from the founders in return for their largesse). His friends asked him if he needed money in the next few months. No, said Maulik, he needed it in the next few days. Meanwhile, Maulik was on the road trying to sell what GeneEd had to offer in terms of products, and was receiving expressions of interest from biotech companies like Celera Genomics. Maulik also approached Celera's Silicon Valley rival Incyte, not just as a customer but as an investor. Like John Couch at Pangea, the management at Incyte was enamored of the idea of a company that would effectively be educating the industry about products it made and services it offered, and agreed to invest $500,000 in GeneEd.

One Saturday morning, when Maulik was spending time with his mother, he received a call from a friend saying that he should make a pitch to Ernest Mario, CEO of Alza Corporation, a Silicon Valley biotech company (since bought by Johnson and Johnson) that makes improved drug delivery systems. Getting an appointment from Mario for that very afternoon, Maulik drove unshaven to Alza's headquarters. He strolled through Alza's spacious, fountain-bedecked grounds into Mario's huge executive suite and talked him into investing another $500,000 into GeneEd. Within the next few weeks, Maulik, who was really looking for about $500,000 in total to get his company going, had two and a quarter million dollars, and not a cent of it venture capital money. His failure to obtain venture capital funding has had serious long-term consequences for GeneEd's corporate culture, allowing it to be molded by the personalities of the management and employees, but also making it acutely dependent on constant sales in order to stay afloat: the sort of desperate fiscal discipline and pressure to produce, innovate and sell that most dot coms, flush with millions of dollars of venture capital money, never had to deal with.

I will talk about some of these pressures, and the culture they have given birth to, at subsequent points through this thesis. For the time being, however, GeneEd had emerged.

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2.3. Field sites and reflections on field work

The field sites that I have chosen are a reflection of the "objects" that I have followed around. These objects include information, drugs and health. Each of these objects has distinct notions of temporality associated with them. Information, particularly as it pertains to DNA sequences, is, among many things, the enabler of "rational" drug development (this does not mean that sequence information will necessarily enable the successful development of new therapeutics; what it does mean is that it will enable a rational *process* of drug development, whose outcomes, nonetheless, will remain uncertain). In other words, sequence information is drug in-formation, information here assuming a transitory space towards future possibilities rather in the way Alberto Melucci describes information in his formulation of new social movement

theory (Melucci 1996). Drugs are temporally oriented towards the present (and indeed, ethically oriented towards the present as in gift, drugs being discursively articulated through corporate public relations instruments as the "gift" of the genius and industry of pharmaceutical companies that undergo high-risk, decade-long drug development ventures in the cause of Food, Health and Hope). Health meanwhile is salvationary, and is oriented almost by definition towards a utopian future.

Each of these three objects also has different symbolisms associated with them. Information is science: it is, indeed what the science of biology has become, an information science; or so, again, goes the discourse. Drugs are magic: they are the colorful black-boxed pills that we can all pop and get better on. The salvationary utopia that constitutes Health is messianic and religious. In following the set of "objects" that get constituted by information, drugs and health, I am in effect tracing the complex imbrication of science, magic and religion in contemporary capitalism.

Igor Kopytoff has forcefully argued for the social life of things (Kopytoff 1986). This thesis is *not* the social life of a drug in a post-genomic world, and those are not the circulations that this project traces through its choice of field-sites. Rather, this thesis is about the *imaginary* life of a drug, as it morphs between information, pill and Health. These transformations reflect the epistemic shift that genomics marks in the first place, as it shifts the primary site of articulation of bioscience from drugs to information. They also reflect the institutional shifts that genomics partakes in, shifts that portray the corporatization of life sciences as natural.

So what are all these people who I am studying constructing? Are they constructing one object? Reading this as tracing a *social* life of a drug might imply that they are; understanding this as tracing the *imaginary* life of a drug makes it clear that they can't possibly be, even though, in some sense, they're all involved in the same enterprise, however they might approach it and

whatever their politics towards it might be. What is biotechnology? Is biotechnology a boundary object (Star and Griesemer 1989)? Is biotechnology capital?

These are not questions that I arrive at answers to; they are questions, however, that I constantly ask throughout this thesis. What is clear, however, is that materials, people, money and information are all flowing, at and through each of the sites I study. I am not interested, therefore, in tracing the culture *of* particular sites, even though what might be read as "cultural" stories of them are variously embedded through the thesis. What I am interested in tracing are the multiple exchange relations *between* these sites. The sites that I outline, therefore, are not studied in and of themselves as reified, static or solitary entities, but are rather studied for their place, and articulations, as nodes of multiple sorts of exchange. I believe that it is by enabling such studies *about* a system *through* a set of interacting locales that multi-sited ethnography, as a conceptual topology, is *not* simply about going to many different sites and comparing them to one another.

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In my fieldwork, I have adopted a six-pronged approach: intensive, medium-length participant-observation (1-2 months per site); short targeted "probes" (1-2 day site visits); on-going monitoring of written products of the drug development marketplace; semi-structured, multiple, life history and career development interviewing; use of scientific conferences and trade shows as ritual spaces for seeing many of the promotional, competitive and status constituents enacted and renegotiated; and seminars that I gave at one of my sites, GeneEd, which emerged as an ethnographer's variant of a focus group technology. In the process, I have physically covered a number of sites in the US (mainly around Boston and the Bay Area) and in India. The list of sites at which I have undertaken field work is outlined in Appendix 1.

Alongside the "body" of my thesis, then, runs the stories of two major field sites at which I undertook targeted participant observation of a few weeks to a few months, GeneEd (a San

Francisco based e-learning start-up) and the Centre for Biochemical Technology (India's flagship public sector genome lab).

A standard question that the choice of these sites would generate would be how they are in any way representative of genomics, and how indeed I could write a "real" history of an emergent present from what are at best peripheral sites. My response would be that these are both fascinating ethnographic sites in and of themselves, and fascinating vantage points onto the processes I'm studying. While they may be "peripheral", they are sites that are deeply invested in the marketplace I'm studying, and certainly start-ups and "Third World" countries significantly impact and shape drug development marketplace agendas. These sites are not just interesting, but reflective of the fact that *place matters*, as they highlight the insights that ethnography can provide onto political economic systems.

The first of these sites is GeneEd, a San Francisco based e-learning start-up that provides web-based multi-media courses for biotech executives. There are a number of reasons why I believe GeneEd, more than almost any other place I have studied, provides a complex set of embodied perspectives on the systems and phenomena that I am trying to study.

GeneEd sells its courses both to small biotech and large pharmaceutical companies. It is, therefore, extremely invested in the drug development marketplace, which, at the end of the day, is the "space" that I am trying to elucidate myself. Of course, GeneEd is by no means a "neutral" or "impartial" observer: no situated observer can be, and I am trying to capture neither an "objective" view of the marketplace nor one that mirrors my own. By selling to both small and large, biotech and pharma, upstream and downstream companies, however, GeneEd's worldview is less self-refractory than those of biotech / pharma companies themselves, who tend to view marketplaces and market logics very much through a situated perspective that discursively constructs terrains and logics as *only* capable of being the way they see it. One of my arguments throughout this thesis is that capitalism draws its sustenance, and encounters its resistance, from

the multiple contradictions of the marketplace; for biocapital, a lot of those contradictions play out between biotech and pharmaceutical companies. GeneEd is able to "see" those contradictions in a more complete, though by no means less self-interested, manner than many companies that are actually in the business of making drugs.

The location of a start-up is itself an interesting and important one to identify. Biotechnology is a form of venture science. Genomics in particular, taking place as it is in the midst and immediate aftermath of the dot com boom, has as central to its calculus entrepreneurs and venture capitalists. GeneEd itself is not a venture capital funded company, though not for want of effort. It is nonetheless very much a company that is at the heart of venture science.

The particular location of this company in geographical terms adds to its interest. Being in San Francisco, it is a Silicon Valley company, and yet not a Silicon Valley company. Location does count for start-ups, and being in places like, especially, Silicon Valley, enables the creation of networks and contacts that are of prime importance in hiring the best workers and managers, being in corridors of conversation with investors, and being able to easily access customers and collaborators. It's a lot harder to be a start-up in Kalamazoo, Michigan. GeneEd is very much a product both of its times and its place. And yet that place is not alongside a freeway in Palo Alto, Fremont, Santa Clara or San Jose, but in a run-down part of San Francisco south of Mission Street. Within two blocks' walk one can reach a rather trendy part of San Francisco's shopping district; an extremely ornate Hispanic church; a community kitchen where homeless people get fed; a café - cum- laundromat where one can have lunch while washing one's clothes; a bakery that sells x-rated cakes; and a transvestite nightclub. Until the latter moved out, GeneEd shared its office building with a company that manufactured jeans. Many of GeneEd's employees, including their co-founder and CEO Sunil Maulik, live in the Mission district, and share in the general community concerns over the progressive corporatization of their locality. That they themselves are a part of that corporatization is an irony that is acutely felt within the company. GeneEd's

Silicon Valley is not the Silicon Valley of strip malls and suburban villas that most Northern Californian biotech companies inhabit, nor even that other sought after biotech locality made famous by Genentech, South San Francisco (which calls itself "The Industrial City").

GeneEd's founders, Sunil Maulik and Salil Patel, are both of Indian descent, both grew up in Britain and have both lived in the Silicon Valley for over a decade. There are stories of friendship and hybridity in their biographies. As is the case with many start-ups, the founders' biographies leave a significant mark on the culture, identity, even (perhaps unwittingly) corporate strategy of the company they create. The Indian entrepreneurial community in Silicon Valley is one of the central links in this thesis between the drug development worlds of India and the US. Maulik and Patel both belong to, and yet by virtue of their British upbringing are distinct from, that community.

In terms of being a site of knowledge production, GeneEd is an interdisciplinary space that reflects the centrality of interdisciplinarity in the scientific – corporate worlds that I am studying. GeneEd's courses are physically designed by a team of graphic designers (most of whom have no advanced training in the life sciences, and so are picking up their biology on the job), their computers are maintained by programrs while content is provided by Maulik and (mainly) Patel, who are both biologists. Indeed, my own function in exchange for the access I was given was to give a weekly seminar on the history of biology to the entire company, in order to get the employees aware and talking about issues in the life sciences. Needless to say, these seminars were fascinating ethnographic moments.

The Centre for Biochemical Technology (CBT) is one of the forty or so labs of the Indian Council for Scientific and Industrial Research (CSIR). Founded in the 1960s, it has for most of its life been a dilapidated, musty center that has sold biochemical reagents. In 1995, the Indian government realized that it was missing out on the global genomics bandwagon, having decided not to be a part of the Human Genome Project (HGP) at its inception in the late 80s. India didn't

really have very many "genome scientists" at the time, and the best known was S.K. Brahmachari, who had worked with initiators of the HGP such as Charles Cantor, and who had been clamoring for India to do genomics for much of the previous five to six years. Brahmachari was at this point ensconced at Bangalore's Indian Institute of Science (IISc), India's premier scientific research institution, and without a doubt the best place in India (and possibly among the best in the world) to do unfettered basic life sciences research. The Indian government persuaded Brahmachari to move from IISc to head a new center that would do genome research. The government's idea was to build an entirely new genome center, which Brahmachari rejected. He felt that India was already behind the genomics curve, and building a new center would mean that his (and the country's) energies would be spent just getting a building up and labs functional for the next four to five years. In other words, by the time a new genome center was ready to go, Brahmachari felt, the genome would already be sequenced or nearly so, putting the Indian effort at a virtually insurmountable competitive disadvantage. He felt it would be a far better idea to retool an existing lab into a genome center, and so was given the Directorship of CBT in order to convert it into India's flagship public sector genome lab.

In addition to reinventing the agenda of a public laboratory (which in itself would have made CBT an interesting ethnographic site to study), Brahmachari has, along with the Indian pharmaceutical company Nicholas Piramal (NPIL), seeded a genomics start-up called Genomed on its premises. There is, in parallel, another Genomed that is located in Bombay, in the very different setting of a hospital owned by the Piramals. A comparison of Genomed Delhi (housed in an academic research center) and Bombay (housed in a private hospital) again highlights the importance of place in the production of "global" knowledge.

Brahamachari has also become a major policy player, as India very actively tries to come up with laws regulating the circulation of human genetic material out of India. This is an area of some concern as human (and other) genetic material becomes important "raw" material in the

generation of therapeutically relevant knowledge, and India has lagged behind especially many Latin American countries in coming up with legislation to deal with the dangers of expropriation of this genetic material by (usually Western, often corporate) researchers.

Many of Brahmachari's colleagues and friends thought he was crazy to move from IISc, where he could continue to grow and establish himself as a premier genome scientist, to assume Directorship of a CSIR lab, one of the most politically charged positions in the Indian scientific establishment, in Delhi, one of the most bureaucratic cities in India. And yet, this move has seen his career path go from scientist to entrepreneur and policy maker, making his a fascinating biography to trace as part of a tracing of multiple hybrid genome worlds. What is important to emphasize is that this is a trajectory that could only have emerged by physically moving to Delhi and to CBT, which has the additional advantage of being located on the campus of Delhi University, and is thereby able to draw easily upon the students and resources of a major university.

There is a third site that I have followed through contact with its key actor, who provides a third biographical vantage point upon biocapital to place alongside those provided by Maulik and Brahmachari. This site is PXE International, a patient advocacy group headquartered outside Boston.

PXE stands for pseudoxanthoma elasticum, and is a rare genetic pigmentation disorder that usually leads to blindness by the mid-twenties. PXE International was founded by Patrick and Sharon Terry. Pat Terry used to be in the construction business, but started reading up on PXE when he realized that both his children were afflicted with the disease. Now, the Terrys have not only managed to form a transnational patient advocacy group for the disease, but Pat Terry is also the co-founder of a new biotech company called Genomic Health, whose other co-founder is Randy Scott, the co-founder of Incyte Genomics (one of the largest and most established genome companies). Further, PXE International is writing itself into intellectual property agreements with

companies like Genomic Health that they donate samples to. Therefore, organizations like these highlight the huge investment that emergent biosocial entities such as patient groups have in genomics, but are also involved in strategically recharting intellectual property terrains. In that sense, they are engaged in an activity not dissimilar in substance (though often dissimilar in form, tactics and motivation) from the policy making activities of the Indian state as it tries to regulate the flow of genetic material from its territory.

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A project such as this, not surprisingly, brings with it a host of ethnographic challenges. The first is one of scale, when confronted by a range of disparate sites across two countries. This makes the importance of different sorts of collaboration particularly salient. The call for collaborative ethnographies has been an explicit part of Marcus and Fischer's agenda for multi-sited ethnography. Even informally "collaborative" networks are often of unanticipated use in the field. For example, Brahmachari was very keen to get a comparative sense of policy arrangements on intellectual property issues regarding the circulation of genetic material in other (especially Latin American) contexts, and the work of Corinne Hayden on bioprospecting in Mexico, and the complicated benefit sharing agreements that get drawn up between various Mexican and American institutional actors, was invaluable in helping provide answers.

The second challenge has to do with access, in an environment that is often defined from the ground up by its secrecy. This is especially a problem in the US, where secrecy as part of corporate culture is culturally sanctioned and legally institutionalized. Corporations are understandably wary of researchers like myself who will be traveling to a range of other sites, including possibly to visit their competitors. In addition, corporations are very careful about regulating what gets said about them, their public relations apparatus often being sophisticated and a central component of their corporate strategic apparatus.

I have received a range of responses from various companies that I have tried to get access to, and it is perhaps useful at this point to mention the divergent responses of three of the main genome companies. Millennium Pharmaceuticals refused to even give me a tour, citing reasons of lack of time. The fact that Millennium is one of the most aggressively growing biotech companies, and the fact that this growth has largely been fuelled so far by clever corporate strategy and public and investor relations rather than the in-house development of tangible therapeutic products,[19] however, makes it seem quite evident to me that the lack of time was probably not the only factor contributing to Millennium's hesitation to show me around. Indeed, it is often possible, even when not given a formal tour of a company, to informally get to know some of the company's employees and learn about non-proprietary aspects of the company's activities, or what it is like to work there. Those of Millennium's employees whom I have met have undoubtedly been the most reticent and least informative of any biotech employees that I have met in my travels. This leads me to suspect that an aggressively closed-door attitude is very much a part of Millennium's corporate culture, and has also meant that I have only been able to

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[19] Millennium's major therapeutic areas are cardiovascular disease, oncology, metabolic diseases and inflammatory diseases. Their cardiovascular products include Integrilin® and Campath®. Much of Millennium's cardiovascular disease focus has emerged as a consequence of its merger with COR Therapeutics, which had done the early discovery work on Integrilin®. Campath® is a 50-50 joint venture of Millennium with ILEX Products. Millennium has two other development stage product candidates in Phase I clinical trials. Velcade™, their major oncology drug, is also an acquisition, and as of August 2002 was in Phase II and III clinical trials for multiple myeloma, Phase I and II for other hematological cancers, and Phase I and II for solid tumors. In addition, Millennium has three other oncology candidates: MLN 518 has finished pre-clinical trials, and MLN 591 and 576, as of August 2002, were in Phase I clinical trials. In the area of inflammatory disease, as of August 2002, MLN02 was in Phase II trials for Crohn's disease, and Phase I and II for ulcerative colitis, while MLN 519 and MLN 01were in Phase I. In the area of metabolic disease, MLN 4760 was in Phase I.

All in all, Millennium, as of mid-2002, was testing seven drugs in people, out of which only one was derived from its own gene databases. This is in contrast to Human Genome Sciences, several of whose drugs in human clinical trials have been derived from its own gene databases. Millennium's strategy of buying potential drugs to tide them over, rather than developing drugs from their own databases, is evidenced in the case of MLN 341, a candidate for the treatment of multiple myelomas. The initial work in discovering this drug was done at Proscript, which got acquired by LeukoSite, which in turn was acquired by Millennium. It is now Millennium's most-funded drug. If this drug clears FDA trials, then it will be the first that Millennium has brought to market entirely on its own. Millennium, however, is not unique in adopting such strategies. For example, the most promising drug in the pipeline for Myriad Genetics, R-flurbiprofen, was acquired from the Riverside, CA based company Encore Pharmaceuticals.

The above information was obtained from Millennium's website, www.mlnm.com. For the story of MLN 341, see Herper 2002a. For the story of Myriad's acquisition of R-flurbiprofen, see Herper 2002b.

learn about Millennium from public documents, which, unsurprisingly, are invariably spun to Millennium's advantage.

Celera Genomics, the controversial company that raced the public Human Genome Project to sequence the genome, was willing to give me a tour, but wanted to know exactly what the purpose of my visit would be. When I explained my research project, their Investor Relations person said, "Oh, I get it! You want the media tour, not the investor tour!", thereby letting on that Celera's PR apparatus is so evolved as to be compartmentalized into "media" and "investor" components.

Incyte Genomics, based in Palo Alto (unlike Millennium and Celera, which are both East Coast companies), was in contrast by far the most open of the three major genome companies,[20] and I received a wonderful and extremely informative tour of their premises. In addition, Incyte executives that I have met have always been willing to spend lots of time talking to me, suggesting that cultures of openness and secrecy are established at the top, and permeate to become normative corporate behavior: "corporate culture", if you will. This difference might to a certain extent simply reflect a more laid back, informal and friendly West Coast attitude compared to the hard-nosed formality of the East Coast. Whatever the reason, I am extremely grateful for the generous amounts of time and information I have been given by people at Incyte. Having said this, when I pressed Incyte with a request for doing longer term ethnographic research there, I was asked to send a research proposal so that it could be vetted by Incyte's team of 60 lawyers (in a company of around 700!). Needless to say, I never saw my proposal again, or heard back from Incyte.

It is, of course, much easier to negotiate with a company that has 20 people as opposed to one that has 60 lawyers, since in the former case the CEO often has a definitive say in deciding

[20] Is it perhaps not a coincidence that Millennium is one of the most aggressively growing biotech companies today, while Incyte is in serious trouble?

on issues such as access to a traveling ethnographer. This makes me no less grateful to the people at GeneEd for the time and information they gave me. Before meeting with them, however, I had engaged in lengthy negotiations with another Bay Area start-up called Neomorphic. I met with a number of people in their management team, all of whom were intrigued, if cautious, regarding my proposal, but was finally denied access when Neomorphic got bought up by Affymetrix, making it overnight a part of a company of 750 from one of 25.

As mentioned above, it is that much easier to get access to a small start-up like GeneEd, that only has about 20 employees and a CEO who likes the idea of being written about, but even such access has to be negotiated. An account of the encounters leading up to my getting access there will I think provide interesting insights into the challenges of initiating corporate ethnographies.

I first met Sunil Maulik at one of the many receptions that define industrial genome conferences, in September 2000. He immediately struck me as being very smart and extremely erudite. We went to his hotel and had a wonderful lunch in a restaurant by the seaside. It got established right at the outset that this was going to be a conversation, as Maulik clearly wasn't one of these extremely-busy-corporate-executive-doing-grad-student-a-favor type of people, but was really interested in what I wanted to know and why I wanted to know it. So in fact we started with him wanting to know about my work rather than the other way round. When I told him that I'm interested in studying the changing corporate strategies of genome companies, he immediately said this is going to be a very interesting lunch.

After a fascinating initial conversation, I stayed in touch with Maulik, and met him again on a trip to the Bay Area in November of that year, when he was in the midst of dealing with a company that wanted GeneEd to design a bioethics course for them. By this time, I had broached to Maulik the idea that I might do fieldwork at GeneEd. Maulik himself was open to the idea, and

so arranged for me to come and give a talk at GeneEd, as a way of introducing myself to the other people in the company to see how they felt.

The day I went to give my talk, GeneEd had just signed a major agreement with Sumitomo Corporation in Japan, who had bought all of GeneEd's packages and translated them into Japanese for a Japanese market. This was a major coup for the young start-up, and one that occasioned them much optimism.

What daunted me most about having to talk at GeneEd was Maulik's generous e-mail introduction of me to the company earlier in the week, which he had circulated along with my abstract, and in which he told his employees "Don't be discouraged by all the big words, Kaushik will give a very interesting, stimulating and articulate talk". So now I had to be interesting, stimulating and articulate, and watch out for the big words!

I proceeded to give them a quick overview of science studies and cultural anthropology, how the two came together (especially with Sharon Traweek and then quite a bit about Paul Rabinow's work), how they meet in my work, and how I expect GeneEd to fit into it. I actually thought I'd have to do a lot of explaining about the last part, as GeneEd is not a genomics company, and I expected them to be preoccupied with the question of how they would fit into a contemporary (which generally gets understood as linear) history of genomics. On the contrary, they seemed to assume that GeneEd would quite obviously fit into a story such as mine, and in fact picked up on a lot of the history I was giving to ask me questions, something I really didn't expect as I was basically reeling off names.

In fact, I received many questions and comments on my summaries of science studies literature. For instance, they really took on Bruno Latour and actor-network theory, and Salil Patel in particular really wanted me to explain how actants *work* (being quite readily convinced at the outset that science is basically a recruiting exercise!). Maulik meanwhile wanted to know what *I* thought scientists' motivations were, since scientists constituted GeneEd's consumers, so

they really needed to understand what drove them. In other words, I was already being co-opted into their interdisciplinary enterprise in a way I just couldn't be at a genome company like Incyte or Neormophic.

After the talk, the employees went round the table introducing themselves, and then Maulik got up and started what he called a "values and visions" session. Apparently the management (which consists of himself, Patel, Paul Eisele [a much more senior person, the chief operating officer who was steeped in years of sales and marketing experience in the entertainment industry] and Barry Giordano, the VP sales) had sat down together and tried to come up with a series of core values for the company. Basically, this was an acknowledgement and reflection of the fact that their relationships between their primary markets (executives of other biotech / pharma companies) and their secondary / tertiary markets (which really could be anyone, including other biotech / pharma companies but also more lay consumers as they made courses more accessible to lay people) was so complex. Maulik started by talking about an article in the *New York Times* (January 31 2001) on direct-to-consumer advertising to parents of children with respiratory syncytial virus (R.S.V.), but out by the biotechnology company MedImmune, in order to highlight GeneEd's complicit and complicated relationship with the marketplace they are so invested in.

Issues like direct-to-consumer advertising point to situations that directly confront a company like GeneEd as "value" questions, in both senses of the word. This is because GeneEd is caught in a peculiar dialectic between being an education company and an advertising company. In the former role, it creates its own, supposedly "neutral", education packages: neutral in the way a textbook would be neutral, drawing on generally known scientific literature to create the packages. But much of GeneEd's immediate revenue comes from doing contract work for other companies. In these cases, GeneEd doesn't provide the content, only the form. Therefore situations such as the MedImmune advertisements immediately highlight the need to question and

critique what is meant by "public education". Further, these are not hypothetical situations: GeneEd had already developed an antibodies course, and had already been approached by one of MedImmune's competitors to develop courses that they could use.

So Maulik talked about GeneEd's values. There is a tension in that word itself which reflects the tensions in GeneEd's complex relationships with its primary and secondary / tertiary markets. These values, as mentioned earlier, were initially outlined by the four executives of the company, and Maulik was now laying them open for discussion by everyone else. Eisele summarized some of the "internal" values by saying that basically GeneEd wanted to be a company that would allow its employees to "have a life". Tara Beyhm, one of the younger workers, mentioned the need for the company to have an ethic, to have "unbiased opinions" on ethical issues. Patel immediately scorned the possibility of such a thing as "unbiased opinion", and said instead that they need to have at their disposal "enough information to make up our own minds". Maulik now introduced the central tension for the company, that half of their courses are customized for companies. The question then becomes what to do when the company has ethical conflicts. The question, as Maulik posed it, was: "Should it be the company [GeneEd]'s business to walk away from business?"

Jill Blue Lin, one of the graphic designers, immediately translated Maulik's hypothetical company that GeneEd might have ethical conflicts with into "evil company", and equally immediately into the hypothetical case that Monsanto might approach them for business.[21] Lin said that a company like Monsanto, whether regarded as "evil" or not, should be allowed to say (through the medium of GeneEd) whatever they wanted to. She didn't think it was unethical to work with a company whose business plans or projects were controversial. Her argument was for a company (like Monsanto)'s free speech.

[21] This emblematic status that Monsanto has acquired as the "Evil Company" in activist circles is interesting enough; even more interesting that it has done so in corporate circles, as the benchmark to either avoid or be distanced from.

Eisele however said that GeneEd's walking away from a company doesn't deny that company its free speech. Neil Mackenna, a bioinformaticist visiting GeneEd for the day, then said that it was important for a company like GeneEd to maintain its credibility. Patel said that in fact one of the first suggestions doing the rounds amongst the executives was to prepare courses on genetically modified foods, but that he personally was disinclined because it is such a polarized issue and GeneEd didn't want to get caught in the middle. Maulik then asked the central question: Is it GeneEd's role to rule on the content? Do they want to be a censor? Patel admitted that GeneEd had already developed a number of custom courses in which the content isn't a hundred percent honest, and gave the example of a course they developed for a customer that he knew had lies in it. Eisele argued that in these cases GeneEd was the messenger and not the message. Again, therefore, the central question being contended with here was: Is GeneEd an education company or an advertising company?

Eisele then phrased the tension in so many words: "How do people feel about the aspect of the company that makes GeneEd similar to an advertising company?" Mai Grant, GeneEd's office manager, responded that in capitalism, this compromise always had to be made. Spencer Yeh, the Chief Information Officer and Systems Administrator, said that GeneEd was trying to be neutral. Maulik added that it made good business sense to be seen to be neutral. One way of seeming neutral is to do business with everybody. But that means that if an evil company X comes along, you'll have to do business with them. Beyhm pointed out that usually the most evil companies have the most money. Maulik then said that companies are composed of individuals, and are not intrinsically bad or good. He said that his sister is a pharmaceutical company sales rep, so he knows the levels that these companies will go to sell their product. Therefore, he said, "they're not inherently evil, *they do business*".

At this point, Maulik looked at me, and said, "You're scribbling furiously. What do you think?" Of course, putting the neutral participant observer out on an extremely brittle limb! Even

if I had an answer, I presumed that telling them I was a Marxist who sought death to multinational capital would not be strategically a wise move, so avoided an answer altogether by telling them the story of Jim Kim, a doctor-activist-medical anthropologist at the Harvard Medical School, and how he does business with pharma companies because as a doctor he has to get drugs to patients who need them desperately and fast, while he at the same time urges Act-Up on the side to storm the offices of Pfizer. It's precisely that idea of a strategic field of action that GeneEd could, in this introspective moment, still develop, even though, as they themselves admitted in so many words, business is a form of prostitution, an enterprise of selling oneself at the highest cost possible, but also at any cost. Maulik arrived at in many ways the happy (albeit easy?) for the time being compromise that "if we get lots of money from pharma companies, we can redistribute it". He then suggested that 5% of GeneEd's time and resources would be used to contribute to non-profit sources. He also, in that vein, mentioned the possibility of being involved in technology transfer to developing countries, and of course all sorts of possibilities exist for a company like GeneEd in a place like India.

So that was the conclusion of the Values and Visions session. Maulik then took me aback by asking everyone publicly and in front of me what they wanted to do with me, whether I should be invited back for a longer-term interaction. Both an uncomfortable and a refreshingly honest mode of operation. I suggested that this might be a conversation better had in my absence. Beyhm said she would be happy to have me back if it meant free lunch again. Generally, everyone seemed receptive, though Yeh suggested that they eventually decide through secret ballot. But Maulik was very upfront about the fact that he certainly wanted me back, and was equally upfront about the fact that it was his ego prompting him to be written about as much as anything else. On the other hand, both he and I realized that I might be valuable to him in ways I simply might not to a genome company , precisely because his consumer base is potentially anyone, and he knew that I could give him access to consumers such as patient groups, bioethicists and other scientist -

businesspeople, and that I might also be invaluable in helping him think through ways of moving into India. This was always already a complicit ethnographic relationship.

What remained at GeneEd, then, was negotiating the terms of access, especially as they related to confidentiality. After two weeks of negotiation, we finally agreed upon a 14-point, legally binding, modified non-disclosure agreement (NDA), that requires me to respect GeneEd's confidential information but that allows me to write or speak about their non-proprietary information for academic purposes. On the strength of this contract, I was given full access to the company, including to their weekly management operations meetings and their company financial documents. I reproduce the agreement in Appendix 2, as a possible template for future ethnographic work of this kind.

Getting access to CBT, in India, brought with it a host of other issues. I describe these to point to some of the concerns over confidentiality that structure terrains of ethnographic access — concerns that often manifest in similar ways, but for different reasons, in India and the US. I therefore follow my story of negotiating access to CBT with that of getting Institutional Review Board (IRB) clearance from MIT for undertaking my project in the first place.

Indian corporations, while keen to protect their confidential information, do not adopt their American counterparts' attitude of extreme defensiveness, and I in fact received immediate permission from the pharmaceutical company NPIL (through the mediation of Brahmachari) to do fieldwork at Genomed, which as I mentioned earlier is physically located in CBT and in which NPIL have equity stakes, without even having to sign any agreements with them. Getting formal approval to do work at CBT, however, proved much more fraught, this time not because of the concerns of the defensive American corporation but because of the concerns of the defensive Indian state, as operationalized by its bureaucracy.

Once again, Brahmachari, like Maulik, was keen for me to do research on CBT, for reasons very similar to Maulik's: the self-satisfaction of being written about on the one hand, and

the idea that I could help Brahmachari by inserting him into my networks in the US, by helping him think through policy and managerial issues and by publicizing some of his concerns regarding the expropriation of Indian genetic material to a wider audience. My presence was also accepted by the Director General of the CSIR, Ramesh Mashelkar, who was the ultimate authority to sanction my access. And yet, doing the paperwork to actually get access at CBT was an intricate and frustrating maneuver that highlights the bureaucratic contexts in which Indian institutions work; the security concerns of the Indian state; and a whole local political economy of red-tape that is of some importance to understand if one is to adequately understand India's path to globalization in ethnographically informed ways. Since these encounters also ended with a legal agreement (also reproduced in Appendix 2), I feel they are useful in throwing comparative light on the politics of ethnographic access.

The formal paperwork at CBT had to be negotiated with the person in charge of their Business Development and Marketing Group, a man called Pankaj Bansal. I had initiated correspondence with Brahmachari more than two months before I was due to start my fieldwork at CBT, because he had warned me that it would take time to get all the clearances, especially from the Ministry of External Affairs (MEA), since I qualify as a "foreigner" on account of my American institutional affiliation. I had been assured by Brahmachari the week before reaching India that all the clearances had been obtained. Here was Bansal, however, who was clearly completely ignorant of any of these happenings, and who decided to go about reinventing the wheel.

Bansal started off by saying that I need to get both MEA clearance and security clearance. I told him that Brahmachari had already obtained these. He said, how can Brahmachari obtain these on his own, he has to go through proper channels (which meant Bansal). So Bansal told me that I couldn't start tape recording until *he* had sorted out clearance issues, and suggested that until then I just have "broad" conversations with various people so that I can decide who I

wanted to formally interview later. I told him that I've now had "broad" conversations with people three times over (since I had made earlier shorter visits to CBT, when I talked to a number of their scientists off-tape. Also, like Maulik, Brahmachari had arranged that I give a talk to the entire institute explaining my work and where I'm coming from). What's more, I had already drawn up a list of people I wanted to interview, and Brahmachari had formally approved that list. None of this, of course, was good enough for Bansal, who kept talking about security considerations, and about how he'd be in trouble if I turned out to be a Pakistani spy. Bansal then called up someone in Ramesh Mashelkar's office to consult with him. This other person made it clear that:

a. I would have to get all the clearances, and

b. Getting all the clearances would take a lot of time.

Bansal then started looking over the NDA I had drafted, which involved him ruminating over the document for a full 20 minutes. As a part of any ethnographic agreement that I draw up with my informants, I tell them that they will get transcripts of on-tape interviews for review, in order to address proprietary concerns. Bansal said that getting transcripts for review is all very well, but there might be written notes that I take that won't include what is in the tapes, and that CBT would like to see those too. I made it clear that showing him written notes is not on, and a clear violation of my professional ethics; but that what I am willing to do is provide them with a written synopsis of what I have observed at the end of the month.

Bansal then got an assistant to draw up a list of people I could talk to, even though Brahmachari had already formally approved a list of people that I had come up with. Needless to say, Bansal's list was much more selective than the one I had got approved. Bansal then asked his assistant to e-mail the people on the list he had made, to sound them out about the likely questions I would ask, and to ensure that they gave "proper" answers.

The next morning was spent in continued negotiations with Bansal, who was a lot friendlier, since he had to talked to Brahmachari and realized that, as I had been insisting, all the paperwork had indeed been done. However, friendly, it was evident from the get-go, doesn't translate into productive. Bansal had wanted me to e-mail him a copy of the agreement that I had drafted, since he didn't want to retype it all. This I had done the previous day, but he still hadn't received it. I told him I'd e-mail it again to him from the Centre, but couldn't follow through because the servers at the Centre were down all day. No more progress.

The following day, I did manage to get the agreement e-mailed to Bansal, but by the end of the week found that he had still not signed it, because he wasn't the person vested with the authority to do so. The only person who can sign agreements of this sort in a public institution like CBT is their administrative officer (AO), and CBT didn't have one. A new one was supposed to join the following week, which ended up delaying the whole process by another week. Once the new AO did join, Bansal insisted that it would only be fair to give him a few days to review my proposal before being asked to sign it.

Finally, two weeks after starting at CBT, I got the agreement signed. This however was no simple feat, but rather a protracted ritual. Bansal outlined the projected *modus operandi* for me to follow, since as far as he was concerned the moment of signing the agreement was the time when I actually started my research at CBT. This *modus operandi* involved my having to report every move to Bansal's assistant, so that Bansal could constantly monitor who I talked to, and when. The agreement itself had to be signed on judicial stamp paper, because plain paper agreements in India are not legally valid.

Bansal and I then went up to the new AO, a rather pleasant man called Jayaram. But that didn't make him any less bureaucratic. He wasn't trying to obstruct the signing any further, but it was clear that he was quite perplexed by the sort of agreement we were signing, and it was not the sort of thing he was used to encountering. More than anything else, it was very evident that he

wanted to cover his back in case anything went wrong, and kept saying that people shouldn't later put him on the spot and ask him questions if anything went wrong. Therefore, he wanted me to pass on to him not just the transcript but the actual physical audio-tape also after recording, which seemed to me a bit excessive.

Jayaram had meanwhile ordered tea for all of us from the canteen. The waiter from the canteen brought tea in plastic Nescafe cups, and Bansal threw a fit at him. He said that the canteen had no business sending tea up in plastic cups when it was being sent to the room of an Officer such as the AO, and insisted that the canteen manager be summoned. He then ticked off the canteen manager for his impropriety, in public, and threatened to fire him if proper deference wasn't shown to the officers in the future (deference here meaning that tea should always be served in the ancient chipped bone china cups that one gets in government offices, rather than in plastic cups).

Bansal then decided that he would continue to make things hard for me, so after all these conversations, and in spite of the fact that Jayaram had had two days to read my proposal and all the paperwork, he insisted that I repeat my project to Jayaram. Fortunately, Jayaram wasn't too keen on my doing so, and just wanted to go ahead with the signing.

The actual signing itself was quite a ritual, since each person's signature had to be counter-signed by a separate witness. In other words, quite a congregation for tea in Jayaram's room. But the job was finally done, and I was finally ready to officially roll.

I mention these access stories not so much to throw scorn on a mid-level Indian bureaucrat (though the hassle of getting my paperwork done at CBT was indeed extreme), but rather to point to the situations that ethnographers have to face when access is not just a question of personal intrusion into lived individual or community lives, but is access to *information*, which is always already over-determined as commodifiable, valuable and sensitive, whether by corporations or by the state. While at some level Bansal was acting difficult, at another he was

merely playing out an institutional role that in all likelihood would have been played out in similar ways (though perhaps in less antagonistic fashion) by others in his position. Having said this, the level of petty bureaucracy that prevails at CBT is a function both of its institutional culture and of its location in Delhi, notoriously the most bureaucratic city in India. The Centre for Cellular and Molecular Biology (CCMB) in Hyderabad, a CSIR lab with an almost identical mandate to CBT's, is marked precisely by the absence of this type of bureaucratic hierarchy that is directed not just against outsiders like myself, but also against CBT's own scientists. CCMB's more co-operative and egalitarian, and less bureaucratic, culture, is both a function of its location in Hyderabad, and of the managerial practices of its founding Director, Pushpa Bhargava, who ensured through personal example that bureaucratic one-upmanship would not be tolerated. Once again, place does matter, leading to differences even within entrenched and institutionalized normative behavior.[22]

It must also be emphasized at this point that bureaucracy is by no means an Indian prerogative, and the time it took me to get Institutional Review Board (IRB) clearance at MIT for my project far exceeded the time it took CBT to sort out my paperwork. In principle, of course, any professionally ethical researcher would recognize the importance of having IRB mechanisms in place for any work that involves human "subjects". And yet, IRB guidelines have clearly been drawn up with biomedical experiments in mind, and these guidelines translate poorly (if at all)

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[22] Further comparison between CCMB and CBT would be instructive, since they have almost identical research mandates from the Indian Council for Scientific and Industrial Research (CSIR). While both are "academic-sector specific" (as opposed to business sector specific) labs of the CSIR, both labs are encouraged to be entrepreneurial. It is impossible for me to say from a much shorter duration of time spent at CCMB whether there is an equal degree of conflict there over the introduction of a new mandate, though it is very clear that this new mandate is not received with unanimous approval amongst every scientist at CCMB.

Further, I do not wish to imply a comparison between Bhargava and Brahmachari, or to blame Brahmachari for setting an example of, or tolerating, one-upmanship and stifling hierarchy. Indeed, Brahmachari is acutely aware that the only way the changes he brings about can outlast his tenure as CBT's Director is to introduce a more democratic and egalitarian style of functioning. The contradiction is that it is precisely through taking advantage of the already existing conditions of possibility for hierarchical, inegalitarian functioning that Brahmachari is able to introduce the changes that he wants to introduce in the first place. It would be an interesting hypothetical question to consider how similar, or different, CBT's culture might have been under Brahmachari had it in fact been in Hyderabad and not Delhi.

into a context where the experimental "subject" is simply an interviewee. After assuring MIT's IRB that I did not intend to cause any of my interviewees serious physical or psychological trauma, I was confronted with the IRB's core fear, which was that a legal issue might arise with a company that felt I had violated their confidentiality. In other words, just as CBT's bureaucracy stemmed from a fear of being held accountable by the Indian state for a breach of security, so did MIT's bureaucracy stem from the fear of being held accountable by the American corporation for a breach of confidentiality.

This fear, however, was layered under another institutional manifestation of MIT, as itself a corporation rightfully seeking to protect its intellectual property. Therefore, just as MIT's ethicists were insisting that I produce proof that I would be adequately protective of my informants' confidentiality, so MIT's lawyers were insisting that the copyrights on any audio recordings I might make would belong not to me, but to MIT. I finally succeeded in assuaging the former fears by reproducing the GeneEd NDA for them, and argued further that there was no way MIT could have copyright over recordings that they were legally (as per the NDA) not entitled to see (since of course the recordings might contain proprietary information that I would subsequently edit out before making public). It must also be remembered that the MIT IRB only concerned itself with interviews I was doing in the US, not in India, suggesting again that it wasn't an ethical concern over the possibility of breaching individuals' privacy that was at issue so much as it was a legal concern that MIT shouldn't land in a litigious situation.

The third major ethnographic challenge in a project such as this involves having to be vigilant. My project involves going into the belly of the corporate beast that I have from the outset regarded in broadly adversarial terms. And yet, it is easy to get swept into the enthusiasm of one's informants, in a field that is essentially driven by its own salvationary promises. Biotechnology's various scientific-corporate actors are completely caught up in and live the hype

that they create, and it is hard to be a faithful ethnographer without getting caught up in some of it oneself.

Ethnography also brings with it a host of complicit trade-offs, some of which I have already hinted at in terms of my interactions at GeneEd and CBT. Some of those complicities get painfully highlighted while translating fieldwork into narrative, as I discovered while writing Chapter 5 of this dissertation, on ownership. These dilemmas are quite common for medical anthropologists, for instance, who come across questionable ethical practices in their sites of study, necessitating a choice between an obligation to publicize unethical behavior, and an obligation to respect one's informants' anonymity. The best way to highlight some of these dilemmas, as a segue into talking about the outline of this dissertation, would be to reproduce a footnote that appears in Chapter 5, regarding my decision to anonymize the name of a company (that I call Rep-X) that I had toured and have written about, whose practices in India have been quite controversial:

> I have wrestled with the issue of whether to name this company or not, and am still not sure that my decision to keep it anonymous is the correct one. However, there are a number of reasons why I have chosen to do so, and I think this extended footnote is of some consequence in thinking through methodological questions surrounding the ethical choices that one makes while doing corporate ethnographies.
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> Joseph Dumit ponders these questions very seriously in his recent work on venture science (still unpublished), where he names two biotechnology companies and has therefore consciously decided to avoid interviewing people at these companies. In this case, however, I had already interviewed two people at Rep-X (one employee and one manager, one on-tape and one off-tape) before I learnt of the company's controversial situation in India that I discuss in this chapter. At no point in this chapter do I draw upon these conversations. As Dumit has shown, it is both legitimate and a challenge to do corporate ethnography by working from the public record in order to reserve the right to

"tackle" certain actors. While that is precisely what I have done in this chapter (using not just the public record, but public documents that Rep-X has had a significant hand in "spinning" to its own advantage), the problem of how to "forget" my conversations at Rep-X is a lingering one. I have decided to keep Rep-X anonymous until I have resolved it for myself.

This is, as much as anything, an acknowledgement that anthropology is different from journalism, and one of the lines of difference is the relationship with informants. Journalism is adversarial by nature: the work is to "get" a story out of a subject, even if there is a long-term relationship involved. The challenge for an anthropology such as this is to be ethical and non-adversarial, which is not to say non-critical. At the end of the day, anthropologists write, in part, to their subjects, not just to their colleagues and beyond.

Corporate ethnography involves writing about what is fundamentally a culture of secrecy. It is possible to be fascinated by how and why things get made secret, without necessarily feeling the obligation to make public what the subjects want kept secret. This is precisely the opposite of the investigative journalist. On a basic level, the journalist wants the "truth" that is "out there", while the anthropologist wants, at least as one set of perspectives without which one cannot understand the motivational or intentional side of social action, something like the subject's truth, or truth in Foucault's sense of "the system of ordered procedures for the production, regulation, distribution, circulation and operation of statements...linked in a circular relation with systems of power that produce and sustain it" (Foucault 1980: 133).

One strategy I considered was going to Rep-X's Investor Relations department to ask for their comments on what I heard in India, but I decided against that journalistic tactic as well. My sense is that if this really is a public relations disaster that is waiting to happen for Rep-X, then there are strategies that can be employed in conversation with the involved representatives of the Indian state -- who are, after all, extremely articulate and media savvy -- in making that happen.

> Finally, I believe that a number of people invested (in all senses of the word) in the world I am studying will read this chapter with an eye that will see through most anonymizations. Also, any agreements I have with companies that I have done longer-term work with (this not applying to Rep-X, where I only had a couple of conversations, and no long-term agreements) make it clear that I have the option of using the companies' names unless they would explicitly prefer me not to. Until shown otherwise, I adopt the methodological rule that the anthropologically interesting issues do not resolve into "dirty secrets" but are structurally interesting dilemmas.
>
> I feel, in spite of that discomfort, that the story of Rep-X will be illustrative of situations I want to explain even if I don't directly locate it. This is a common dilemma for medical anthropologists working in hospital settings, who often choose to report medical mistakes with clinical consequences that they observe through official channels which are not public. When they write about such situations, they tend to severely anonymize them so that the account can't be pointed back at all.[23]

Another set of questions for ethnographic ethics gets thrown up when one studies the work of those who operate not in the belly of the corporate beast, but with the most marginalized and subaltern of sufferers. A particularly powerful example of this is the work of Paul Farmer, Jim Kim and their organization, Partners in Health (see www.phi.org, and also Farmer 1993, 1999; Kim et al 2000). Farmer and Kim are medical anthropologists as well as medical doctors with clinics in Haiti, Peru and Roxbury (an inner-city locality in Boston), and their work with patients of AIDS and multi-drug resistant tuberculosis (MDR-TB) highlights for me the sorts of ethico-political imperatives that anthropology needs to concern itself with. This is because the work of Partners in Health is necessarily riddled with contradiction. For instance, their work makes them acutely aware of the sorts of price gouging tactics pharmaceutical companies indulge in, tactics that often make drugs unaffordable to Third World countries in the midst of major

epidemics (I explore this in greater detail in the next chapter). At the same time, they are equally aware of the importance of doing business with these very companies, since that is their only chance, as doctors, of getting therapies to patients who sorely and urgently need them. This brings into focus a tension between their role as anthropologists, writing about pharmaceutical corporate tactics, and doctors trying to intervene in and cure patients in an epidemic.

It also leads to contradictions in the sorts of political "facts" they subscribe to, believe in and do work with. For instance, their agreement with the received wisdom of the international medical community that Brazil has provided a model in dealing with the AIDS epidemic,[24] is at odds with ethnographic analyses of the situation in Brazil such as that of Joao Biehl (Biehl 2001, Biehl et al 2001), who shows how the *non*-accounting of AIDS deaths by the state amongst certain segments of the population is constitutive of the former's mode of functioning, as operating what he calls a "technology of invisibility". And yet, Farmer's and Kim's work is such a powerful model of ethnographic ethics precisely because of their implicit acknowledgment of the impossibility of uncontradictory practice, and *therefore* the absolute necessity of strategic contradictory practice. Strategic contradictory practice is an imperative equally, in projects such as mine, where the anthropologist inhabits extremely powerful spaces that s/he is politically / morally / culturally / socially ambivalent about; and it is, after all, what corporations themselves are so good at.

Let me, therefore, turn an ethnographic gaze away from scientists for a minute and towards historians and social scientists – the tribes that I belong to, in the nebulous and constantly morphing inter-discipline of STS – to locate symptoms, at the very least, if not offer a diagnosis, of the difficulties of incorporating certain forms of ethical-political practice, difficulties that often

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[23] Many thanks to Joseph Dumit for a series of conversations and correspondences on this dilemma, many of which I have directly borrowed from in making my argument for anonymizing Rep-X here.
[24] This assessment is based on a talk given by Kim at a conference in Harvard in May 2002 on the subject of "Global Pharmaceuticals: Ethics, Markets and Practice" and the subsequent discussion based on that talk.

have consequences for the politics that work produced from these by no means marginal spaces subscribe to / operate within / create.

I start with a talk in the STS Department at MIT, organized by a group interested in issues of technology and identity as they relate to psychopharmaceuticals. This group periodically calls in speakers who are associated in one way or another with thinking about / writing about / prescribing psychopharmaceutical medication, to present to the group, and to others in the department and outside, and to have a discussion (the group itself includes scholars from both within and outside MIT). One of the speakers the group invited was a lapsed historian of medicine called Eric Caplan, who now works in an R & D unit at Pfizer. Caplan gave a Pfizer pitch, interspersing his packaged powerpoint presentation with reflexive, situated musings that provided fascinating ethnographic insights into the workings of a pharmaceutical company – insights that are quite rare and valuable for an ethnographer interested in understanding how these corporations work. And yet, the reception amongst the academics (not quite) hearing him out was premeditatedly hostile; there seemed to be an implicit criticism of Caplan working for the "evil empire" in the first place (even though a major reason he does so is because of a lack of adequate job opportunities in academe), and a more explicit criticism that he could bring himself to present a corporate pitch of a pharmaceutical company in addition to working there. So on the one hand, there is a staunch "moral" refusal amongst enough of the broadly speaking "leftist" academic community to listen to people inhabiting the spaces these very communities are trying to understand – a refusal, of course, that is as old as institutionalized Marxism, to which most of the said "leftist" community doesn't belong in any formal way; and a refusal that has had a history of devastating consequences for progressive political intervention in and through academic critique.

On the other hand, however, there are real questions that have been asked by thick empirical critique, certainly from within medical anthropology (which, for perplexing, and I believe debilitating, disciplinary reasons, is often regarded as a separate institutional discipline

from STS, with relatively little formal communication existing between the two) – questions of state violence, often rabid and incomprehensible yet completely selective and discriminating; of the inefficiency of state-market regimes of making things work on the ground; of irrationalities that are completely embedded not just in the practice but even in the *logic* of rational action – that, while in and of themselves are vital components of any rigorous critical enterprise, still beg the question, *and then what*? Once thick description has shown the violence, contradiction, inefficiency, instability, irrationality, disconcertment, disjuncture – then what? What are the stakes in unearthing all of this?

In other words, reflexivity and critical nuance – which anthropology, perhaps more than any other social scientific discipline, can pride itself on – are up to a point important as ends in and of themselves, but it is *precisely a continuation of that same process of reflexivity and critical thinking* that should be pushing the question of "and then what" as a consequence of such critiques. The question that I am asking, then, is how can we, as academics, inhabit structures of contradiction *productively* rather than *paralytically*? I do not profess answers, but I think work such as this dissertation, as well as the work of people like Jim Kim (described above) and of a number of others (the work – as in not just product but *practice* – of Byron Good, Sheila Jasanoff and Paul Rabinow have, in addition to Kim's, been particularly influential for me in this regard) force us to constantly ask such questions. These are, precisely, the questions of theorizing *praxis*. These are exactly the problems that Marx (1977 [1852]) is writing with and through in *The Eighteenth Brumaire*. These are exactly the questions of the tension between describing the world and changing it, that Marx poses in the 11th Thesis on Feuerbach (Marx 1963 [1845]: 199), where the problematic posed by Marx is *not* a *choice* between the two (as it is often misread as being), but the question of how those spaces of critique can be productively inhabited. As mentioned above, these are not important questions because they are part of some Marxian "program" that "leftists" should subscribe to, but because it is asking these questions, of productively inhabiting

structural contradictions, that capitalism is so good at doing, and it is impossible to understand, engage with and, to the extent one might want to, counter, the capitalist enterprise without being able to understand and inhabit that mode of productive being.

A common misreading of a call such as I have just made would be to equate it with a call for reducing all critique to either activism or policy formation (and indeed, similar arguments that I have made at various academic fora have often been precisely misread in such a banal reductionist manner). Praxis, however, as I have been trying to argue above, *is not simply prescription, it is in itself an ethics of reflexive critical engagement* that goes beyond the understanding of nuance and complexity – "thickness", if you will – to interrogate the thickness itself. It is a deconstructive ethics, a hermeneutics of suspicion, that has been so powerfully enunciated by Derrida, and incorporated into works of thick ethnographic analysis such as *Debating Muslims* (Fischer and Abedi 1990), that I argue and strive for.

The danger of not theorizing praxis is particularly acute, I believe, in anthropology, because there is the tendency amongst anthropologists to reify and fetishize *presence* – the ethnographic "encounter" – as somehow definitive or authoritative. The recent work of Joseph Dumit on venture science (unpublished), where he tracks the histories of certain biotech companies that he feels typify the new assemblages of naturalized corporate bioscience, is, as I have argued earlier in this chapter, an important example of strategically knowing when, as an anthropologist, *not* to be present in a naïve manner that simply fetishizes the ethnographic encounter, and hints at the sorts of critiques that are in fact made impossible by presence. I think anthropology is most powerful – and it is the way I use ethnography myself in this thesis – when it is used as *illustration* rather than *evidence*, especially since believing in the latter involves reifying ethnography as an enterprise of *factual* knowledge production that is precisely what anthropologists of science and technology try and deconstruct in the objects of their study. In other words, in this dissertation quite explicitly, "I was there" doesn't translate in any simple way

into "that is how it is", though "being there" undoubtedly can provide a set of situated perspectives that would be impossible to come by otherwise, perspectives that carry with them not just insights but erasures.

CHAPTER 3: BIOTECH AND PHARMA

Overview

The drug development process is basic to understanding the ways in which biocapitalism is reshaping the strategic terrain for companies (both established pharma and small biotech ones), and for the relations among research in academia, government regulation, industrial development, and clinical practice. This chapter provides an overview as a basis for the arguments for the following five chapters which take up the five theoretical themes of the dissertation.

There are two basic principles underlying the drug development process. The first is that the conduct of any human experimentation, which at the end of the day is the basic necessity before a developed drug can go to market, carries with it the greatest ethical responsibility that a physician can bear. The *ethical* concerns here include the necessity of respecting the people being experimented upon, and the principles of beneficence (the experiments need to both do good for the individual and advance science)[25] and justice. These concerns translate on the ground most directly into mechanisms of oversight and protection of privacy.

The second is that the basis of medicinal chemistry, which ultimately underlies most therapeutic development, is a biochemical hypothesis that gets translated into clinical benefit. This means that when a drug is put into a patient with a disease, and it doesn't work, it means either that the initial hypothesis was wrong and a new one needs to be formulated, or that the biochemical objective was never achieved. Therefore, one of the fundamental sets of technologies

[25] Many new biotechnologies of course problematize some of these principles. For example, xenotransplantation (trans-species organ transplantation, usually from pigs to humans) has great potential for both advancing science and doing good to the individual who receives the transplant, but the collective risk to society from the possibility of transmitting a porcine retrovirus that subsequently mutates and creates an AIDS-like pandemic in the human population is considerable. Such situations force a re-evaluation of the basis of *medical* ethical principles that are founded ultimately on considerations of individual benefit. Nonetheless, the fact remains that it is these medical ethical principles that form the

underlying drug development which needs to be emphasized at the outset, are *measurement* technologies. Perhaps more than anything else, measurement if critical to drug development from the get-go; and the development of technologies that enhance measurement capabilities, rather than fundamental conceptual advancements, are critical to the emergence of cutting edge drug development technologies. These are important facts that I will return to in the next chapter on speed and information, where I talk more specifically about the paradigm shifts that genomics represents.

Industry estimates put the average cost of bringing a drug to market as being between 300 and 500 million dollars. This might be a contentious figure,[26] but it is one whose naturalization by the industry has consequences for technological development, especially for the development of technologies, like genomics, that purportedly speed up drug development. A blockbuster drug can generate revenues for a pharmaceutical company of $3-4 billion a year. Therefore, goes the rhetoric, a delay in bringing a possible blockbuster drug to market (and of course, any drug that is being brought to market, it is hoped, will be a blockbuster drug) costs the pharmaceutical company potential revenues of about a million dollars a *day*. This is the material justification made for constant speed within the industry, where daily delays are calculated as huge possible losses in an endeavor that usually takes up to 15 years from initial R & D to market launch. But speed is also a rhetorical fulcrum, integral to the operation of hype and the making secondary of ethical issues and considerations, to lever the government, venture capitalists and the public to further invest themselves in biotech.

Therefore, on the one hand, the estimated cost to bring a drug to market emphasizes from the get-go that drug development needs to be as speedy a process as it can possibly manage to be. On the other hand, it also restricts the types of drug development ventures pharmaceutical

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templates for much formal *bio*ethical reflection, which is why I state that doing good for the individual is deemed to be one of the fundamental ethical principles underlying drug development.

[26] And I examine its contentiousness later in the chapter.

companies want to get into in the first place. In the United States, the minimum estimated market that a big pharmaceutical company is likely to be interested in, for it to undertake the development of a drug, is in the vicinity of $250 million a year. Drugs that are predicted to garner a significantly lower revenue than this are simply not likely to be developed by a big pharma company. The third consequence of the capital intensitivity of drug development is that it makes it a struggle for smaller biotech companies, who often have considerable innovative capabilities but not the deep pockets to translate those capabilities into predictable therapeutic pipelines. Therefore, the capital intensivity of drug development makes it much more likely that big pharmaceutical companies, that are often less innovative than their smaller biotech brethren, and that are less likely to invest in small therapeutic markets, are much more likely to be successful developers of therapy. This is the fundamental market terrain of drug development, that I will constantly re-emphasize, and that structures the political and strategic terrain on which the drug development enterprise plays out.[27]

Drug development stems, in the simplest possible terms, from an unmet medical need. An unmet medical need is determined through medical assessments, marketing (commercial) assessments and scientific assessments (which generally have to do with what is called "druggability", which means the determination of whether there are any targets that the drug can act upon within the body). Commercial assessments are, ultimately, determined by the marketing department of a pharmaceutical company. Marketing departments tend to be brilliant at assessing possible revenues when there is already a similar drug on the market. When there is absolutely no therapy for the disease in question, however, it is impossible for marketing people to identify the market. This places a further stymie on the development of drugs for needs that are truly medically unmet, and places a contradiction at the heart of the decision making process of a

[27] Pharmacoeconomics, therefore, represents one of the many forms of what gets accepted as expert calculation, forms of "scientific" expertise that have a huge impact in shaping political and strategic terrains of drug development (as I explore at a number of points later in this chapter).

pharmaceutical company: on the one hand, an untapped market is precisely the potential goldmine that a pharmaceutical company is looking for, but on the other it is precisely the unquantifiable quagmire that a pharmaceutical company doesn't want to risk getting into.[28] What is important to emphasize, therefore, is that drugs are developed primarily for markets, not diseases.

Related to the unmet medical need is the pharmaceutical company's "wish list", which is what is called the *package insert*, that describes the properties of the drug once it gets approved for marketing. These properties have to do, firstly, with the indications for the use of the drug. Pharmaceutical companies want the broadest possible indications. Secondly, they have to do with warnings regarding the use of the drug. It is possible for physicians to prescribe use of a drug that isn't indicated on the label (off-label use), but pharmaceutical companies prefer not to rely on off-label use for covering certain indications, as it tends to be much less financially rewarding than on-label use.[29] Drug development plans, therefore, are significantly organized from the get-go in terms of what the company wants on the package insert.

The stages of drug development then go from an idea to a multi-disciplinary project team through discovery to manufacturing. The key first step after going through these preliminary processes, in the US, is the filing of an investigational new drug (IND) application with the US Food and Drug Administration (FDA). This is the beginning of what transpires as a lengthy dialogue of the pharmaceutical company with the FDA, that extends all the way through the drug

[28] Actually, the situation is a little more complicated. While on the one hand, developing a "me-too" drug allows an assessment of existing markets for the drug, on the other, it is much harder to quantify or predict *how much* of the existing market share will be successfully cornered by the new drug that gets developed. In other words, one can assume a 100% market share for a novel drug, but not for a drug that is simply an improvement of existing therapies for a particular indication. In the latter case, in fact, it is not rational economic calculation but strategic marketing practice – in the form of selling the new drug to physicians, or to consumers through direct-to-consumer advertising – that will really determine the market share. This is why sales and marketing is much more than a calculating agency for a pharmaceutical company, and also why companies spend so much on their sales and marketing forces. Many thanks to Naira Ahmad for discussions that helped me clarify some of the difficulties and contradictions involved in assessing pharmaceutical markets.

development process to launch. The consultative role of the FDA with industry is exceedingly important throughout the drug development process. After this, the drug enters Phase II clinical trials, then Phase III, before filing a new drug application (NDA).

The earliest stages of trials for a drug start with pre-clinical testing, which involves the identification of an appropriate model system *in vitro* and *in vivo* (the *in vivo* system being an animal model);[30] the definition of end points (what are called outcome variables); an initial study of efficacy, and an initial study of toxicity. In many ways, the initial toxicology constitutes the most basic and important early study in the drug development process, because it will indicate whether the drug is at all safe to even try going further with. Toxicology studies involve looking first at a single species for acute toxicity (what is known as an LD_{50} study), then at multiple species with more prolonged exposures to the drug (of 30 – 90 days) followed by a full autopsy evaluation of any animals that die in the process. After this comes the clinical pharmacology, which involves studying pharmacokinetics (what the body does to the drug) and pharmacodynamics (what the drug does to the body), and coming up therefrom with dosing schedules for humans. The essence of drug development lies in relating pharmacokinetics to pharmacodynamics, as it is this relationship that ultimately relates to dosage.

Pre-clinical testing is done in order to gather the data necessary to file an investigational new drug (IND) application to the FDA. A successful IND is needed to try the drug in humans. Complete pre-clinical data limits the risks in clinical trials. Pre-clinical tests are done in test tubes, cultured cells and animals. This is a stage at which pharmacogenetic tools -- sequence analysis, expression analysis and family and population studies – could be very attractive strategically for pharmaceutical companies. The strategic importance arises because pharmaceutical companies are very eager to kill those projects that eventually won't lead to the

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[29] Though it is always possible to add further indications to the package insert subsequent to initial approval.

[30] This is generally what smaller biotech companies do a bad job of.

development of an FDA approved therapeutic as early in the process as possible. One way to use pharmacogenomics, as explained in greater detail in Chapter 8, is to profile the genes involved in coding for the isoforms of the cytochrome P-450 family of enzymes, which are involved in drug metabolism. Pharmacogenomics can increase drug efficacy and reduce risk to patients by predicting their drug response based on their genetic profile, and can be used to develop diagnostic tests for directing therapeutic decisions for improved care.

Clinical testing in humans consists of four phases. Phase I involves pharmacokinetics and initial human safety testing, and is usually carried out on up to 50 normal volunteers. The purpose of this phase is to narrow the dosimetry to one – two doses. Phase II involves dose finding in human disease, and it is in this phase that specific patient populations who can signal efficacy are leveraged. Usually about 100 patients are recruited for Phase II trials. Phase III trials are the pivotal clinical trials for the NDA. Phase IV trials are post-marketing clinical trials for new indications or to answer new questions. A pharmaceutical company really needs its Phase III trials to be successful close to 90% of the time, because this is by far the most expensive stage of the drug development process. In other words, if a drug isn't going to work, or is going to be too toxic, the company would really like to know so before going in to Phase III. Also, a separate Phase III trial is needed for each claim the manufacturer makes for the drug. This also means that, strictly speaking, one can only get intellectual property protection for specific claims, and, though rare, it is possible for someone other than the original manufacturer to market an identical product with a different claim.[31] The valuation of a drug, were it to be out-licensed to another company (which is often the *modus operandi* adopted by smaller biotech companies who don't have the capital to take a drug all the way to market), increases exponentially in value the further through the clinical trials process it has gone, though such valuations are often extremely critical

[31] For example, MIT has obtained a use patent to use Prozac, manufactured by Eli Lilly, for pre-menstrual syndrome. See http://web.mit.edu/newsoffice/nr/1997/pms.html for MIT's press release on this matter.

judgment calls made by the in-licensing department of the concerned (usually big pharmaceutical) company.

Therefore, clinical trials are, from the get-go, about integrating both clinical and economic *research* efforts. Pharmacoeconomics is not simply a given body of knowledge that biological researchers can draw upon to formulate research and trial designs, but is rather constantly evolving with and being co-produced by research considerations. Further, this emphasizes the basic point that drug development is *not* about linearly progressive science that drives evolving economic considerations to adjust to its progress. Rather, it really is about the operation of a whole set of economic indices that are based in various forms of market calculation, cost-benefit analyses and risk profiling.

Phase I trials represent the first exposure of humans to the drug being developed. Most often, as mentioned above, normal volunteers are recruited to address risk / benefit issues on single dose and multiple dose schedules. This is a major point at which genomics, especially population genomics, is likely to have an impact (see chapter 8 for a further elaboration of the use of genomics in clinical trials).

Phase II sees expanded clinical testing for efficacy in the target population. These are controlled clinical trials, in which expanded pharmacokinetic profiles are developed along with tolerance profiles, that indicate side effects and dose tolerance. Endpoints are established at this stage, making this the stage where measurement technologies become important. A successful Phase II development program should assure success in Phase III. Dose measurement really is the key here, and of course dosage is intimately linked to race, gender and the problematic notion of population. I will return to this in the last chapter while talking about how personalized medicine is all about generating information at the population level, when the "population" is often arbitrary and hard to define. This is a key point of insertion for genomic approaches (see Reardon

2000 for the controversial history of population genomics as science and as organized [public] scientific enterprise in the Human Genome Diversity Project).

Phase III trials are large scale controlled randomized clinical trials. These are the trials that are used as the basis for submitting an NDA to the FDA. What might be called "pharmacovigilance" becomes integral to the operation of Phase III trials and after. This is because a truly successful drug development process that leads to a blockbuster drug has within it the germ of a contradiction that can manifest itself quite acutely after successful Phase III trials. This is that drugs, after Phase III, are basically approved on the basis of trials in five to ten thousand patients. Certain adverse events, however, occur at much lower rates (for example, once in every 50000 patients). Therefore, there could be serious adverse events that do not show up in Phase III trials, and that could become serious problems in a really successful drug that has a very large market.[32] There are two antibiotics that have actually faced such problems. Augmentin showed rates of liver failure of 40 / 100000 patients taking the drug after it was approved, an indication that didn't show up in clinical trials. A much more publicly covered adverse event surrounded Pfizer's Trovan, which is a fluoroquinolone that looked like the best of its class to have come along at that point. Within six months of its approval, reports of liver failure started appearing, at a similar rate to augmentin, and the drug had to be withdrawn.[33] The result of such adverse events has been a greater emphasis by pharmaceutical companies and the FDA on post-marketing surveillance (what is known as Phase IV). An increased prevalence of Phase IV testing makes it less likely that drug prices will get cheaper.

A major actor in the clinical trials process is the clinical research organization (CRO). This is a lab (often private) to which pharmaceutical companies tend to outsource clinical trials

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[32] Pharmacovigilantism and its opposition by pharmaceutical companies of course brings into sharp focus the discursive power and strategic importance of the public relations apparati of pharmaceutical companies.

[33] For FDA's public health advisory regarding Trovan, see http://www.fda.gov/cder/news/trovan/trovan-content.htm.

operations. The job of the CRO is to accumulate trial data and keep records; they are generally not involved in the design of the studies, which is usually done by the pharmaceutical company itself.

The relationship between the pharmaceutical industry and the FDA has been an ambivalent one, and is not something that I explore fully in this dissertation. However, a brief mention of some of the contradictions embodied in this relationship would be worthwhile in understanding the larger institutional dynamics within which drug development (and clinical trials in particular) operates.

Contrary to popular intuitive perception, the pharmaceutical industry really does welcome the existence of the FDA, because it provides a foil for adverse events that, if seen as the consequence of an unregulated drug development marketplace, could represent disastrous PR for a company. In practice, however, the FDA's stringent regulatory requirements are what contribute dramatically to an increased time and cost of drug development. Therefore, ideally, they would like the FDA to "streamline" its activities in order to be as close to a rubber stamp as possible. This is reflected in the following quote from an overview of the drug development process by John Somberg (1996: 17), a clear enthusiast of the pharmaceutical industry and the free market:

> There are times when the delays [at the FDA] are needless and the debate is not helpful.... [E]xcessive drug regulation is not the goal. Rather more expeditious, less costly development in the information age is a goal that needs to be set by the FDA. A case-by-case review is no longer needed. To have each data point separately chronicled and meticulously reviewed for efficacy and toxicity by a junior reviewer is an immense waste of time. Having the primary reviewer recreate the NDA piece by piece and then producing [*sic*] their own summary is a laborious process that obviously can take a year or more. The NDA is put together by hundreds of individuals highly trained in the pharmaceutical industry and having one or two people go through this on a line-by-line

basis and check every data point and reanalyze the presentations is going to be a most arduous time-consuming process.

In other words, people like Somberg would like the review *process* to exist, as long as it does less reviewing. Presumably, in the case of an adverse event in such a review situation, the blame could also conveniently be placed on the FDA's "shoddy" review mechanisms rather than on the industry. Paradoxically, it is also true that the laborious FDA procedures are a competitive advantage for big pharma over smaller biotech companies. While in absolute terms, FDA reviews lead to increased delay and expense for pharmaceutical companies, in relative terms, it's a delay and expense that big companies can deal with much more readily than small ones. It is also true that less stringent approval procedures do not necessarily need to lead to less stringent monitoring of drug safety. In Britain, for instance, initial approval tends to be much quicker than in the US because of less stringent clinical trial requirements up to Phase III, but there is much greater post-marketing surveillance of the drug there than there is in the US.

Therefore, a stringent American regulatory environment has led to a legitimate "ethical" image being created for the clinical trials procedure in the US. This is a particular, historically specific, framing of ethics, *as* concerning itself specifically with safety rather than other possible "ethical" issues, that goes back to the marketing of "ethical pharmaceuticals" as safe, prescription, non-quack medication in the early part of the 20th century (see Silverman 2000 for a discussion of ethical pharmaceuticals). A similar concern with ethics *as* safety manifested itself in the initial years of the biotech industry, with the Asilomar conference on recombinant DNA issues concerning itself exclusively with safety concerns surrounding recombinant DNA experiments. US clinical trials fit this ethical paradigm, of ethics *as* safety.

However, issues around clinical trials, I argue, don't just have to do with ethics and experimental regimes, but relate directly to modes of production. For example, Indian pharmaceutical companies that might want to sell generic drugs in the United States need to set

up a manufacturing plant to FDA specifications, which is much more expensive than the plants in which they manufacture drugs for consumption either in India, Africa or Europe (which usually adhere either to South African or British regulatory guidelines). Just as FDA guidelines operate as a bigger barrier to biotech companies than big pharmaceutical companies, they in this situation operate as barriers to entry for "Third World" pharmaceutical companies into US marketplaces. In other words, regulatory environments quite literally regulate capital flows, setting up a political economy of drug – subject – capital circulation that is completely intertwined: the "Third World" becomes porous, especially as a site for recruitment of subjects, while US borders become more rigid. It is in such a political economic regime of differential circulation that the "homogenizing" effects of global trade as instituted through multilateral fora such as the World Trade Organization (WTO) need to be situated and read.

The rationality of pharmaceutical governance – what one might call *pharmamentality* – that emerges around clinical trials is particularly emphasized when it comes to pharmacogenomics, which, as I describe in detail in Chapter 8, is about the stratification of trial populations on the basis of genetic variability to drug response. On the one hand, as the industry enthusiasm for pharmacogenomics generally gets articulated, pharmaceutical companies absolutely want to stratify patients based on *safety* profiles – they absolutely do not want a drug either to fail clinical trials or be pulled off the market because of adverse events that only occur in certain population segments that could be identified and isolated from the trials. On the other hand, pharmaceutical companies are much less enthused with the idea of stratifying patients based on *efficacy*, because that will fragment their market. A drug that doesn't work for someone is not a public disaster in the way that a drug that is shown to be toxic is, and indeed the FDA's

own concerns, in spite of being stated as being both about safety and efficacy, and much more about monitoring safety than monitoring efficacy.[34]

For a small biotech company, however, pharmacogenomics presents a whole different strategic rationality, as it may well want the fragmentation of, for instance, Bristol Myers-Squibbs' oncology market today (thereby allowing a rupture in big pharma market monopolies), but not its own fifteen years from now, when it (hopefully) becomes a big pharmaceutical company in its own right. The emergent rationality of pharmacogenomics has everything to do with the structural contradictions inherent to the marketplace as they get exacerbated and made visible by clinical trials regimes.

A major mode of analysis that I adopt throughout this dissertation is, indeed, to map such structures of contradiction, as a way of getting at pharmamentality without simply attributing motives. It is important, however, that such a structural analysis is always tempered by a mapping and understanding of the political agencies of different corporations.[35] I believe it is precisely this challenge, of *analyzing political agency in the face of structural contradiction*, that Marx (1977 [1852]) faced in the writing of *The Eighteenth Brumaire.* Of course, it is difficult to get access to something such as corporate political agency, for instance in the case of pharmaceutical corporations and their interactions with the FDA, especially when companies themselves are extremely secretive about their actions. At best, it is possible to construct tell-tale patterns from publicly available FDA information, patterns really that are more illustrative of particular

[34] The parallels of such logic to the logic of the automobile industry are striking. Car makers have never been particularly worried about the odd car that doesn't perform so well, but are absolutely terrified of cars getting a reputation for being unsafe, even if that reputation is based on accidents in the hands of particularly crazy or maverick drivers. For an early discussion of safety issues in the automobile industry, see Nader (1965).

[35] I am grateful to Harry Marks, for instance, for pointing out to me that Eli Lilly has always been particularly aggressive in pushing the political limits of FDA regulation, in ways that other companies have not been willing to do. In other words, corporations in the same structural position do not necessarily act the same way, and these strategic patterns are important to the dynamics of the strategic terrain.

interactions with the FDA than they are evidentiary of the "character", in any fundamental sense, of particular companies.[36]

But what I also want to highlight through my brief account of clinical trials politics is *how values are incorporated into specific techniques*. The clinical trials procedures are a major site for such incorporations, of values in all senses of the word. They are the key set of practices that determine whether a pharmaceutical company can realize value off a promising lead compound by developing it into a drug. A well regulated procedure leading to the generation of a "safe" compound is both a requisite badge of ethical legitimacy for the drug and the company, but also a symbolic badge, in terms of the brand value that accrues to an FDA approved patented therapeutic. And these are techniques that directly speak to ethical issues about human subject experimentation globally, and trade issues in terms of global "homogeneity" and differential barriers to entry in a "homogenous" trade regime comprising different regulatory standards.

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[36] For instance, the FDA makes available a list of warning letters that it has sent out to different companies. As an experiment, I analyzed the warning letters the FDA had sent out over the last five years (1998-2002) to pharmaceutical company headquarters relating to issues of drug marketing and communications (which is a different category of a slap on the wrist than, for instance, warning letters regarding non-compliance with safety directives or good manufacturing practices). I found that, generally, companies get between one and three warning letters from the FDA's division of drug marketing and communications yearly. Generally, the number of warning letters issued in 2001 was far fewer than especially in 1998 and 1999 (whether because companies were being more compliant with FDA advertising regulations or whether because the FDA was being more lenient, with its regulations or their enforcement, I don't know). Pharmacia topped the list with 5 warning letters in 2001. In 1999 and 2000, it was Glaxo-Wellcome (the British pharmaceutical company that merged with SmithKline Beecham in 2001 to become Glaxo SmithKline) that topped the list, with 8 and 6 warning letters respectively in each of those years. Glaxo Wellcome, indeed, had 8 warning letters in 1998 as well, but lost out to Bristol-Myers Squibb (BMS), which staggering 15 warning letters that year. All in all, companies that received an average of more than 3 warning letters a year over this time period include Glaxo-Wellcome (7.3 a year for 3 years, before merging with SmithKline Beecham), BMS (4.4: after 1998, the number of letters BMS received dropped drastically, so that they have only received 7 warning letters in the following 4 years); SnithKline Beecham (4), Zeneca Pharmaceuticals (4; Zeneca merged with Astra in 2001 to becomes AstraZeneca), Pharmacia (3.6, together with its predecessor, Pharmacia Upjohn), Schering Corporation (3.4) and Merck (3.2). Companies that have received an average of less than one warning letter per year over this period include Boehringer Ingelheim (0.8), Johnson and Johnson (0.8), Fujisawa (0.8), Baxter (0.6), Abbott Laboratories (0.6) and Novo Nordisk (0.4).

I have so far broadly outlined and hinted at differences between big pharmaceutical companies and smaller biotech companies. The historical beginnings of the latter really can be traced to the beginnings of recombinant DNA technology (RDT). RDT led to an increased complexity of drug research, but it also led to a change in its institutional structure. Once again, it must be remembered that from the outset, drug development is a highly *inter-disciplinary* enterprise. The emergent biotech industry simply represented an additional new discipline that got incorporated into this enterprise, but one that institutionally got incorporated as the "discovery arm" of the pharmaceutical industry. The biotech industry has often played the role of a bridge, facilitating technology transfer between academe and big pharma. There are two modes of relationship between biotech and pharma: either pharmaceutical companies purchase small biotech concerns, or they form strategic alliances with them. An early example of the latter is the alliance between Genentech and Eli Lilly, in which Genentech developed human insulin, which was then marketed by Lilly under its trade name Humulin.[37]

The initial, pre-biotech, development of different therapeutic areas was largely spontaneous and occurred by chemical diversification, where often serendipitously found biological substances with therapeutic activities were derivatized to obtain better therapeutics with better safety and efficacy profiles. The major driver of new molecule development over the last 75 years has indeed been synthetic chemistry. These traditional methods haven't gone away with the emergence of biotech and now such tools and genomics and bioinformatics, but have been added upon.

[37] A major exception to this latter mode of functioning is provided by the Cambridge, MA based company Genzyme. In the words of its first CEO, Henri Termeer: "We looked at the other companies and came up with a strategy that is still the underpinning of what Genzyme does now – a diversified business, a plan to try to get profitable as soon as possible, all financed through product sales or selling equity rather than through corporate partnerships. This would give us off-balance-sheet benefits and still avoid us being dependent on other companies that might change their strategic plans. To this day, we still have no major partners" (quoted in Robbins-Roth 2000: 44).

Without a doubt, the story of the pharmaceutical industry has been one of the most dramatic stories of industrial growth in the 20th century. At the risk of an extremely compromised and sketchy history, it is worth mentioning that what is arguably the largest legal industry in the United States today was basically an "industry" consisting of a total of four drugs – digitalis, quinine, pecacuanha and mercury – at the end of the 19th century. The pharmaceutical industry was actually incubated in and grew out of the dye industry, just as, indeed, the biotechnology industry in the 1970s was initially supported by and grew out of the petrochemical industry. The "boom" in the pharmaceutical industry occurred in the 1930s, with the discovery of the sulpha drugs, followed by the industrial scale manufacture of penicillin as part of the World War II effort, which highlighted the importance of the links between defense and security needs during war and pharmaceutical innovation.[38] At the end of the 19th century, the two companies that could be called pharmaceutical companies were Bayer and Hoechst. They were joined in the 1930s and 40s by would-be pharmaceutical giants such as Ciba Geigy, Eli Lilly, Wellcome, Glaxo and Roche. The burst in natural product chemistry occurred in the 1940s and 1950s, starting with the successful development of streptomycin for the treatment of tuberculosis. The most successful early biotech companies that have produced biopharmaceutical products are Amgen (which has developed granulocyte colony stimulating factor [G-CSF] and eyrthropoietin) and Genentech (which has produced recombinant insulin, tissue plasminogen activator [tPA], human growth hormone and α-interferon products) (see Walsh 1998: 1-36 for a good summary, from which I have drawn for this account).

While I have argued so far for a considerably constrained playing space for biotech companies in the face of the power and clout of big pharma, it should not be misunderstood as a

[38] This becomes particularly pertinent in the wake of the recent bioterrorism scares in the United States, including the incidences of letters coated with anthrax spores in September and October 2001. At a venture capital conference that I attended in Boston at the end of October 2001, there was unmitigated excitement amongst the VCs I met, who saw anthrax as a pure and simple business opportunity because it would focus the attention of the Defence Department on the biotech industry. See also Hoyt (2002), who analyzes the

reflection on the biopharmaceutical market, which is very significant and growing. In 1997, the world-wide sales of biopharmaceutical products was over $7 billion, and is expected to grow to be in the region of $30-35 billion by 2003, which would be about 15% of the overall world pharmaceutical market (figures from Walsh 1998). At least three biopharmaceuticals: α-interferon, erythropoietin and recombinant insulin: had world market values of at least a billion dollars in 1997 (Walsh 1998: 10). On the other hand, biotech has had a wildly fluctuating presence on Wall Street, its stocks subject to periodic cycles of boom and bust. I analyze this in greater detail in Chapter 6.

If biotech has on origin story, then it probably is that of Genentech, even though Cetus Corporation, formed five years before it in 1971, is considered the first biotech company. It was Genentech's initial public offering (IPO) on October 14, 1980, however that really announed to the world the reality of biotech companies on Wall Street, and further pointed to the market possibilities of companies that could by definition only operate on promise for years, until tangible therapeutic products could emerge from their R & D efforts (and I analyze this fundamental driving temporal structure of the biotech industry in Chapter 6). Initially, however, biotech companies were far from focused on biopharmaceutical development, but were much more diffuse in their aims. This at least partly comes from the contexts of their genesis, with Cetus, in particular, being supported and incubated in large measure by the petrochemical industry in the 1970s (see Rabinow 1997: 46-78 for a brief history of Cetus as it transformed into a more focused biopharmaceutical company that eventually developed polymerase chain reaction [PCR]). While Genentech, co-founded by one of the developers of recombinant DNA technology, Herbert Boyer, was more focused on human healthcare aspects than Cetus initially was, it too had in addition industrial chemical applications and animal health as two additional foci in its initial

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role of the military-industrial complex in post-World War II America in the innovation of vaccine development.

years (indeed, Genentech's earliest achievements included the production of a human protein, interferon, and an agricultural product, bovine growth hormone).

It also needs to be remembered that the innovative capabilities of smaller biotech companies that I have alluded to is not simply the consequence of them doing "newer" science, but is actually a manifestation of a smaller, more adaptable and managerially supple organizational structure. Understanding how big pharmaceutical companies work involves being attentive to an inertia that is constitutive of their mode of functioning. This is an inertia that is often simply a consequence of the companies' size, and results in a reluctance both to embrace new technologies (therefore, most pharmaceutical companies "do" genomics by in-licensing genomic information from upstream companies, rather than undertaking genomics or bioinformatics research within their own companies) and to abandon what in some cases may be flagging technologies, modes of operation or research projects. This inertia due to size is further compounded by what might be called a strategic inertia, where pharmaceutical company managers are also reluctant to abandon technologies, products or markets in which their company or research division already has a significant lead or stranglehold. In other words, like many other "high-risk" enterprises (venture capitalism, which I will talk about later in this thesis, immediately comes to mind), the everyday strategic operations of a pharmaceutical company are all about *minimizing* risk rather than *taking* it.

Nonetheless, there is no questioning the starkly differential positions of power and bargaining that biotech and pharmaceutical companies occupy when they actually do business with one another. This is wonderfully captured in Barry Werth's accounts of the negotiations between the then start-up Vertex Pharmaceuticals with the British pharmaceutical giant Glaxo-Wellcome (now Glaxo Smith-Kline, or GSK), as they tried to interest Glaxo in a collaboration that was anticipated as structurally quite typical for biotech – pharma alliances (Werth 1994: 100-103). In this situation, the only way Vertex could interest Glaxo in the collaboration was by

revealing enough about their projected immunosuppressive targets that they risked being scooped by Glaxo: a risk that was considerably larger than being scooped by a competitor with relatively similar resources to Vertex's own, since Glaxo were in a position to throw many more people and far more resources into a project to gain competitive advantage than Vertex ever could, should they desire to develop targets in-house rather than through a biotech collaboration. The tension was even more acute because the decision by Glaxo to enter into a collaboration with Vertex would imply that the money for that collaboration would come out of the budget of Glaxo's immunology department, whose chief, Leslie Hudson, by virtue of his expertise in the field, was one of the people Vertex was presenting to. In other words, in order to interest Glaxo in a collaboration that at the time was quite crucial for Vertex's future, they had to convince a person who would be undercutting his own budget in order to accommodate the collaboration, and who further could walk away from the meeting having gleaned an intimate knowledge of the research being conducted at Vertex, decide against the collaboration, and use that information to compete, with far more resources and humanpower, with Vertex. The stakes, in such interactions, are high indeed for the biotech company, and they really have little choice but to hope that the big pharmaceutical company, perhaps as much as anything else because of its constitutive managerial inertia, will prefer a collaborative in-licensing agreement to an in-house research initiative.

There are, however, historical parallels between the biotech industry and the pharmaceutical industry in its early days, and one of those parallels has been the mantra of the "magic bullet", the drug that can cure not just the symptoms of disease but its causes, and that is tied inextricably into the miracle and magic that provides the drug development enterprise with so much of its symbolic capital. This mantra was first noticeable as far back as the the mid-1930s, with the development of the sulpha drugs, which really did mark the beginnings of the pharmaceutical industry as a legitimate industry rather than as a largely failed purveyor of quack medicine. Another parallel is the aggressive patent environment in the 1930s, that often did lead

to a stifling of innovation in ways ironically similar to the ways big pharmaceutical companies now accuse biotech (especially genomics) companies of stifling innovation through upstream patent protections, such as on DNA sequences (see Chapter 4 for an elaboration of this).

What is different, if one is to believe Werth's account of Merck in the 1940s in *The Billion Dollar Molecule* (which he uses as a backdrop in many ways to his story of Vertex in the early 1990s), is the fact that the existence of pharmaceutical companies *as a ruthless business alone* (in spite of the huge investment that the industry does place in the generation of symbolic capital by distinguishing itself as being in the business of therapeutic development), which, indeed, is not just a value system but a fiduciary duty for the heads of these companies under US corporate law, was far from naturalized in those days. Indeed, one of the criticisms I have often heard of pharmaceutical companies today is that their corporate cultures have shifted to an "MBA culture": that, unlike in the days of George Merck, pharma companies are not run by visionary founders, but by professional managers. Therefore, goes this line of criticism, pharmaceutical companies' corporate cultures today are little different from corporate cultures in the oil or tobacco industry, even though the symbolic capital associated with pharmaceutical development is significantly different.

This is very different from the image of the industry in the post-World War II years. For one thing, the industry had just emerged from a war effort, where it had been mobilized, pretty much in its infancy as a legitimate industry, in the cause of public health. At that point in time, therefore, the symbolic capital of especially the American pharmaceutical industry, which could easily distinguish itself from the German pharmaceutical industry that was heavily implicated in the Holocaust, did not come from saving individual lives through blockbuster drugs as much as it came from being a crucial ally of the State in the defeat of Nazism (I explore the former, current imaginary of the pharmaceutical industry as being in the business of individual therapeutic salvation in Chapter 7). But secondly, this tied into the public image of the leaders of Merck – its

founder, George Merck and its most famous chemist, Max Tishler – as altruistic, as being in the business, in the words on the cover of *Time* magazine in August 1952, of an industry that is "for people, not profits" (cited in Werth 1994: 131). Indeed, Werth goes on to tell of the annoyance that Tishler, a Jew who had been involved in Merck's wartime R & D efforts with a passionate zeal, felt when the company merged in 1953 with Sharpe and Dohme, who were best known for manufacturing throat lozenges, and who were keener to make products for people who were well rather than those who were sick, believing that the former represented a greater market.

The current image of the Western pharmaceutical industry culture as "merely corporate" is also at odds with the image of the Indian industry, which, because of the provisions for bulk generic manufacture that were allowed by the Indian Patent Act of 1970, has been an industry whose fundamental value system (in every sense of the term) over the last 30 years has been based in making large amounts of cheap drugs available to many people in competition with other generic manufacturers. Here again, there is a "culture" that gets marked out and epitomized by people such as Yusuf Hameed, Chairman and Managing Director of Cipla, the Indian pharmaceutical company that (in)famously made available anti-retroviral therapy to Southern African countries at a third of the price that Western multi-nationals were selling these drugs at. While Cipla's action is in every sense a shrewd business move that garners symbolic capital while opening up potential African markets for the company, it is not an insignificant fact that Hameed runs a company started by his grandfather in the 1930s, and that he was one of the people involved in drafting the 1970 Act that was responsible, in almost sole measure, for the reduction in drug prices through the generation of a competitive generic market. Similarly, Anji Reddy, the founder of the Hyderabad based company Dr. Reddy's Laboratories (DRL), has succeeded in being hugely influential in creating a public image of DRL in his own image: studious, humble, academic, committed to research, anything but an "MBA culture". I will digress to a more detailed analysis of the Indian pharmaceutical industry in the next section,

before coming back to analyze some economic considerations in drug development, and the sorts of politics such considerations tie into.

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The Indian pharmaceutical industry

The Indian pharmaceutical industry is one of the most interesting "national" pharmaceutical industries in the world, in large measure because it has been co-produced by patent regimes. As mentioned above, the 1970 Indian Patent Act fundamentally helped shaped this industry into one that was capable of cheap reverse-engineered bulk drug manufacture, that enabled Indian drug prices to become amongst the lowest in the world. In 1995, India became a signatory to the World Trade Organization (WTO), and needs to be completely WTO compliant by 2005. It is in this context that I am interested in outlining a brief history of one Indian company, Dr. Reddy's Laboratories (DRL).

DRL started in 1984, very much a product of the business environment created by the 1970 Patent Act. At that time, the company purely concentrated on the development of cost-effective processes for existing molecules, catering entirely to domestic market requirements. The provision in the 1970 Act that enabled this was one that only allowed process patents, and not product patents, thereby allowing Indian companies to manufacture molecules that were already available in Western markets. DRL's focus initially was to supply active pharmaceutical ingredients (APIs) to other companies at an affordable price for bulk drug manufacture. In 1988, they started making their own branded formulations. This was quite a profitable business model, and allowed a number of Indian pharmaceutical companies, most notably Ranbaxy and Cipla, to generate significant revenues. Indeed, the profitability of such a business model was one that was judged by revenues rather by growth (growth being the index by which Wall Street judges U.S. pharmaceutical companies). The change in patent regimes towards a WTO-imposed one therefore necessitated a paradigm shift in the Indian industry, as after 2005 Indian pharmaceutical

companies will not be able to take a molecule already on the market, remake it through an indigenous process and then sell it. Indian companies will now have to focus on novel drug discovery.

DRL actually envisioned drug discovery as a business model well before India became party to the WTO: in fact, they were thinking of this as early as 1986, even before they had started putting reverse engineered branded formulations on the domestic market. Along with Ranbaxy, India's largest pharmaceutical company, DRL has been India's R & D pioneer.

The reason for this, according to the Director of DRL's research foundation (Dr. Reddy's Foundation, or DRF), R. Rajagopalan, has to do with the fact that the major visionaries who charted the agendas of these two companies, Anji Reddy for DRL and Parvinder Singh for Ranbaxy, were themselves scientists – an argument for the shaping of a corporate ethos by the value systems of its visionaries that completely echoes the story of Merck under George Merck in the 1940s. Anji Reddy was trained as a chemist at the National Chemical Laboraties, Pune, a lab of India's Council for Scientific and Industrial Research (CSIR), and itself the pioneering Indian public lab to go global.

In 1993 (a year before India signed the Dunkel Draft at the Uruguay Round on the General Agreements on Tariffs and Trade, GATT, the prelude to India's becoming a signatory to the WTO), DRL officially established its research foundation, DRF, on a sprawling compound north of Hyderabad, a beautiful 100,000 square foot building with lots of courtyards, open corridors and fresh air, expensive art work on the walls, bouganvillea lining the driveways, that looks more like a Mediterranean villa that it does a research lab. DRL, the parent company, recently merged with Cheminor, a bulk drug manufacturer that has provided active pharmaceutical ingredients to global pharmaceutical markets and that has a manufacturing facility built to FDA specifications, and, in addition to DRF, has seeded a small U.S. based subsidiary that focuses on biopharmaceutical research, Reddy U.S. Therapeutics. The founding of DRF is

not simply a reflection of DRL's interest in R & D; it is also a sound strategic move, since non-profits like DRF can import chemicals and equipment without having to pay the duties that would be applicable to for-profit chemical or drug companies.

While a few Indian companies are getting into novel drug discovery ventures, the basis of these efforts, Reddy U.S. Therapeutics notwithstanding, still lies firmly in traditional organic chemical synthesis rather than in biopharmaceutical development. Understanding DRL's rationale behind their continued, what might be perceived as "conservative", faith in organic chemistry as the continuing route to drug development, will help place in a certain situated context the hype in the West surrounding the impacts of biotechnology, genomics and proteomics on the pharmaceutical industry, and will also perhaps help one understanding of the ambivalent enthusiasm that even Western pharmaceutical companies have for these technologies. For this, I will quote DRF's director Rajagopalan extensively:[39]

> In my personal opinion, sequencing genes *per se* is not going to say anything. The gene has to be functionalized: what exactly is the function of the gene? What exactly is the protein that is going to come out? People might take the gene sequence and make an arbitrary call, okay, we'll take the patent. But that may not give us any information. We have to go in deep. That is, more and more information from genomics, and *functional* genomics, is most important. And proteomics. They are going to really serve us lots of templates for making molecules.
>
> Now we know what exactly goes wrong in the case of breast cancer. A particular gene has been up-regulated. A particular protein is over-secreted. A particular thing has been over-expressed. Now expression *per se* is not going to lead us to disease or lead us to abnormal proteins, by looking at one aspect you cannot... looking at one tooth of an excavation, you can't build a whole man. It's not that simple. Even though most of the

[39] R. Rajagopalan, interview with the author, 8 August 2001.

multi-national companies invest, a lot of hype has been created, I still feel it will take some time for us to understand what exactly is happening.

Similarly biotech also. Biotech is a sort of buzzword now. They say everything is going to be biotech. I have a strong belief in that also. But at the end, we have to go step by step. It cannot be done just overnight. You know in the US, especially on the West Coast, there are one dozen companies that have started and one dozen companies that have vanished. Because most of the companies are based on one platform technology. A particular professor or particular scientist feels that is going to be the answer, and then when they try to translate it in terms of effectiveness in humans, they fail. We tend to make it very simple, Kaushik. You know, our body is highly complex.... Definitely they are the pieces of a jigsaw puzzle. Today, it may not be helpful for you to understand it. But in the long run, we can put it together. That is what my perception of genomics and proteomics and biotech industry is. Definitely they will be a future source of potential, but it is too early for us to make sort of an effort that, okay, you just have to jump in.

Rajagopalan, therefore, straddles an interesting middle ground. He does not buy into the hype surrounding biopharmaceutical development, whether in the biotech, genomics or proteomics industries, because it is a hype that he feels, as a business, DRL cannot afford to buy into. But his is not a cynical repudiation of genomics as "simply hype" either. On the one hand, it offers a stark contrast to the extreme enthusiasm shown by some for the biotech industry, as somehow a one-stop *replacement* for outmoded and antiquated chemical bases for pharmaceutical development, enunciated quite bluntly by analysts like Cynthia Robbins-Roth, precisely the West Coast U.S. biotech consultant that Rajagopalan would probably be wary of. In sharp contrast to Rajagopalan's views, for instance, Robbins-Roth prefaces her glory story of the biotech industry, *From Alchemy to IPO*, thus:

[T]here are 65 new drugs on the market that came from biotech labs and another 140 in the final stages of the regulatory process. Every day, the industry labs generate more

> information about how our bodies work, in sickness and in health, down to the single-molecule level. For the first time in history, it is possible to design new treatments for diseases such as Alzheimer's disease, Lou Gehrig's disease, breast and prostate cancer, and heart disease – and aim those drugs directly at the molecular causes of the disease. More effective drugs, with fewer nasty side effects, will be possible because of biotechnology....
>
> As we begin the 21st century, literally hundreds of new biotech projects begun in the last decade are poised to power into the marketplace. This explosion will fuel opportunities for investors and employees alike, and we will all benefit from the products....
>
> Biotech's Golden Age lies ahead. (Robbins-Roth 2000: ix-xi).

On the other hand, Rajagopalan's views are a reflection of a certain temporal understanding, whereby insights gained in the present build up to future technoscientific advancements, that is completely inverted by the very rationality of biotech, that, as I argue in Chapter 6, depends on the conjuration of futures in order to create the present that might enable those futures to happen. In other words, the contrast between Rajagopalan's careful appraisal of the promise of biotech and Robbins-Roth's enthusiastic embracing of it is not simply a contrast between cynicism and hype, conservatism and risk-taking, chemist and biologist, Indian and American, but relates to their very different conceptions of temporality and its relationship to inventiveness and to business strategies.

Rajagopalan, further, points to the fact that the difficulties with biopharmaceutical development are not simply difficulties in understanding enough to develop a molecule that might be therapeutically efficacious, but also have to do with delivery systems that biopharmaceuticals often require compared to small chemically synthesized drug molecules:

> [Y]ou cannot go in to treat every disease by giving proteins, you know? Patient compliance is going to be a problem. Some sort of a via media has to come out. Novel delivery systems, so that the proteins can be given. As you know, now people are trying

> to make insulin that can be inhaled. You know, otherwise insulin has to be given by sub-cutaneous injections. No patient would like to have the injections. It is still painful. Nothing like popping one pill, rather than taking one prick.

In addition to the technoscientific difficulties Rajagopalan sees in an unreflexive embrace of biotechnologies are the actual logistical difficulties for an Indian company doing so:

> In our country, we are quite strong at organic chemistry. We have to take leverage on our strength. We cannot compete with all the things, what is happening at NIH or some private competitor, Celera and all. We cannot really compete with them, because they are much more advanced in terms of technology.... We are leveraging the strength of our country, which is quite strong in organic chemistry.... You know, you cannot really fight the multi-nationals. Multi-nationals have got strong muscle power, money power. They have deep pockets. There'll be about 5,000 people working in that R & D, whereas a company like Reddy's, you can't expect them to. We are 250 people.

Two things emerge from this analysis. The first is the question of leveraging "national" strength. For DRL, that "national strength" is in organic chemistry. However, there is also the case of the Centre for Biochemical Technology, the CSIR lab that I write about in detail in Chapters 5 and 7, that is precisely going into the sorts of genomic research that Rajagopalan is wary of because its Director, Sameer Brahmachari, feels that India can leverage its "national strength" in population genomics. The "national strength" in question here is a combination of software talent that can be put to use to generate bioinformatic tools and applications, combined with the genetic *heterogeneity* of the Indian population. The latter itself seems a paradoxical position for those who are aware of the pitches made by the Icelandic genome company DeCode Genetics, that is also a population genomics company that is leveraging the purported genetic *homogeneity* of the Icelandic population as their source of competitive advantage. The DeCode pitch suggests that it is in homogenous populations that genetic variability really can be traced back to population patterns. Brahmachari, on the other hand, asserts that heterogenous genetic

populations can be significant sources of genetic information if, like in India, they are present in large families with very little genetic counselling, thereby allowing researchers to do linkage analysis on genetic diseases across whole families in a way that just wouldn't be possible in the West.

The difference in the apparent "national strengths" between DRL and CBT doesn't just have to do with the fact that DRL is a corporation in the business of doing research that can be translated into commercial value, while CBT is a public lab that wants to do "basic" research, since much of CBT's population genomics effort is feeding into a start-up it has seeded, Genomed, which has been co-seeded by another Indian pharmaceutical company, Nicholas Piramal India Limited (NPIL). In other words, "national strength" is invoked to provide justification and rationality to two very different ventures relating to drug development, in the case of DRL to offset any potential criticism that they might somehow be acting conservative, or behind the times, in their continued faith in organic chemical synthesis, the other, in the case of CBT-Genomed-NPIL, to rationalize what really is a high-risk enterprise that directly throws them in competition with Western genome companies like DeCode.[40]

The major question facing the Indian pharmaceutical industry today does regard the effect becoming WTO compliant will have upon it, a question of what exactly the consequences will be of a paradigm shift towards a property regime that will not allow reverse engineered bulk drug manufacture. According to Rajagopal (and this in spite of the fact that DRL is perhaps amongst the Indian companies best positioned not just to deal with WTO, but also to take advantage of the new regime to itself leverage global playing fields), much of the Indian industry

[40] DRF has, indeed, been quite successful so far with its R & D efforts, and has struck three major licnesing deals with multi-national pharmaceutical companies. DRF 2593 is an anti-diabetic molecule that has been licensed to the Danish pharmaceutical company Novo Nordisk (as early as March 1997), after which was licensed another anti-diabetic, DRF 2725 in August 1998, also to Novo Nordisk. DRF had as of summer 2001 received $8 million from these deals, and is likely to get a total of $17.3 million in fees if the molecules pass Phase III. In May 2001, they licensed DRF 4158, a novel insulin sensitizer, to Novartis for $55 million in up-front and milestone payments.

was against WTO, and he feels – in stark contrast to constant government assertions to the contrary – that the government was, in fact, directly pressured by the West into becoming a signatory. The basic fact that needs to be remembered is that the Indian pharmaceutical industry was not a sick or a dying industry in need of market rejuvenation, but was, throughout the 1980s, a quite profitable industry. Therefore, changing over to a WTO regime, for this industry, does not just mean adopting new and unfamiliar methods of drug discovery, which necessitates the setting up of R & D facilities; it also means abandoning a revenue based business model in favor of the potentially lucrative but far riskier growth based model, in which Indian companies would be pitted in direct competition against more powerful Western companies in order to achieve any growth.

There are, however, an increasing number of Indian companies who have been in the process of retooling themselves to become companies that can discover new chemical entities. The stakes, as suggested earlier, are not just profits, but global expansion. The niche that those Indian companies, such as DRL, that invest in R & D occupy becomes similar to that a Western biotech company occupies with respect to big pharma. DRF, for instance, has 250 people, the size of a small-to-midsize biotech company; it is involved in drug discovery rather than development, and out-licenses any molecules it discovers to big pharma, so that the latter can take the molecule through clinical trials. From the revenue garnered from such licensing, companies like DRL hope to move further up the value chain by holding on to the molecule longer before out-licensing it. While it is near impossible to actually get breakdowns of milestone payments at different stages of drug development when the drug has been licensed from a discovery company to a development company, it is well understood that the value of a molecule increases exponentially the further up the clinical trials it gets taken before being out-licensed.[41]

[41] The difference of DRL / DRF from many US biotech companies is that the former are organizations run by some of the most experienced members of the Indian pharmaceutical industry, many of whom have been in the business for the last 20-30 years, and therefore come much closer to the ideal type of the "grey-

The company with the most aggressive global ambitions in India, however, has not been DRL but Ranbaxy, which already operates in 40 countries, with five manufacturing units outside India. While DRL is focused on out-licensing as the cornerstone of its business strategy, Ranbaxy is trying to take molecules to clinical trials on its own. The corporate cultures of the two companies also could not be more starkly different. As mentioned earlier, DRL is a quintessentially "scientific" company: laid-back, pleasant, relatively open and deeply informed by Anji Reddy's own background as a basic researcher. Ranbaxy, on the other hand, is an aggressive streamlined corporate entity, providing, by Indian standards, many luxuries and benefits for its employees, but demanding more than its pound of flesh in return. The driving force there is the head of research, J.M. Khanna. Ranbaxy has a high employee turnover, and every former employee I have talked to has emphasized Khanna's authoritarian manner of running research activities in the company. One former employee told me that when even senior managers in the company made presentations to Khanna, their hands would be visibly trembling.

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Management of pharmaceutical R & D

The question of innovation is the question of where the transition from scientific research to drug development originates. Drug research and development (R & D) is funded by both the public and the private sectors. This section briefly traces the enabling role that the public sector plays in making drug development possible.

The question of why is it even an important question to ask where research money for drug development comes from is both a banal and an important one to ask, because along with it are tied issues of both ownership and productivity, that are central thematics returned to throughout this thesis. It is important to emphasize here that it isn't just industry that is interested

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haired big pharmaceutical manager" that epitomizes the perceived managerial caricature of American big pharma companies.

in return and productivity, with public labs left to pursue "basic" science out of some kind of "pure, altruistic" motive. The National Institutes of Health (NIH) is as interested in returns on investment as big pharma is. The difference lies in the constituencies (Congress versus a company's board of directors) that are involved in the respective cases. In other words, I am arguing that political debates over the corporatization of research are best served not by taking recourse to some inherent (and possibly ahistorical) notion of the "purity" and (in Robert Merton's terms) disinterestedness of public research, but by acknowledging that questions of representation – democratic access to control over research agendas and consequences – is what is really at stake. It is the *privatization* of *public* research (an encumbrance of the commons and the stifling of certain types of discursive and strategic praxis), rather than the *corporatization* of *academic* research (the shifting normative structure of what counts as legitimate science) that is of primary political concern to me throughout this thesis. Of course, the fact that both of these are the same process of science becoming venture science means that it is impossible to entirely disentangle the two as political concerns; but to the extent that the changing normative structure of science does bother me, it is because of the constraints that such changes place on genuinely democratic representational possibilities in the republic of technoscience.

The question of where research money comes from is also an ethical question that is recognized as such within the scientific community. Editors of the major medical journals, the *New England Journal of Medicine*, *Journal of the American Medical Association*, *Lancet*, *Annals of Medicine* and *British Medical Journal*, have for instance set up a series of disclosure rules for all authors in terms of where funding has to come from, the concern here being one of avoidance of conflicts of interest.

A working paper by MIT's Program on the Pharmaceutical Industry (POPI) has studied the contributions of public sector and private sector R & D to commercial drug development (Stallings et al 2001). This is based on and taking off from two landmark studies on this topic. In

1976 Comroe and Dripps published a seminal paper that has been hugely influential on science and technology policy, demonstrating that 41% of all articles judged to be essential for later clinical advance in cardiovascular and pulmonary medicine between 1945 and 1975 (including in cardiac surgery, vascular surgery, oral diuretics, chemotherapy and antibiotics to prevent infection and prevention of polio) were not clinically oriented at the time of the study and 62% of key articles described basic research (Comroe and Dripps 1976). This was an identification of what the researchers called "essential bodies of knowledge", in a review and classification of 500 published articles into "basic", "clinical", "mission oriented" and "non-mission oriented" categories. A 1990 study by Robert Maxwell and Shohreh Eckhardt found that 60% of innovative drugs would not have been discovered or would have taken much longer to discover without research contributions from government labs and non-commercial institutions (Maxwell and Eckhardt 1990). The conventional wisdom that comes out of such studies is that fundamental scientific advances are much more likely to come from public sector research and are crucial inputs to the development by the private sector of successful commercial products.

The MIT POPI study identifies what constitutes the top therapeutic advances, considers the relationship between top therapeutic advances and market success, undertakes a detailed literature review of 21 important drugs, conducts detailed field interviews with scientists at 13 large pharmaceutical firms and identifies the "key enabling discovery". Of course, this covers various modes of discovery and development, ranging from "old-fashioned" or "random" drug development, through mechanism driven research that involves targeted mechanism specific screening of compounds[42] and drugs discovered through fundamental science (such as cisplatin, erythropoietin [EPO] and β-interferon). Their results show that the overall percentage of "enabling" discoveries made in the public sector is 67%. This figure is 33% for drugs discovered through "random" screening, 90% for "mechanism" driven research and a 100% for drugs that

[42] The genomics era is premised on mechanism based drug discovery.

emerge from fundamental science. The insights they provide therefore are that most "basic" discoveries are made in the public sector; that there are very long lags between the "enabling" discovery and the enabling research that translates these discoveries into drugs; that publicly funded "clinical" or "applied" research may be as important as "pure" or "fundamental" research; and that the US institutional structure may play a crucial role in the transfer of knowledge from the public to the private sectors, with individual researchers playing a key role.[43]

Studies such as these assume importance in the context of the vexed relationship of drug development to drug prices. This is especially so in the US, which has the highest prices in the world for prescription drugs, but is increasingly becoming a global issue due to efforts at homogenizing global intellectual property regimes through the World Trade Organization (WTO).[44] The pharmaceutical company argument is that lower prices would lead to lower incentives to innovate. Of course, such an argument naturalizes as fact what is an implicit assumption, that it is the private sector that is chiefly responsible for breakthrough prescription drugs. This is the context in which studies such as the ones conducted by Comroe and Dripps, Maxwell and Eckhardt and the POPI group become important counters to pharmaceutical company rhetoric (even if they didn't intend to be appropriated thus).

Breakthrough drug development has always, at least since the sulpha drugs, had an element of miracle associated with it (and I talk about this in greater detail in chapter 7). It is this element of miracle that becomes an integral part of pharmaceutical company rhetoric – the fact that these are companies that are in the business of "Food, Health and Hope" (to use Monsanto's logo) is hugely significant to the symbolic capital that this industry accrues, symbolic capital that in all sorts of ways enables the refiguration of political terrains so that huge amounts of material

[43] A landmark Congressional Act that facilitates this transfer is the 1980 Bayh-Dole Act (1980 enactment of P.L. 96-517, The Patent and Trademark Law Amendments Act).
[44] Of course, this is a particularly poignant is situations such as the AIDS epidemic in Africa, which many anti-pharmaceutical company activists claim would not have been so serious if drug companies had made anti-retrovirals available at affordable prices to these communities.

capital can accrue as well. It isn't surprising, therefore, that an author like Cynthia Robbins-Roth, a long time biotech industry consultant, starts her account of the biotechnology industry, *From Alchemy to IPO: The Business of Biotechnology*, with the rhapsodic story of how IDEC Pharmaceuticals' monoclonal antibody Rituxan provided a miracle cure for a patient afflicted with what would otherwise have been an intractable cancer (Robbins-Roth 2000). These stories are not untrue – far from it – but what they hide is the economic context within which such "miracle cures" take place. It is in situating such miracle cures in political economic contexts that the story of Genzyme's Ceredase (and its successor drug Cerezyme) becomes so interesting. Here, I draw upon and summarize Merrill Goozner's history of this drug and its relationship to the history of Genzyme as a company (Goozner 2000).

Ceredase is Genzyme's miracle drug for Gaucher's disease, a rare genetic disorder of lipid metabolism that leads to progressive lung, kidney and bone problems and usually death by the early 40s, and that only afflicts about 5000 people worldwide. Fortnightly infusions of Ceredase, however, cost $8000, which means that an annual treatment regimen can cost nearly a quarter of a million dollars. In a context of a managed care environment where insurance companies constantly seek to reduce or remove coverage from patients who cost them so much (and Goozner's account does draw upon a real case, that of Brian DeGrenier, whose father had to face such insurance company battles to continue to get Ceredase treatment for his son), this puts such patients in a very vulnerable position.[45]

Of course, it must be remembered that it is only biotech companies that are even likely to develop such "orphan" drugs as Ceredase. But this does not mean that Ceredase has in any way been an unprofitable venture for Genzyme. With 1999 revenues of $479 million, Ceredase

[45] Of course, the political economy of healthcare reimbursement is an important part of the political economy of drug development, and as much so in countries (such as much of Europe) where the state has a significant role in healthcare reimbursement as in the managed care environment of the United States. Even without the direct economic pressures that operate in both managed care and welfare systems, there is a

accounted for 70% of Genzyme's total revenue (figures from Goozner 2000). According to its Securities and Exchange Commission (SEC) filings, Genzyme's pretax profits for the year were $223 million, compared to the $98 million it spent that year on research and development.

These are the sorts of figures that are used both by companies and by activists to justify their cases for or against exorbitant pricing. Companies will precisely point to the fact that orphan drug innovation would never have happened without the possibility of patent monopolies that allow exorbitant pricing, which therefore again gets justified through a logic that suggests that exorbitantly priced drugs are better than no drugs at all. Activists such as Goozner will precisely point to the fact that drug regimens are exorbitantly priced, and make access to therapeutic advances impossible or very difficult for the consumer.

This becomes particularly magnified in the context of biotech (as opposed to big pharmaceutical) companies, because while on the one hand one could point to the huge profits Genzyme makes from Ceredase in a manner that accuses Genzyme of somehow illicit surplus value generation (and there is no doubt that the surplus value that successful drugs generate is enormous), these figures also suggest how important Ceredase is for Genzyme's continued existence as a company. The field of politics, in drug development (which is always already intimately related with drug pricing), is quite literally a struggle for survival, where the survival of the company is often pitted directly against the survival of the patient. Of course, when it is a big pharmaceutical company that is involved, the question of corporate survival is often not so acute, as bigger companies often don't depend to the same extent on a single drug for their revenues.[46]

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contradiction at the heart of the reimbursement process: health planners make reimbursement at a population level, while physicians prescribe at a patient level.

[46] While this is very true in speaking of pharmaceutical companies relative to biotech companies, the situation is much more complicated, since many of even the bigger pharmaceutical companies make 40-70% of their profits from one or two blockbuster drugs. This is why patent protection for those drugs is of such vital importance to these companies. Hence the serious hits that have been taken by Eli Lilly, with

The question of survival and incentive alone however still implicitly assumes a narrative whereby it is the corporation that is the entity responsible for drug development, and that it therefore ought to be "justly" recompensed for its efforts. However, as Goozner shows, the enzyme glucocerebrocidase, which is what Ceredase is, was purified, clinical trials conducted on two patients and the results published as far back as 1974 by Roscoe Brady, who has been a basic researcher at the NIH since the 1950s and who still conducts research in the field. Brady's problem in the 1970s was an "industrial" problem, of large scale manufacture of the enzyme for use as a therapeutic. This ramping up, and the provision of large quantities of the enzyme, was still done not in a company, but by researchers at Tufts University. And yet in the world of venture science, university researchers are always already corporate entrepreneurs in waiting, and indeed in this case it was the scientists at Tufts who provided Brady with the enzyme who then left Tufts in 1981 to form Genzyme to conduct dosing studies on the enzyme. Genzyme built an enzyme purification plant on the strength of $72 million raised from private capital markets, and it was this plant that finally enabled the generation of enough enzyme for clinical trials.

However, this plant relied on purification of the enzyme from placenta, which was still time consuming and costly. The next generation drug to Ceredase, Cerezyme, is a recombinant version of Ceredase. However, the gene for glucocerebrocidase was discovered not at Genzyme, but by public researchers at the Scripps Institute in La Jolla, from whom Genzyme licensed the gene.

It is in the context of these sorts of strategic and extremely high-stakes political terrains that the estimate of $500 million as being the amount required to bring a drug to market becomes so contentious, because much of the rationale for the subsequent rhetorical justification by the industry for their pricing strategies comes from the existence of this figure, that somehow serves

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Prozac going off patent, and Schering Plough, with Claritin going off patent. What is definitely the case is that big pharmaceutical companies can cushion the failures of upcoming products more easily than biotech

as a "fact" that can be bandied about without dispute. However, as Goozner argues, these are themselves extremely contentious figures that have histories tied into them. The figure is in fact derived from a substantially industry-funded 1991 study carried out at Tufts University (DiMasi 1991), which mentioned the figure to be $231 million. This figure was arrived at by looking at the number of new drugs approved by the FDA and dividing it into industry research and development budgets that were discounted for the length of time taken to bring a drug to market. Since then, this figure has been adjusted for inflation and the time taken for the development of new drugs. But, as Goozner says, two-thirds of development costs come in pre-clinical research, most of it taking place in government-funded settings. Further, as mentioned earlier, most drugs that come to market are not new drugs targeting new, genuinely unmet medically needs, but are, rather, "me-too" drugs that serve to improve upon already existing medication or to replace a drug that is coming off-patent. Indeed, as I have already argued, there is a serious disincentive for especially big pharmaceutical companies to invest in drugs that don't already have a predictable market on the basis of which market assessments for the new drug in consideration can be made. Goozner also indicates that company research and development budgets are invariably rivaled by their marketing budgets, and states that the direct marketing costs of pharmaceutical companies in 1999 was $13.7 billion (55% of their R & D budget for the year). Out of this, $1.8 billion was spent on direct-to-consumer advertising alone.

Having said this, it is true that pharmaceutical R & D is a complicated and expensive enough proposition for its planning and execution to be an integral matter of corporate strategy for a company. Pharmaceutical R & D is divided into drug discovery, drug development and marketing support (though often market support drives, rather than follows, the discovery and development). It is important to emphasize the distinction between the discovery (identification and prioritization of promising leads) and development (going through the clinical trials process

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companies can, since they usually have larger product revenues to fall back on.

for a lead compound that has been identified as a potential therapeutic) phases, because costs, and the strategic allocation of costs, differ in these two phases. The biggest cost in the discovery phase has to do with personnel, materials and facilities, but contracting becomes a major cost in the development phase, especially if the company contracts its clinical trials to a CRO. Often, strategic resource allocation within the company becomes a case of discovery and development teams *competing* with each other for company resources. The calculation of risk, which is the theme I will return to in the final chapter of this thesis, is a major driver of strategic portfolio development, which ultimately is about measuring risk-reward indices; these indices too are different in discovery and development.

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Early economic considerations in the development of a new drug

As mentioned above, a benchmark study describing the cost of developing a new drug is the Tufts University study by DiMasi et al (1991). A second benchmark study, which, like the DiMasi study gets periodically updated, relates to the returns to R & D for new drugs, and was done by Grabowski and Vernon (1994) at Duke University. The cost of developing a new drug, in studies such as DiMasi's, includes all costs of discovering and developing a drug to the point of regulatory approval, as reported by a survey of representative samples of large pharmaceutical firms. The cost of developing a new drug also incorporates the cost of failed candidates, and the opportunity cost of capital. As mentioned above, DiMasi's study puts this figure at $231 million. An Office of Technology Assessment (OTA) study done in 1993 puts the cost at $350 million, a study done by Myers and Howe in 1997 puts it at $467 million, and the $500 million figure is the one commonly cited in the media. The latest Tufts study, also conducted by DiMasi (yet to be published) puts the figure at close to $800 million. This new high figure is partly because of high opportunity costs, since returns in financial markets in the 1990s has been staggeringly high.

"Opportunity costs" themselves are calculations based on a rather perverse logic, and represent the money companies would have made if they had been an investment bank, investing in the financial markets, rather than companies ploughing money into R & D (in other words, by putting opportunity costs into my personal budget, I could say that a new car I plan to buy costs me $36000 even though its MSRP is $18000, because buying it prevents me from spending the $18000 on other things! If those "other things" are wildly profitable financial investments that I might otherwise make, such as would have been possible in the dot com heyday, then I could appropriately indicate that my car is orders of magnitude more imaginatively expensive by being an even bigger "lost opportunity"). And of course, these are costs that are derived largely by the self-reporting of their own expenses by pharmaceutical companies.

Indeed, the validity of the DiMasi study has been seriously called into question by James Love (1997), who re-examined the costs of clinical trials for orphan drugs by looking at tax credits for orphan drug development that pharmaceutical companies received, and by analyzing the costs of 58 NIH-funded clinical trials. He obtained a figure of $7 million as the cost of clinical trials from the NIH data, which, even if adjusted by the same parameters DiMasi used in a confidential industry survey in 1995 to determine clinical trials costs, yields an overall clinical trials cost of $16.1 million. Meanwhile, from the Orphan Drug Tax Credits evaluation, Love shows that pharmaceutical companies only report spending $3.2 million for clinical trials of each orphan drug. Love cites DiMasi's confidential 1995 report as placing the cost of clinical trials for a single drug as being being $24.5 million, which is adjusted to $54.8 million to account for the risk of failed trials.

The first major question, as Love points out, is that of *where* figures such as DiMasi's come from, and the conflicts of interest inherent to a survey procedure that depends significantly on industry figures to calculate industry costs. While it may be understandable that Di Masi's study would use industry figures that are favorable to industry, since the Tufts Center for the

Study of Drug Development, to which the authors belong, is significantly funded by the industry (a vital issue of conflict of interest in itself), it is particularly ironic that the OTA report in 1993 – a *government* document – used as its only source the DiMasi study, and did not look for any public sources to arrive at its conclusions. In other words, the OTA report ultimately relied on unaudited industrial calculations to further naturalize the $300-500 million figure as *state-sanctioned* "fact". It is even more ironic that these questions are still not being revisited in spite of the accounting scandals surrounding corporations like Enron, when in fact the latest Tufts study results putting the figure at $800 million were announced around the same time as the Enron crisis was breaking.[47]

In the 1991 study, the "expected" costs DiMasi et al. arrived at for clinical trials after adjusting for the risk of failed drugs was $48.1 million per approved drug. From here, the figure of $231 million (which has since been added upon, as mentioned above, by the OTA report and the latest Tufts study) for the entire drug discovery and development process was arrived at by firstly assigning $65.5 million in "expected" outlays for pre-clinical research. This itself was a rather imaginative undertaking, since as Love shows it was based on no project-level data. Indeed, logically, it is completely counter-intuitive that pre-clinical research would cost more

[47] Indeed, it is quite likely that pharmaceutical companies adopt many imaginative, if not necessarily illegal, auditing procedures to increase profit margins. One such was recounted to me by an anonymous informant. Since I have not been able to verify this, it must remain simply as a story told to me by a possibly reliable source, rather than a "fact" (though it is arguably every fit as "factual" as the DiMasi studies are).

Apparently, many of the biggest pharmaceutical companies have offices in Singapore. This is not because they manufature lots of drugs in Singapore, or because Singaporeans drug themselves much more than people in other parts of the world, but because it is a tax haven. Apparently, these companies select specific drugs that they decide will be "imported" from Singapore. Pfizer's blockbuster Viagra is one such. Therefore, a Viagra pill manufactured in a Pfizer manufacturing plant in the US will be exported to Singapore and reimported back into the US before it is sold in the US market. On their US tax returns, Viagra can then be stated as having been taxed in Singapore, and therefore, on the basis of double taxation avoidance treaties, Pfizer would not have to pay taxes on Viagra in the US. Given that Viagra earns revenues of $1.5 billion a year, that is a pretty substantial loss to the American taxpayer. If multiplied by other, carefully selected, blockbuster drugs by other companies who also export and reimport drugs to and from Singapore, and if further multiplied by the fact (as suggested by critics such as Goozner or Love, but also by studies such as Stallings') that much of the enabling research for these drugs occurs with public money in any case, then the loss to the exchequer is truly significant.

than clinical trials, especially since the value of a molecule as one goes further along the clinical trials procedure increases exponentially. The remaining costs, roughly equal to the combined purported costs of pre-clinical and clinical research, are the opportunity costs of capital.

Therefore, Love points to a host of problems with the DiMasi study: the fact that the figures rely solely on unaudited information supplied by the industry, the fact that there are no reliable pre-clinical estimates upon which to base those figures, the fact that the clinical trials estimates themselves don't bear up, the fact that much of the enabling research was done in public labs (as Goozner's story of Ceredase and Cerezyme shows, but also as the Stallings study – done by a group that is hardly a pharmaceutical company antagonist – shows) and the dubious logic of opportunity costs, which by definition are calculations that are based on the assumption that pharmaceutical companies are investors playing the financial markets – a rather odd assumption for an industry that takes great pains to continually project itself as being in the business of "people, not profits". (For example, Alan Holmer, President of the Pharmaceutical Research and Manufacturers Association [PhRMA], insists in his message introducing the Association's 2001 Pharmaceutical Industry Profile that while the Profile "does not discuss the millions of patients – in this country and around the world – who are being helped and healed every day by the medicines discovered and produced by this country's pharmaceutical companies", we should "make no mistake – these patients, today's and tomorrow's, are the motivation that drives all of those fortunate enough to work in America's pharmaceutical industry").[48] Clearly, however, this is a motivation that needs to be budgeted as a huge lost financial opportunity.

As mentioned above, Love shows through an analysis of Orphan Drug Tax Credits that the cost of clinical trials for orphan drugs comes to $3.2 million per approved drug, which is a fraction of DiMasi's 1991 figure of $18.9 million per approved drug before accounting for failed

candidates. Love therefore argues that *either* DiMasi's figures are an over-estimate (and remember, these are just clinical trials figures, and don't take into the account the further over-estimations from pre-clinical and opportunity cost additions), *or, if* in fact clinical trials are as expensive as DiMasi argues they are, then the fact that companies get such a small tax credit (the Orphan Drug Tax Credit is 50% of the amount spent out-of-pocket on human clinical trials) indicates clearly the extent to which clinical trials are in fact paid for by the public and are not out-of-pocket expenses for the company (Love calculates that if DiMasi's figures are to be entirely taken at face value, then that means that 92% of the costs of human clinical trials for orphan drugs are paid for by the taxpayer).

PhRMA, predictably, spoke up vehemently against Love's study,[49] but it was a response that continued to leave most of the questions Love raised on the DiMasi study unanswered. PhRMA did emphasize that figures arrived from looking at Orphan Drug Tax Credits cannot legitimately cast aspersions of DiMasi's "average" cost figures because orphan drugs are tested on fewer patients, and are approved more easily by the FDA. However, as shown by Goozner's story of Genzyme, the high prices of Ceredase and Cerezyme are very much justified by taking recourse to the naturalized DiMasi figures, figures that PhRMA itself in its response to Love admits is higher than the costs to develop orphan drugs! Further, the PhRMA response doesn't address any of Love's other challenges, regarding the conflict of interest, dubious pre-clinical cost estimates, the extent to which R & D is publicly subsidized and the opportunity costs that get imaginatively added on. Indeed, what qualifies as an orphan drug is itself somewhat of a question, for it is by no means guaranteed, as the case of Ceredase and Cerezyme shows, that orphan drugs are unprofitable. Some extremely profitable drugs that have qualified for orphan drug status include Amgen's blockbusters Epogen ($1.96 billion in 2000 sales) and Neupogen ($1.2 billion)

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[48] Available online at http://www.phrma.org/publications/publications/profile01/intro.phtml
[49] See Jeffery Warren's letter to the editor of *Marketletter*, available online at http://www.cptech.org/pharm/phrmarep.html

(figures from Love 2001a). Perhaps one of the most perverse classifications of an orphan drug is Bristol-Myers Squibbs' breast cancer drug Taxol. While the market of breast cancer patients for Taxol far exceeds the 200,000 patient limit below which a drug can qualify as an orphan drug, Taxol qualifies as a drug that is also used for AIDS-related Kaposi's sarcoma, and is thereby eligible for tax credits even though it might be used for indications that don't qualify for the credit.

The original study on returns to R & D for new drugs looked at the universe of new medical entities approved from 1980-84, while an update (cited earlier) looked at the universe of new medical entities approved between 1990 and 1994. Approximately 80 drugs were included in each cohort. The authors accessed actual worldwide sales data for each drug, projected future sales revenue for the remainder of each product's life, classified drugs in deciles, according to the total returns and calculated the rates of return (using estimates of out of pocket costs from the DiMasi study). They showed that for a breakthrough drug, which could have annual worldwide revenues of up to $1400 million dollars, the corresponding cost for each day of delay amounts to $3.8 million (again testifying to the material – rhetorical importance of speed in drug development).

Studies like this are really important for the public relations apparati of pharmaceutical companies, who like to talk about how expensive it is to develop drugs. Not only does it justify high drug prices, it also makes the companies look less potentially profitable. And herein lies a double-edged sword. On the one hand, pharmaceutical companies like to look less potentially profitable to Congress, in order to avert the always existent possibility of Congress introducing drug-pricing legislation;[50] on the other hand, these companies want to look as potentially profitable as they possibly can to their investors. PR often reflects in acute fashion the contradictions inherent in biocapitalism.

My purpose in this section is not to adjudicate between Love's figures and DiMasi's. Even though I think Love makes a completely convincing case that DiMasi's figures are a gross exaggeration of the actual costs of drug discovery and development, that in itself is incidental to my larger argument, which is to show how figures such as DiMasi's get *naturalized* and assumed as *fact*, to the extent that they subsequently get used as the starting point for further studies, such as the OTA's on drug pricing, or Grabowski's on returns to R & D. In other words, these are constructed "facts" with huge consequences not just for policy or legislation, but for further enterprises of fact production. What is key then are the silent rhetorics that go completely unquestioned. For instance, Love shows that the latest announcement regarding the $800 million figure (announced by the Tufts group in an event co-organized by PhRMA, Merck and the Boston Consulting Group), while based on data obtained from ten companies, was said to constitute an "average" estimate (see Love 2001b). What the word "average" suggests is both normativity and naturalization on the one hand, and, on the other hand, that some drugs cost much more than $800 million to develop – an "average" cost cannot by definition be the highest cost. Other normalizing techniques included the assertion by Merck CEO Richard Gilmartin that the "typical" clinical trial involves 4,000 patients, which is by no means the case (Love shows that this is, for instance,

[50] Lobbying Congress tends not to be such a major concern for most biotechs.

three times the number of patients enrolled in anti-HIV drug trials, as cited by the FDA). Further, it was claimed that the increased cost of drug discovery and development from $500 million to $800 million was largely a consequence of the increased cost of clinical trials – and yet the researchers did not disclose the cost of clinical trials at this event. Once again, Love's research based on Internal Revenue Service (IRS) data shows that even if 4000 patient clinical trials were assumed as "typical", there is no way clinical trials costs alone could account for the increase, suggesting that much of the increase is likely to be mainly a consequence of assuming increased opportunity costs (especially given the staggering returns on the stock markets in the last few years of the 1990s).

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Innovation and Emerging Technologies

Where, then, does genomics fit into all of this, and what exactly is "post-genomic" drug development all about? The answers to these questions are more properly explored in Chapter 8, on personalized medicine, but a brief summary would be appropriate here. Quite simply, the steps involved in what might be called a "genetic approach" to the diagnosis and treatment of disease could be said to consist of the following: first, the identification of a disease with a genetic component; second, the mapping of the gene(s) involved in the disease to specific chromosomal regions; and third, the identification of the involved gene(s).[51] At this point, one could develop diagnostics to identify the presence or expression of the involved gene(s) in patients to determine predisposition to the disease in question; use the gene itself as a drug (gene therapy); or understand the underlying biology of the disease to "rationally" develop therapeutics to target the molecular mechanisms of disease etiology. The diagnostic tests could further be a precursor either

[51] The question of whether the gene(s) in question are singular or plural, or whether they are *understood* as being either singular or plural, of course has great consequences for understanding etiologies of genetic

to steps taken to prevent the onset of disease (that could either be interventionist or involve lifestyle changes), or to what is known as pharmacogenomics, which involves tailoring prescriptions and drug regimens to individuals based on their likely, genetically determined, response to these drugs (these steps are summarized from Collins and McCusick 2001). Of course, some of these advances are likely to be more easily realized than others. The development of diagnostic tests, for instance, is relatively straightforward (and indeed, as I argue in Chapter 8, likely to be the one realizable goal of "genomic" or "personalized" medicine for some time to come). Targeted therapeutics based on understandings of the underlying biology of disease is much more complicated, since diseases are always complicated multi-factorial events that are difficult to understand at the molecular level, and further not necessarily easy to target and set right even if ever properly understood. Gene therapy, too, has been hindered by the lack of finding optimal methods of gene delivery, and was further hindered by the death of a volunteer, Jesse Gelsinger, in a trial in 1999.

Most scientists, when they write or speak of "histories of" or "prospects for" genomics, do admit that some of these advances are more immediately realizable than others. Francis Collins and Victor McCusick's way of summarizing this is that "[t]he rate of progress for applying a genetic approach to the diagnosis and treatment of each disease will be different depending on the research investment and the degree of biological complexity underlying the disease.... Diagnostic opportunities may then come along rather quickly, but will be of greatest clinical usefulness [*sic*] once prevention measures are developed that have proven benefit to those at high risk.... In general, full-blown therapeutic benefits from identification of gene variants will take longer to reach mainstream medicine" (Collins and McCusick 2001: 543). And yet I argue that it is this temporality – the different likely rates of realization of each of these genomic advances – that is the real issue, and that gets elided over as a relatively linear and equivalent set

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determinism, and consequently for the role of genomics in fashioning subjectivity. I explore this in greater

of outcomes in accounts such as Collins and McCusick's. It is this what might be called therapeutic lag that is actually both the ethnographic window and the political terrain of "post-genomic" drug development, and it is the ensemble of events in the world that happen during the therapeutic lag that will determine whether, how and what "full-blown" therapeutic development actually takes place, and when. Making what seem suspiciously like Soviet-style 5-year and 10-year predictive plans, as Collins and McCusick do in their article, closes down this ethnographic window at the expense of relatively banal crystal-ball gazing (though, as I will argue in Chapter 6, such modes of prediction themselves have powerful influences in creating ethnographic windows and political terrains).

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Political Terrains and Fields of Action

I have made numerous references to political terrains within which drug development operates: terrains of competition and collaboration between biotech and pharmaceutical companies; global regulatory terrains within which clinical trials operate; discursive terrains that involve interactions between pharmaceutical companies, investors, policy makers and activists regarding drug pricing (both locally and globally); and discursive terrains of marketing and public relations that are integral to the generation of sales as well as symbolic capital. It might be useful at this point to indicate the broader sweep of political conflicts that biocapitalism gets framed by, because it is such a sweep that constitutes the fields of strategic action that get thrown up by these multiple political terrains.

While issues of drug pricing are as vexed in the US as they are in, for instance, Africa, they do not tie in to issues of drug access and availability in the same way, since the US, at the end of the day, does have an institutional structure (however vexed or controversial) that does, at least for middle to upper class consumers, pay for prescription drugs. The real political battles in

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detail in Chapter 8.

that case then get fought around what gets perceived as the excessive and unnecessary marketing of pharmaceuticals, especially through direct-to-consumer (DTC) advertising (that is allowed in the US but not in Europe). These controversies are particularly highlighted in the case of mental health therapeutics, since defining mental illness is often so difficult and often discursively shaped by corporate advertising as much as it is by "neutral" or "objective" scientific knowledge (see, for example, Healy 1997, 2002). On the other hand, in places like Africa, or Haiti, or Siberia, the criticism of pharmaceutical companies is that their high pricing strategies make drugs that are absolutely and urgently needed, in epidemic situations (such as of AIDS or multi-drug resistant tuberculosis [MDR-TB]), unavailable (see for instance Farmer 1999, Kim et al 2000). These two extreme scenarios, of excessive drug marketing leading to the creation of a "therapeutic society" in the First World on the one hand, with people dying in the Third World due to the lack of accessible therapeutics *that do exist on the market*, on the other, frame the field of action within which pharma-politics takes place. It is a field of action that highlights a problem of distribution that is conceptually similar, though politically very different, from the problem of food distribution in famine (see, for instance, Sen 1981). It is also a field of action that has at its extremes a binary set of politics of regulation, at the level of demand in the former case and supply in the latter, that ties into different sets of theoretical concerns – broadly speaking, Foucauldian in the former and Marxian in the latter – that often operate at odds with one another in academic debates about what the "problem" with the pharmaceutical industry actually is.

What the work of people like Paul Farmer, Jim Kim and their organization Partners in Health (www.pih.org) indicates, however, is that, unlike in the case of famine, the problem is not just the equitable distribution of already available drugs, but, in the case of diseases like AIDS and MDR-TB, the problem that already available drugs *still aren't good enough*, in terms either of efficacy, safety or the complexity of drug regimes required to effect treatment, complexities that tie directly into the difficulties of patient compliance, leading to the further generation of

drug resistant pathogens. Therefore, *there still remains the problem of innovation*, and therefore still the need of pharmaceutical companies to develop drugs. This is quite different from the controversy surrounding agribusinesses over the development of genetically modified (GM) foods, for instance, where the need to innovate and come up with new modes of food production is not at all perceived as urgent by many of its critics. The question of food inequity, in spite of the efforts of agribusinesses to turn it into a question of innovation, is still embedded much more straightforwardly in a politics of distribution than pharma-politics is.

CHAPTER 4: SPEED AND INFORMATION

> We have the awesome potential – should we so desire – of rewriting the language of God and the responsibility of harnessing the genome to improve the human condition in an equitable and ethical manner. The childhood of the human race is about to come to an end.[52]

> If we regularly speak here of technoscience, it is not in order to cede to a contemporary stereotype, but in order to recall that, more clearly than ever before, we now know that the scientific act is, through and through, a practical intervention and a technical performativity in the very energy of its essence. And for this very reason it plays with place, putting distances and speeds to work. It delocalizes, removes or brings close, actualizes or virtualizes, accelerates or decelerates.[53]

4.1: A brief history of genomics: stories and polemics

The US National Institutes of Health (NIH)-funded Human Genome Project (HGP) started at the end of the 1980s as a public-funded effort by five nations to sequence the human genome. The original plan was to sequence the genome starting from one end and working towards the other, with a very stringent error frequency of not more than one every ten thousand base pairs (10X). The HGP, in its initial years, was indeed a rather languid affair.

In May 1998, however, the HGP was thrown into turmoil by an announcement by J. Craig Venter that he was going to sequence the human genome through a more rapid method that involved shredding the genome into pieces, sequencing the pieces and putting them back together again, with somewhat less concern for error, through his private sector labs and using his new

[52] Davies 2001: 10.

extra-quick automated sequencing machines. The major reason for the turmoil was the well-known fact that Venter (and other private sector genomicists who were entering the sequencing fray in a big way at this time) would patent the DNA sequences they generated, thereby keeping them out of the public domain. This announcement turned the genome program into a competitive race, in which the HGP researchers were forced to redraft their plans (Collins 1998).[54]

It is perhaps useful at this point to outline some of the other major actors. The NIH-funded HGP is, as mentioned, a public-funded consortium of five nations, the United States, the United Kingdom, France, Germany and Japan, coordinated by the National Human Genome Research Institute (NHGRI) of the NIH. The current head of the NHGRI is Francis Collins. The major sequencing centers of the HGP are located at the Whitehead Institute in Cambridge, MA, Washington University, Baylor College of Medicine, the Joint Genome Institute of the US Department of Energy and the Sanger Centre located near Cambridge, England. In addition to the Rockville, MD based Celera Genomics, which is Craig Venter's company and a daughter company of Perkin-Elmer,[55] some of the other major genome companies include Incyte Genomics (based in Palo Alto and Cambridge, England), Millennium Pharmaceuticals (Cambridge, MA)

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[53] Derrida 2002b: 80.

[54] Before the HGP decided to "race" Celera, largely on the latter's terms, of course, the public project heaped scorn and vitriol on the likely outcome of Celera's enterprise, especially in terms of it being able to generate a good quality sequence in its rush for speed – statements that they seemed to have no embarrassment about once they realized that they needed to follow Celera's lead and get the sequence done quickly for reasons of credit, credibility and ownership. Consider, for instance, the following quotes made before the HGP redrafted its plans in October 1998 (quoted in Davies 2001):

- Harold Varmus said that the feasibility of Venter's approach "will not be known for at least 18 months" (148).
- John Sulston of the Sanger Centre said: "I really don't see this as being any great advance whatsoever. We are going to provide the complete archival product, and not an intermediate, transitory version of it" (151).
- Robert Waterston of Washington University equated Venter's version of the sequence to "an encyclopedia ripped to shreds and scattered on the floor" (151).
- Maynard Olson of the University of Washington Genome Center accused Venter of "science by press release" and predicted "over 100,000 serious gaps in the assembled sequence" (153).

[55] One of the many trials of writing a contemporary history of a field that is as rapidly changing as corporate genomics is that events very quickly outrun the moment of their writing. In January 2002, after I had first written this sentence, Celera got rid of Venter as its CEO, in an ironical attempt to reinvent itself as a drug discovery company from an information / database provider. The reasons for shifts like this are explained more fully in Chapter 8.

and Human Genome Sciences (Rockville, MD). Incyte is a major rival to Celera as well as to the public-funded project. Millennium, which is also involved in drug development in addition to DNA sequencing and functional genomics work, is by contrast rather more friendly with the public-funded project, as one of its co-founders is Eric Lander, who is the head of the Whitehead Genome Center and thereby a major player in the HGP.

A major actor in the recent history of the genome project is the Wellcome Trust. The not-for-profit fund of the big multi-national pharmaceutical company Burroughs Wellcome (which since then became Glaxo Wellcome and is now, after a merger with SmithKline Beecham, Glaxo SmithKline), the Wellcome Trust is well known as being one of the primary supporters of biological research in the United Kingdom. It is important to remember how big a player Britain has been in the sequencing race: the Sanger Centre in Cambridge is in fact the largest of the genome sequencing centers, and generated a third of the public sequence. It was, in fact, the Wellcome Trust that really persuaded the NIH to take up Craig Venter's challenge and not throw in the towel, who really convinced the NIH that it was possible and feasible to get the sequence done first, and who assured the Americans of their support in making that happen.

It is important to recognize just how much the generation of the working draft sequence had to do with technological rather than fundamental conceptual advances. In this regard, major actors in the sequencing of the genome were the sequencing machines called ABI 3700.

The story of the 3700s, as well as of the race to sequence the genome, is in considerable measure the story of an apparently rather unglamorous company, Perkin-Elmer (PE). PE was a maker of lab instruments, hardly regarded as the market segment that does the cool, cutting-edge science. And yet, it was PE that really made it possible for the working draft sequence to be generated by 2000, 5 years ahead of the initial schedule for the genome sequence set by the public HGP (a good summary of this can be found in Ross 2000, from which I draw substantially for this account).

In the mid-90s, in fact, it didn't seem obvious that PE would be making anything revolutionary possible. It was one of a number of ailing instruments companies, with a wide range of products and no particular direction. Three things happened to change this. The first was the acquisition of the rights to Polymerase Chain Reaction (PCR), the technology to amplify DNA that was absolutely essential for genomic sequencing. The second was the acquisition, in 1993, of Applied Biosystems Inc., an instrumentation company that was making sequencing machines; and the third was the induction of Tony White as CEO. White changed the business direction of PE and got it to focus on genomics, changing the name of Perkin-Elmer to PE Corporation, which in turn comprised PE Biosystems, that made instruments, and Celera Genomics, the new genome company that PE seeded and got Craig Venter to head. Celera was able to throw the sequencing gauntlet at the HGP because they had PE Biosystems' 3700s to sequence with. In order to compete with Celera, now, the HGP had also to buy the 3700s. This, in the dramatic words of White, "set off an arms race, and we were the arms business" (quoted in Ross 2000: 102).

In such a conception of the history of the race to sequence the human genome, then, Celera is merely a vehicle, birthed specifically for PE's growth, rather than the "driving force" or "primary agent" in generating the sequence. Indeed, this has been ironically driven home with the recent removal of Venter as CEO of Celera, as Celera seeks to reinvent itself away from being an information provider and towards becoming a diagnostic and drug discovery company.

A key moment in the race to sequence the genome was the generation of the genome sequence of *Drosophila* (fruit fly) by a consortium consisting of Celera and researchers from the University of California at Berkeley. A number of things emerged from this event. The first was that the *Drosophila* sequence was generated by Celera's controversial method of shotgun sequencing, showing that shotgunning genomes was a feasible way to sequence them, and also indicating Celera's abilities to successfully sequence genomes in the first place. The second was

that this sequence was generated by Celera in partnership with a public university, indicating that the divide between Celera and the HGP wasn't a clear-cut divide between public and private *research* worlds, but was more specifically a divide between Celera and those public researchers, of the HGP, who had deeply invested public money and their reputations in getting the genome sequenced first. The third was that, quite clearly, the human genome sequence was only the most glamorous of the genomes to be attempted. Lots of value could be garnered from sequencing the genomes of other organisms, and indeed, for really valuable information from the human genome sequence, it was essential to have the ability to compare genomes of a number of organisms. In addition, organisms like *Drosophila* were being enrolled as Latourian actants in the unfolding race, just as the roundworm, *Cyanorhabditis elegans*, was enrolled by the HGP as the preliminary example of their sequencing prowess.[56]

Fourth, almost incidentally to a grand history of genomics, but absolutely central to a project that is interested more in emergent contours of venture science than to what happened or not to the genome sequence, was the role of a small start-up in the *Drosophila* sequencing enterprise. Called Neomorphic, and set up outside Berkeley by a group of Berkeley and Santa Cruz graduates, Neomorphic was the archetypal late 1990s Silicon Valley start-up, a group of cool and laid back young men, who wouldn't have looked out of place as members of a rock band instead of as scientists in a company, but whose genome annotation tools played a central role in the creation of the *Drosophila* sequence. In other words, a major reason why Celera was able to show off its sequencing prowess to the public project, and garner the symbolic and material capital that it did in those heady days of 1999-2000, was because of a small group of 20 programmers in a garage in Berkeley who were writing the code to make some sense of the series of nucleotide bases being churned out by sequencing machines made by Celera's sister company,

[56] Indeed, model organisms are not just recruited as strategic actants in battles for what Latour calls recruitment of allies, but are also recruited as metonymic constructions of what it means to be human. This is, of course, particularly true with primates, as Haraway (1989) so wonderfully shows in *Primate Visions*.

Applied Biosystems. While Celera *could* be seen as the company that altered the face of medicine by sequencing the human genome, it could also be seen as a company birthed by an instrumentation giant, that used machines that itself were developed in another, acquired, instrumentation company, and that initially validated itself sequencing *Drosophila*, a project that it couldn't have successfully completed without significant input from a public lab and a 20 person start-up in a Berkeley garage that was writing code.[57]

At around the time that Neomorphic was collaborating with Celera to annotate the *Drosophila* genome, the Santa Clara based company Affymetrix was trying to acquire Neomorphic's competitor, Doubletwist.[58] At some level, the histories of companies like Affymetrix and Doubletwist, rather than of the "heroes" of the genome sequencing effort such as Celera or the HGP, are more interesting to outline as a means of generating a stratified analysis of genomics as, firstly, not something that had two distinct originary points (the start of the HGP and the seeding of Celera), and secondly since sequencing itself is just the "end of the beginning" of genomics, as many genome scientists like to say. Companies like Affymetrix and Doubletwist, the former one of the most unique "genome" companies in the business and the latter the most spectacular corporate failure of the genome era, point to the emergent contours of corporate genomics, biocapitalism and venture science in a way that a linear history of Celera's histrionics vis-à-vis the HGP simply doesn't.

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[57] Compare this with the linear historical account provided by Davies (2001: 52) in his "inside account" of the race to sequence the genome: "[I]f there were to be an award for the most influential scientist of the 1990s, the odds-on favorite would have to be John Craig Venter....[A]s the founder of Celera Genomics, he almost single-handedly transformed the odyssey to obtain the sequence of the human genome....If he had not stirred up so much controversy and resentment over the past decade, he would be a certainty for Stockholm's annual Nobel party". This last in spite of the fact that the Nobel is explicitly given for discovery / invention / fundamental conceptual advances, whereas what Venter did most successfully was use strategy, rhetoric and machines developed by a sister company to do what was already being done more quickly! If anybody has indeed come up with a "key enabling invention" (and works such as Paul Rabinow's [1997] *Making PCR* should immediately make us wary of ascribing invention so simply to the solitary romantic inventor), it is probably the pair of Michael Hunkapiller and Leroy Hood, who came up with automated sequencing technology and seeded Applied Biosystems.

[58] This account is based on conversations with a number of people at Neomorphic, Affymetrix and Doubletwist. For obvious reasons, individual informants are kept anonymous.

Affymetrix, as mentioned in the Prologue, is a tool company that makes DNA chips (GeneChip®), 1cm x 1cm silicon wafer substrates with known DNA libraries stuck onto them upon which it is possible to perform comparative hybridizations of different samples in order to analyze differential gene expression, in, for instance, normal or diseased states. Therefore, these chips are basically arrays of DNA probes. It is a technology that has in itself been a driver and marker of the importance of information in genomics (and I analyze the role of the DNA chip in slightly more detail in Chapter 8), and of speed: like the ABI 3700s, the DNA chip is a definitive indicator of the fact that it is the *high throughput* generation of information that defines genomics. Massive amounts of information that are potentially useful for gene function analysis can be obtained at one time using these chips.

Like Applied Biosystems, Affymetrix doesn't "do" biology: it makes technology relevant for biological applications. It has been using processes borrowed from the semi-conductor industry and making DNA probe arrays. Affymetrix has been making such arrays since 1994, basically increasing probe density on each chip to the point where they have managed to fit the entire human genome on to two chips.

Doubletwist, meanwhile, was initially founded as Pangea Systems, and started as a bioinformatics company that was a direct competitor of Neomorphic in its early days.[59] My own first encounter with them was at their stall at a 1999 industrial genome conference organized by Craig Venter's Institute for Genomic Research (TIGR). At that time, they were still Pangea, but on the cusp of reinventing themselves as Doubletwist. They were without a doubt the loudest and most visible presence at any of the public relations events at the conference, typifying the dot com corporate attitude of the time, and clearly spending huge amounts of money to keep themselves garishly visible (indeed, at one point, they even had a billboard advertisement for their company on Highway 101 as it entered San Francisco, possibly the most expensive spot for

roadside advertising in the United States). The reinvention from Pangea to Doubletwist was a reinvention of a bioinformatics company that wrote code (such as Neomorphic did) to a dot com company which was, in the words of its Vice-President of Marketing Rob Williamson "a life science portal for online genetic research geared to go directly to the scientist".

The story of Pangea / Doubletwist is such a fundamental part of the type of contemporary history that I am trying to write because central to it is the role of venture capitalism and venture capitalists, who get written out as significant actors in the Celera – HGP story of the genome sequence (since Celera was seeded by a parent company, and not started by entrepreneurs seeking venture capital), and who are central components of the assemblages that constitute genomics / venture science / biocapital (indeed, the role of venture capitalists in DoubleTwist's saga led a number of its employees to refer to the company as "DoubleCrossed").

Pangea was started by two Stanford graduates, Joel Bellenson and Dexter Smith. Bellenson and Smith were actually crack programrs, and wrote the code, as contract workers, for the first version of Incyte's gene expression database, LifeSeq, that became the industry standard expression database. Of course, as contract workers, the two did not get any share in the intellectual properties or royalties Incyte received, something that they felt very bitter about, though equally something that Incyte felt was hardly to be expected, given that they were hired as contractors and not employees. In starting Pangea, Bellenson and Smith were offered $10 million by the famous Silicon Valley venture capital firm Kleiner, Perkins, Caulfield and Byers, arguably the best known venture capital firm of the dot com boom. In exchange, Kleiner Perkins wanted 50% of the company, which Bellenson and Smith, not knowing any better, were happy to give up. Indeed, on the back of Kleiner Perkins' investment came a number of other extremely prestigious venture capitalists, including some of the most powerful high-tech VCs in the business such as the Mayfield Fund.

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[59] The account of Doubletwist's rather sorry but extremely entertaining history is based on conversations

Now Kleiner Perkins had also seeded a small bioinformatics company in San Diego, which was going nowhere in particular. They suggested to Bellenson and Smith that Pangea buy the small company. Since Kleiner Perkins had a substantial ownership share in the acquired company, the acquisition served to further dilute Bellenson and Smith's share in Pangea. In other words, Kleiner Perkins had managed to get Bellenson and Smith to spend their money in order to further relinquish hold on their company. Eventually, the venture capitalists managed to so dilute Bellenson and Smith's holdings in the company that they finally even got rid of the founders from the company's Board.

Meanwhile, Affymetrix was hoping to go beyond simply being a tool provider to actually turn into an informatics and drug discovery company in its own right. They were hoping to do this by acquiring a promising young bioinformatics company. Pangea / DoubleTwist, perhaps by virtue of their high visibility, was the company they initially sought. In March 2000, they offered to buy DoubleTwist for $300 million: a quite staggering figure to offer for a company that really hadn't developed any genuine value-added commercial products. DoubleTwist, however, felt they were worth much more than that, and turned Affymetrix down.

This failed acquisition was perhaps the most fortuitous event in Affymetrix's history. Seven months later, they had completed their acquisition of Neomorphic instead. Neomorphic had proved their skills as a bioinformatics software developer in their collaboration with Berkeley and Celera in annotating the *Drosophila* genome. Without exception, everybody I have talked to at Affymetrix hails the Neomorphic group as significantly contributing to Affymetrix's value today. Affymetrix, in a further step at diversification, seeded a functional genomics company, Perlegen Sciences, whose job is to leverage their access to Affymetrix's chip technology to identify genetic variations amongst individuals, and find patterns that might be developed for

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with former employees, who are both kept anonymous and not directly quoted.

Perlegen's own commercial use, but also fed back to Affymetrix to enable the latter to develop new genotyping arrays based on this information.

DoubleTwist, meanwhile, spiralled through its huge reservoirs of venture capital money, attempted and failed thrice to go public, and finally, in a symbolic gesture of supreme insult, were offered to be bought for $10 million by Celera Genomics at the end of 2001. Spurning that last offer as well, DoubleTwist finally ran out of money and closed its doors in March 2002. It had managed to burn through $78 million of VC money, a remarkable amount for what was purely a software company, with no wet lab facilities.[60]

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What, then, *was* the significance of the human genome sequence? Answering that probably requires acknowledging the iconicity of DNA, an iconicity that is perhaps only rivaled in recent times by the cloned sheep Dolly (see, for instance, Franklin 2000). Related to this is the probability that its significance is held dearest by those who believe most strongly in definitive causal relationships between genes and traits. Indeed, much of the early mapping projects of the 1980s and early 90s were about finding genes "for" diseases such as muscular dystrophy, Alzheimer's, certain cancers (the most well known being the breast cancer related gene *brca-1*) and, perhaps most famously, Huntington's disease. As I show in Chapter 8, this particular conception of the genomics "revolution", as being *about* target identification, is already historical, as scientists – especially those actually in the business of developing drugs – realize quickly that simple attributions of causality don't lead in any simple way to therapy.

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[60] Bellenson and Smith, meanwhile, started another company in 1999 called DigiScents, which manage to get featured on the cover of the November issue of *Wired* magazine that year. This was a company that had nothing to do with biotech, and the products intended included the "iSmell" (a computer peripheral that would emit fragrances to enhace a user's multimedia experience), "ScentStream" software to drive iSmell, and the "Scent Registry", a licensable digital database of thousands of scents to sell to developers of web sites, games, movies, advertisements and music. In April 2001, DigiScents laid off all 70 of its employees and shut shop, after failing to attract enough VC funding to go beyond developing a prototype.

The question to be asked, then, is the question that I asked at the end of the Prologue: what sort of a revolution *is* genomics? Most (in)famously, the genome sequence has been referred to by Walter Gilbert, a genome pioneer at Harvard and founder of many biotech companies, as the "holy grail" of biology. It has also been referred to as "the book of life", "the code of codes", phrases that have also been imported into some of the most interesting historical and social scientific works dealing with the genome (see Kay 2000, Kevles and Hood 1992). A more apparently secular version of the "holy grail" metaphor is provided by Eric Lander, who analogizes it to the periodic table. And yet in the process of making this analogy, Lander cannot help invoking the metaphor of the evolutionary tree, for instance, in this quote: "The Human Genome Project aims to produce biology's periodic table – not 100 elements, but 100,000 genes; not a rectangle reflecting electron valences, but a tree structure, depicting ancestral and functional affinities among the human genes" (quoted in Davies 2001: 14).

While the tree may be a secular image, it is by no means apolitical, and conceiving of evolutionary relationships in that classical Darwinian sense is by no means without consequence for the way "genes" and "genomes" and, indeed, humanity, gets understood. As Deleuze and Guattari (1987) argue, the imaginary of the tree metaphor is completely rooted in binarisms, it is a "system of thought [that] has never reached an understanding of multiplicity: in order to arrive at two following a spiritual method it must assume a strong principle unity" (5). They propound the image of the rhizome in opposition to that of the dichotomous tree-root. The three principal characteristics of rhizomes, they argue, are connection, heterogeneity and multiplicity.

Understanding genomes, and reading the language of the "book of life", involves a projection of a future and a deciphering of a past. I do not primarily concern myself with the evolutionary stories that genomes are supposed to tell, though I do refer, especially in Chapter 7, to that which gets collapsed into the category "genetic determinism", in which genes are said to be causal agents of organismic characteristics. I discuss this in the context of what I refer to as

"genomic fetishism", whereby the gene is naturally assumed to represent the entire organism, rather than understood as being a constructed and historically specific artifact that allows certain situated perspectives on what we might call, following Foucault and Franklin, life itself. I do not, in Chapter 8, explore deeply the possible causes of this deterministic conception as so quickly reifying into naturalized "fact", at least partly because that particular mode of searching for causality precisely falls prey to the desire to know, and the operations used to determine, a simple relationship of cause and effect that in itself underlies the fetishistic determinism that is so problematic, and that I seek explanation for in the first place. The tree metapahor may not be the "cause" of genetic determinism in any fundamental sense, and indeed, determining that originary "cause" is itself perhaps not the politically most necessary or strategic exercise to engage in in order to denaturalize the fetish of the gen(om)e. But there is no doubt that it is a metaphor that is strongly *associated* with the creation of a naturalized fetish of the gen(om)e as principal, fundamental or originary, if only because the tree metaphor *requires* such an originary substrate for it to hold up against the blowing winds of actual evidence that constantly suggest the metaphor's own insufficiency to account for its continued self-image.

I explore this more fully in Chapter 8, but a brief digression at this stage to emphasize what it is that I am saying with regard to this powerful imaginary of the genome as a set of sacred (even when secularized) and rooted codes (for after all, the holy grail, the book of life, the code of codes and the periodic table all subscribe to the same larger imaginary of the gen(om)e as fundament). This is that if one *really* believes in a science of evolution that demystifies the religious myths of, for instance, the Creationists (and this, perhaps, is a science that needs to be rigorously upheld and believed in for a number of politically very relevant reasons, certainly in the United States), then one has to be confronted, by one's very method, by a genomic heteroglossia that absolutely *cannot* be reduced, or deduced, to originary roots without oneself performing an operation of myth-construction, and thereby performing an operation that is every

bit as religious and counter-scientific and mystifying as the operations of those that sciences like genomics claim to counter.

There are a number of ways to argue for the genome as rhizome. If champions of sociobiology and genetic determinism such as Richard Dawkins (see, for example, Dawkins 1976) provide "evidence" from the plant and animal kingdoms for "selfish genes" that drive and determine organismic behavior, then there are enough counter-narratives – and Deleuze and Guattari, for instance, invoke bulbs, tubers, rat packs and burrows as some – that show the connnected, heterogenous and multiple rhizomatic conceptions of life that are possible instead. Donna Haraway, meanwhile, makes the rhizomatic argument through a study of dog genome worlds, where she shows how it is possible to construct a counter-narrative of the co-evolution of dogs and humans that might more accurately provide co-histories of the two species than the rooted deterministic story that prevails of wolves being domesticated into dogs as a consequence of human settlement (Haraway 2002).

In this dissertation (and especially in Chapter 8), I hint at the limits that such rooted conceptions of genes come up against when the "facts" of deterministically conceived genomic experiments come up against the exigencies of having to "work" in the corporate world, as material-semiotic actants that need to be translated into commercial products. The difficulty of turning "a gene for x" into a therapeutic that can be sold is, in many ways, both the "ultimate" signifier, in venture science worlds, of the inadequacies of such concepts, and is also one explanation as to why it is that industrial scientists are much less ready to jump to deterministic conclusions than academic scientists are.

An example of such differential enthusiasm for genetic reductionism between academic and industrial scientists was powerfully seen at The Institute of Genomic Research genome conference in Miami in 2000. Richard Gibbs, a very high profile public genome researcher who runs the HGP sequencing center at the Baylor College of Medicine, gave a general progress

report of the HGP, which wasn't too different from the progress reports that one has become accustomed to hearing in these fora over the last couple of years -- how well everyone has done, how the challenge is only beginning, how the public and private enterprises must co-operate and are co-operating, and so on. The talk got interesting at the end, however, when Gibbs said that the real thing to do now is to start correlating genes with disease, and that this is the more immediate (next 2 years) question to tackle than proteomics, transcriptomics, etc. (of course, it's also much simpler to simply attribute genes to disease than to do the real biology of protein interactions and transcriptional regulation -- which of course, scientifically, ought to come *before* any correlations can legitimately be made. By creating this artificial separation of all of these into distinct ventures, in a bureaucratic - corporate style, of course, Gibbs manages to rhetorically suggest that studying genetic correlation with disease traits is a *separate science* from studying the basic [and extremely complex] biology of pathways and feedback effects in the cell. If one wants to study the mechanics by which genetic determinism gets instantiated, then the starting points are precisely such slick rhetorical manouevers that pose as scientific like Gibbs was making). What was interesting was that Gibbs was justifying his claims with evidence from scientific literature: how an increasing number of articles in journals such as *Nature Genetics* for instance were talking about "a gene / mutant *for*", thereby suggesting such simple correlations (this is really important to think about while responding to scientific assertions that genetic determinism is merely "bad science", that "good science" will never say such things).[61]

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[61] Look, for instance, at the following titles of articles / letters / correspondence to a single September 2000 issue of *Nature Genetics*:
* Mutations in MKKS *cause* Bardet-Biedl syndrome pp 15 – 16 (Slavotinek et al 2000).
* Methylation of the CDH1 promoter as the second genetic hit *in* hereditary diffuse gastric cancer pp 16 – 17 (Grady et al 2000).
* Domain-specific mutations in TGFB1 *result in* Camurati-Engelmann disease pp 19 – 20 (Kinoshita et al 2000).
* A defect in harmonin, a PDZ domain-containing protein expressed in the inner ear sensory hair cells, *underlies* Usher syndrome type 1C pp 51 – 55 (Blitner-Glindcicz et al 2000a).
* A recessive contiguous gene deletion *causing* infantile hyperinsulinism, enteropathy and deafness identifies the Usher type 1C gene pp 56 – 60 (Blitner-Glindcicz et al 2000b).
* Mutations in MKKS *cause* obesity, retinal dystrophy and renal malformations associated with Bardet-Biedl syndrome pp 67 – 70 (Katsanis et al 2000).

Gibbs then made the remarkable *scientific* claim that 5000 single-gene diseases are likely to exist. He wasn't quite allowed to get away with his assertion, and it was in fact Craig Venter who took him up on it, saying that it's surely not scientifically tenable to say this. Venter's analogy was that claiming single-gene correlation for diseases is basically looking under the lamppost for keys dropped elsewhere: you claim that they're single-gene traits because you haven't found the other genes that are involved. An interjection, of course, that was lost on Gibbs. I recalled how a friend of mine in Delhi, who is doing a Ph.D. in molecular genetics, astonished me with his indelible belief that genetic determinism *is* a scientific fact, that genes *do* directly code for traits. I realized, from presentations such as Gibbs', that of course he gets that not by reading Gina Kolata, but by reading *Nature*! Genetic determinism *is* scientific fact, to the extent that what gets pronounced by a scientific journal is scientific fact. But genetic determinism is also, as Venter was hinting, merely artifact that gets reified into fact. In fact, one of the scientists who worked on the initial development of GenBank, the public DNA sequence database, later expressed profound disgust to me about Gibbs' talk, claiming that one cannot, by definition, have such a thing as a single-gene disease, since the very fact that every disease manifests itself at different times in different individuals suggests that there is more than one gene involved in

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* The common PPAR Pro12Ala polymorphism is *associated with* decreased risk of type 2 diabetes pp 76 – 80 (Altshuler et al 2000).
* Heterozygous germline mutations in BMPR2, encoding a TGF- receptor, *cause* familial primary pulmonary hypertension pp 81 – 84 (Lane et al 2000).
* Mutations of the gene encoding the protein kinase A type I- regulatory subunit *in* patients with the Carney complex pp 89 – 92 (Kirschner et al 2000).
* Autosomal recessive lissencephaly with cerebellar hypoplasia is *associated with* human RELN mutations pp 93 – 96 (Hong et al 2000).
* Mutations in MYH9 *result* in the May-Hegglin anomaly, and Fechtner and Sebastian syndromes pp 103 – 105 (Seri et al 2000).
* Mutation of MYH9, encoding non-muscle myosin heavy chain A, *in* May-Hegglin anomaly pp 106 - 108
* Nf1;Trp53 mutant mice *develop* glioblastoma with evidence of strain-specific effects pp 109 – 113 (Reilly et al 2000).
* Identification of the gene *causing* mucolipidosis type IV pp 118 – 123 (Bargal et al 2000).

This is a total of *14* articles which are linking single genes to disease, out of a total of 30 articles published in the entire journal issue. Some of the words are a little more innocuous: two groups merely *associate* genes with particular diseases; one groups says that strains with a particular mutant *develop* x disease; one group says that a mutation *underlies* y disease; two mutations *result* in a disease, while another three mutations are merely [seen] *in* those diseases. But *five* mutations are claimed to *cause* diseases.

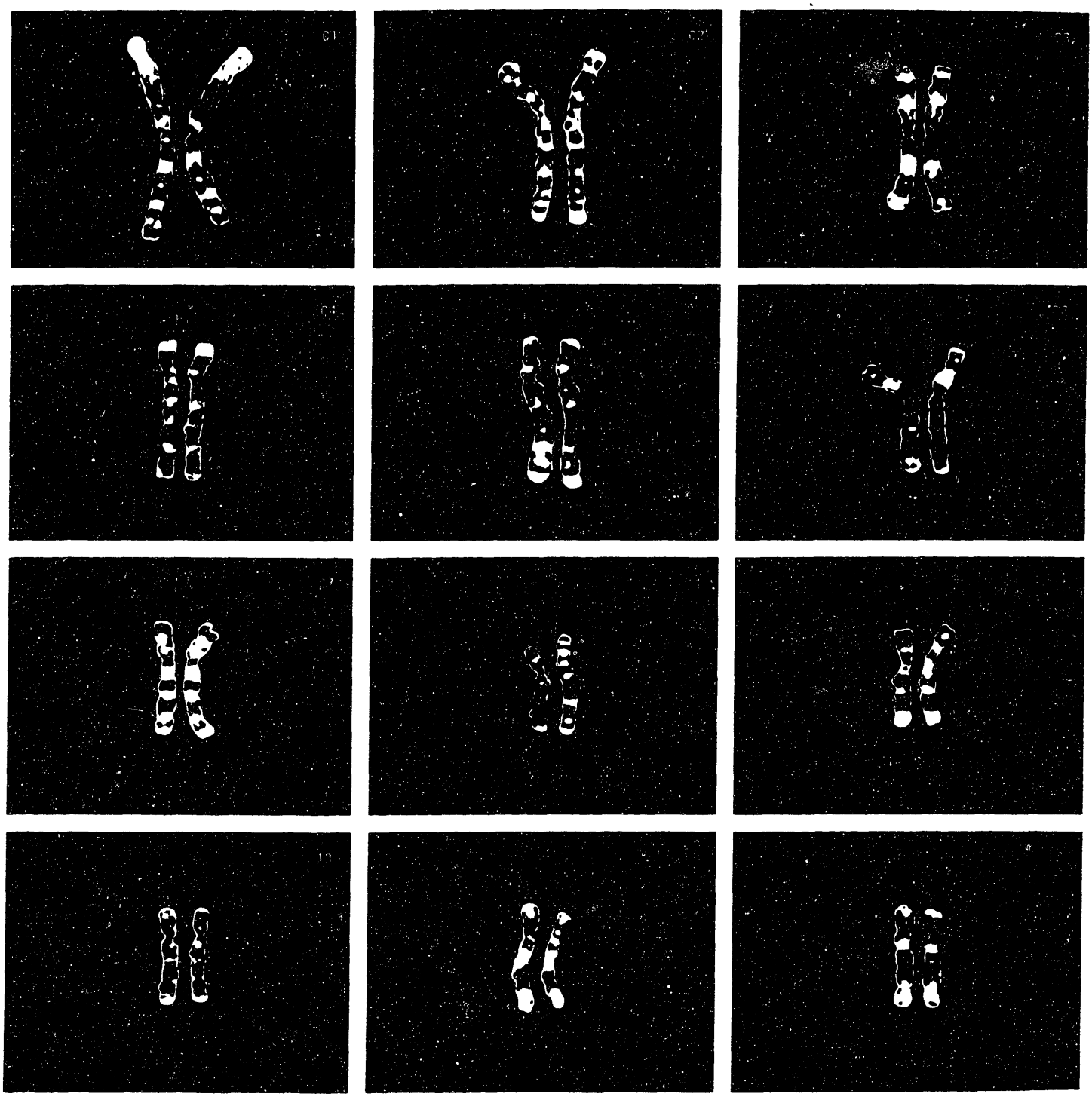
regulating its onset. Further, he mentioned that the notion of a "single-gene disease" was developed as a classification category in GenBank, to represent a shorthand for genes that might be classified as not obviously complex in a database that depended on such shorthand classifications for its creation. He claimed to be dismayed at the way in which a classificatory manouever had been so completely appropriated by even credible and well known scientists to represent the "fact" of the existence of 5000 single gene diseases.

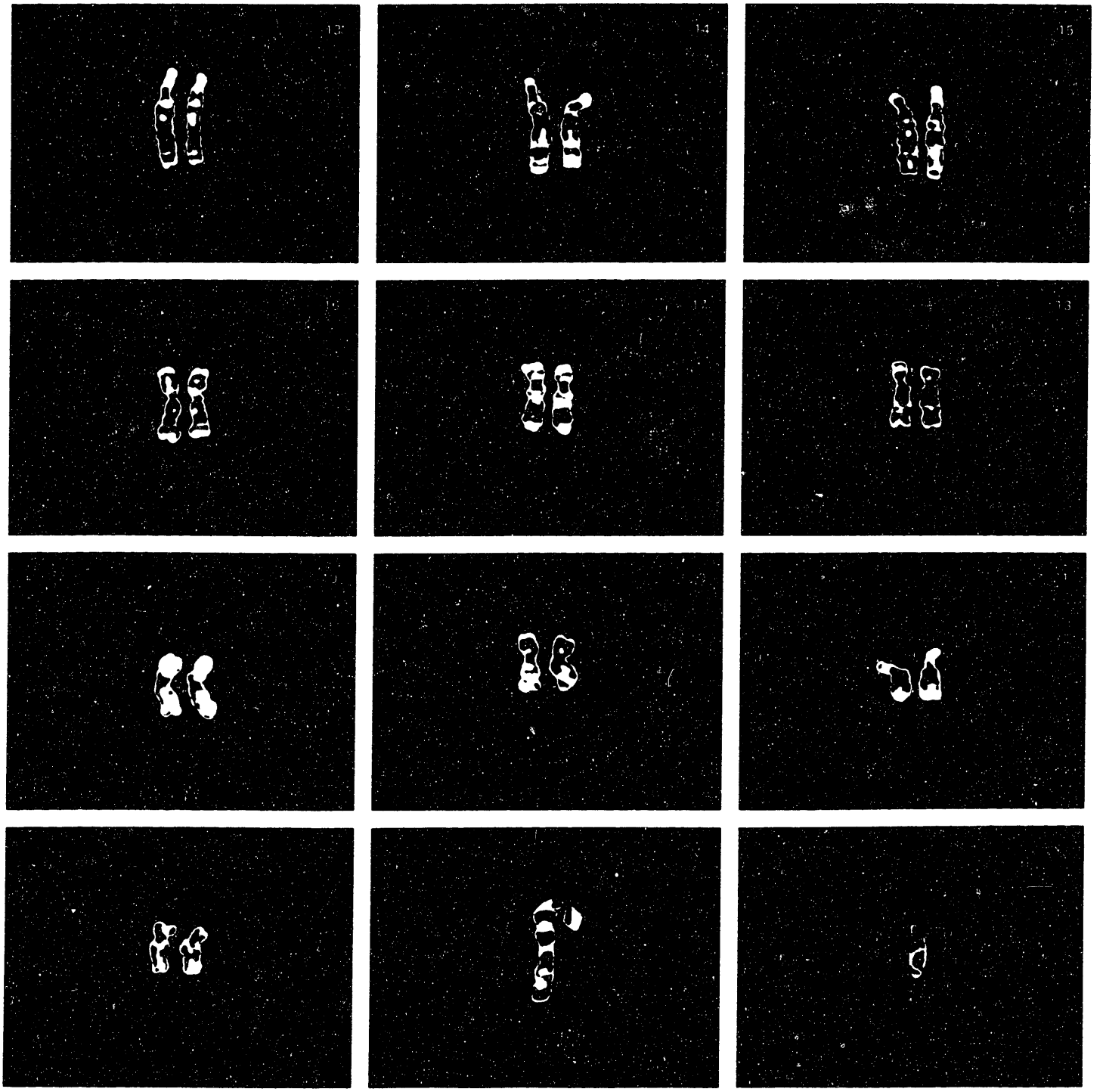
Indeed, the notion of the "single-gene disease" doesn't even always hold up that well as a diagnostic marker, let along as a route to therapy. An example is the equivocality of the tests for the *brca* genes, hailed as the genes *for* breast cancer. A positive *brca* test, like that of any other genetic polymorphism that serves as a diagnostic marker, is, as I elaborate in Chapter 8, merely an indicator of a probability of an event that might occur. Perhaps more worrying for those who lay their stocks (quite literally) in the notion of single-gene diseases is that the *absence* of a *brca* mutation doesn't necessarily indicate without doubt a low risk for breast cancer, suggesting clearly that there are other factors at play.

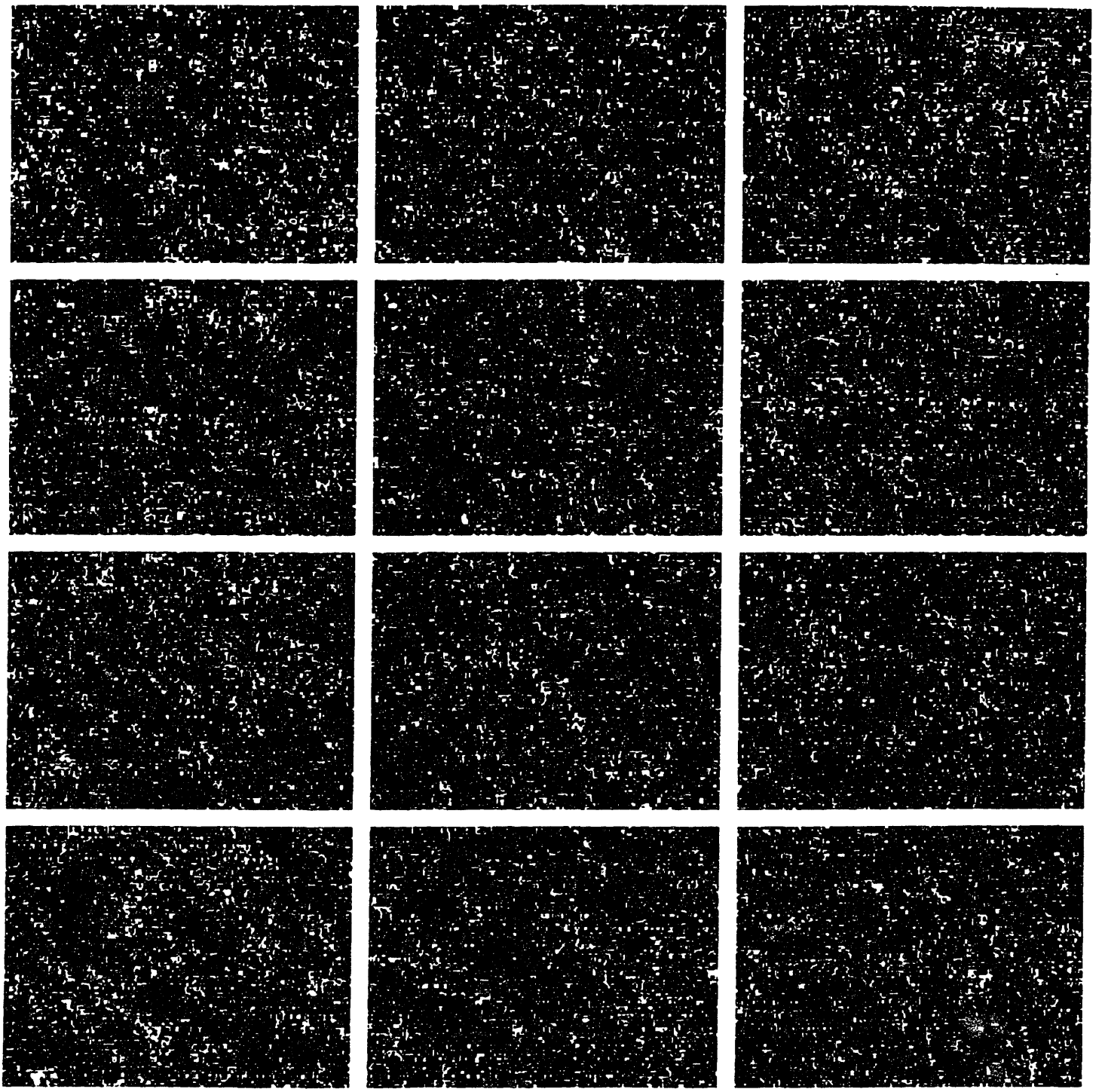
Of course, it is not tenable to make the claim that industrial scientists are emphatically not determinist. What I do argue is that the pressure and duty to produce commercial products, paradoxically, sometimes forces corporate science to be more careful with what it claims as scientific. Indeed, the difficulty of really generating any tangible therapeutic (or even diagnostic) meaning from single-gene associations with disease is a fundamental assumption of many business models, including that of Affymetrix: which is why, in some ways, it is companies such as these that become much more interesting markers of emergent contours of "post-genomic" lifeworlds than obsessively self-absorbed histories of the big vanguard intellectual men (invariably) who lead the HGP. Indeed, Affymetrix's GeneChip®, mentioned earlier in this section, is precisely a tool that analyzes whole genomes, or at least clusters of genes, rather than single genes. Of course, in the process, the results of experiments from Affymetrix's chips, while

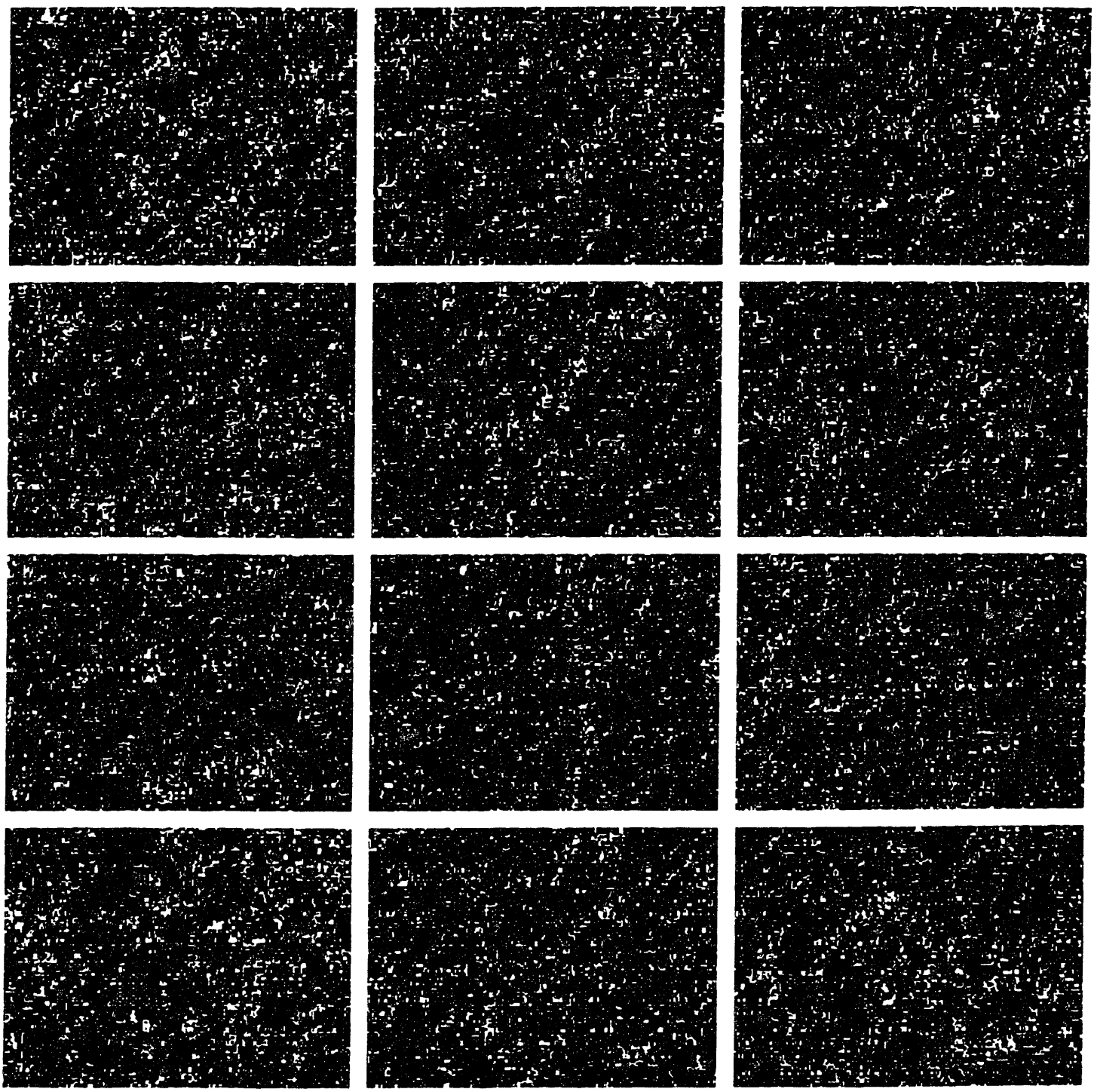
it undoubtedly allows more complex biological analyses than single-gene reductionist hypotheses do, merely articulates the fundament differently: a wonderful set of images (shown in the next few figures) from Affymetrix's 2000 Annual Report, for instance, shows a grid of diverse people, undergirded by a grid of *not genes but chromosomes*, further undergirded by microarray information that Affymetrix chips provide, thereby suggesting that it is the *patterns* of gene expression rather than individual gene expression that are ultimately constitutive of the being "human"; patterns that are, of course, only discernable through Affymetrix technology. The structure of the imaginary is still root-like, even through the Affymetrix chip, rather than rhizomatic.

Another piece of "science" that has come out of the discursive babble of genomics is the belief one can somehow determine one's evolutionary prowess as a species by simply discerning the levels of similarity with DNA of other species, either in terms of the number of genes or in terms of the percentage similarity of the DNA of two species. Therefore, on the one hand is the consternation that there seem to be only 30,000 genes, again thereby reducing evotionary complexity to some kind of a simple numbers game, where more genes add up to more complexity. Of course, the real complexity comes not from the existence, or not, of genes, but from their activity, their patterns of regulation, their ability to splice into alternative forms, and a host of post-transcriptional and post-translational modifications that confer functionalities of different sorts onto the proteins that these genes code for. On the other hand, the "fact" that humans and chimpanzees are almost 99% identical at a nucleotide level is taken to imply some kind of direct correlation with not just the evolutionary relatedness of the two species (because of course sequence homology is related in some way with evolutionary divergence, but again only related so simply if one assumes the evolutionary "tree", as opposed to co-evolutionary rhizomes, to start with), but also with their fundamental "natures". Kevin Davies, for instance, argues that since the DNA of humans and chimpanzees is 98.5% identical, while that









of chimpanzes and gorillas is 97% identical, therefore, "humans have more in common with chimpanzees that chimpanzees do with gorillas" (Davies 2001: 170).

Indeed, disagreements with such statements are voiced by some genome scientists, such as S.K. Brahmachari, the head of India's public genomics initiative and a researcher for many years on the function of nucleotide repeat sequences, that often exist in the non-coding segments of DNA that tend to be dismissed, with little reason, as "junk DNA". According to him, "I believe every nucleotide in the genome has a role in genome organization. It is not that there is junk, there is coding and non-coding. If somebody tells me, man and monkey, they are 99% similar, that is a foolish thing. Because two men vary in their polymorphisms so much more. Men and monkeys vary enormously at their repeat sequences. But we don't understand the function of repeats. So when you say it varies by 2% or 1%, it doesn't make much sense. Our understanding of the 99% is very little".[62]

If the genome is not, then, fundamental in any sense of principal unity to humanity, then neither is the discipline of genetics fundamental to the enterprise of genomics. Indeed, if anything, the disciplinary fundament of what has today become genomics was built during the glory days of structural biology and biophysical chemistry, by such scientists as Francis Crick, Maurice Wilkins, Rosalind Franklin and Linus Pauling through the 1970s by structural chemists such as Alexander Rich.

The other "non-scientific" but nonetheless expert discipline that has become fundamental to the contemporary practice of genomics is bioethics, and I explore and critique some aspects of institutionalized bioethics in Chapter 5. Bioethics was conceived as integral to the genomic enterprise from the get-go, as evidenced by the allocation of 5% of the HGP budget towards the study of its ethical, legal and social implications (ELSI). The official and pious discourse on ELSI, mouthed by historians such as Davies, suggests that "[i]t was a sincere effort to ensure that

society was prepared for the tidal wave of information on the horizon. The prospect of rapid advances in the understanding of major genetic diseases also raised serious issues regarding genetic discrimination, inadequate treatment options, and eugenics" (Davies 2001: 29). Davies then goes on to quote James Watson, the co-discoverer of the double helical structure of DNA and the first head of the HGP, being solemn about ELSI: "We need no more vivid reminders [than Nazi Germany] that science in the wrong hands can do incalculable harm" (*ibid*). There are, however, equally instances of Watson being less than solemn about ELSI.

What I have tried to argue in this section, through a series of disconnected stories and polemics, is, firstly, the importance of automated technological hardware such as the ABI 3700, in making "genomics", as both scientific knowledge and as a set of material-semiotic practices that support the rhetoric of speed, possible, and secondly, the fact that genomic "information" has valence *as* science, even if it is undergirded by what are no more than deeply rooted (both literally and figuratively) assumptions about life itself, assumptions that are full of, to borrow Marx's description of commodities, "metaphysical subtleties and theological niceties" (Marx 1976 [1867]: 163). I explicitly transpose Marx's evocation of commodities in talking about scientific "fact", as I will return to the way the fetishism of the two intertwines in Chapter 8. Suffice to say at this point that origin stories, whether of genomics, or of humanity as a consequence of events that we will discover through genomics, serve us poorly. More immediately, I go on to explore more explicitly the place of speed and information as cogs in capitalist market logic.

Major sites at which the dynamics of the race to sequence the human genome unfolded were two annual conferences. The first, at Cold Spring Harbor, is a major academic conference, at which the researchers of the public-funded Human Genome Project (HGP) gathered. The second, which was held

[62] S.K. Brahmachari, interview with the author, 13 July 2001.

from 1998-2000 in Miami, was organized by J. Craig Venter's not-for-profit research organisation The Institute of Genomic Research (TIGR), and was primarily an industrial trade-show. 1999 was a particularly interesting year to be at these two conferences, since it was the year after Venter had thrown down his sequencing challenge to the HGP. The Cold Spring Harbor meeting in 1999 was the first since the HGP had redrafted its sequencing plans the previous October and moved towards doing a working draft sequence at 5X frequency. It was a conference at which the animosity of the public researchers towards Venter and the Celera sequencing project was very clearly on display.

The Cold Spring Harbor laboratories are amongst the most famous in the history of molecular biology, and have been home to such great researchers of the 1950s and 1960s as James Watson, Max Delbruck and Barbara McClintock. To get there, one takes the Long Island Railroad from New York's Grand Central Station to the town of Syosset. It was raining when I got there in May 1999. Syosset in the rain isn't quite Manhattan in the rain. Dismal Amerikana in the form of diners and parking lots and no public transport presented itself to me upon arrival. The optimistic pronouncements of the Laboratory web page about getting a taxi from the station to the laboratories are clearly misplaced. I had to wait well over 20 minutes for one. I finally ended up sharing my car with Tom, a sequencer from the Stanford Sequencing and Technology Center.

On the way to the labs, we picked up a woman who had to be dropped at the station. She should have been picked up 20 minutes previously, so was in a deep and agitated frenzy at the prospect of missing her train. So we doubled back to the station first, narrowly missing red lights and generally going too fast for comfort. The cab driver was clearly having a wonderful time, managing both to terrify Tom and me, and, for some reason, exasperate the woman further, even though she was getting to the station more quickly. But in the midst of her agitation (and the driver's driving) she did find it in herself to get a conversation going with us, which went like this:

Woman: Are you here doing research?

Sequencer: Yes, we've come for the conference.

Woman: What conference is that?

Sequencer: Genome mapping and sequencing

Woman: Of what?

Sequencer: Oh, the genome.

Woman: Of what?

Sequencer: Human.

Woman: Yes, but of what? What are you mapping?

Sequencer (increasingly perplexed): The whole thing.

Woman: But that's already been done, hasn't it?

And here were these venerable people getting all worked up about Venter getting there first![63]

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4.2: Genomic Capital

In this part of the thesis, I talk about the cultural transformations – institutional and conceptual – that biocapitalism is creating in the materiality and exchangeability of what we call "life". These transformations are created through shifting and variable use of market commodification versus public commons or public goods formation, both of which are disciplined by new forms of capitalist logic, conforming neither to those of industrial capitalism nor those of so-called postmodern information capitalism. Hence "biocapitalism", which basically asks the question of how "life" gets redefined through the contradictory processes of

commodification, and thereby begs to be theorized not just in terms of the formation of subjectivity (though this is undeniably as essential component of theorization that needs to be undertaken, and that is the subject of Chapter 8), but also in terms of property regimes and relationships.

Specifically, I want to start making the argument for the enterprise of genomics as being a window on contemporary capitalism. It is a window that affords a particularly important view into the latter's workings as the confluence today of the information and life sciences redefines not just biology but society and its perspectival vantage points writ large. Paul Rabinow coined the term biosociality to describe social relations organized and coordinated on the basis of shared biological identifications (Rabinow 1992). If capitalism could be understood in the nineteenth century through an understanding of the industrial revolution, which itself was powered by the dynamics of circulation of money and commodities, then the twenty-first century could be said to be an era of biotechnical capitalism, in which the sciences of life construct and articulate new historical modes of capitalism.

While the argument that the life sciences are increasingly assuming a definitive importance in illuminating capitalist dynamics in the 21st century maybe a contentious one, there is no doubt that biotechnical capitalism, or biocapitalism, can be used as an explanatory framework for contemporary capitalism in its emergent and shifting topological manifestations and conundrums of value generation and market logic that come out of the bio-informatic (disciplinary and corporate) mergers of the genome sequencing revolution. The salient features of biocapitalism as I explore them in this part of the chapter are: *(1) a breathless rhetoric of speed, implying seamless flows of information, tempered by speedbumps in the form of ownerships through patent protection; (2) mobile and unpredictable strategic terrains of conflict and co-operation between different companies and types of companies as well as between companies and*

[63] From fieldnotes written at the Cold Spring Harbor Genome Sequencing and Biology Conference, May

public-funded scientists and institutions; (3) the establishment of new forms of contractual alliance such as consortia that are claimed to destabilize the commodity status of information while instantiating the gift regime as a logical, strategic and ethical mode of corporate functioning;(4) the emergence of forms of symbolic capital through confluences of advertising excess and ethical embodification; and (5) the emergence of new biosocialities and subjectivities that are always-already embedded in the logic of the market – a logic which is itself very much at stake in the ad-ventures of biocapitalism.

In trying to understand biocapitalism, therefore, I am interested in asking, firstly, where value resides as biology becomes an information science (and some kinds of information become "biological"), and secondly, what work and (whose) agencies are required to create these values. Answering these questions involves understanding the circulation of information and the changing forms of corporate activity. My attempt is to theorize the dynamics of information flow and corporate action around the fact that information is something that can be and is now *owned*. The rest of this section, therefore, will offer an analysis of the dynamics of information ownership, and its effects on both institutions and on information itself. Specifically, it focusses on the relationship between information flows and the "speed bumps" created by private ownership, in order to trace its implications for understanding the operation of biocapitalist market logics.

It is, however, very important to emphasize that biocapitalism is not just an understanding of an information system. Indeed, genomics itself, while marked most notably by its material representation of life as information, is precisely information *about life*, that both epistemically and materially ties into the creation of tangible knowledges and products. In other words, "genomics" is both an information science and not just an information science. It is aimed towards the production of particular kinds of things, such as pharmaceuticals and crops. It is

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1999.

important to keep in mind that what is at stake is an understanding of how the various elements, practices and objects – informational and "thingly" – of genomics articulate. It is the particular modes of articulation – of information and materiality, rhetoric and practice – that genomics distinguishes itself from other information systems such as the internet economy or finance.

This section looks at corporate genomics today. All three of these words need to be explained right at the beginning. By genomics, I mean an ensemble of events, technologies, discourses and institutions that have sprung / are springing / are likely to spring up around the sequencing of genomes. The "today" is important: there is a tendency to conflate genomics with its best known institutional manifestation, the Human Genome Project (HGP). The HGP, however, as I have already argued, is very much just a fragment, albeit a central one, of genomics today. Firstly, a primarily State sponsored venture, the HGP occupies a particular political space vis-à-vis genomics writ large, as an endeavour which has used and continues to use public money to generate gene sequence information – and I will talk more about this particular political space later in the chapter. Secondly, the sequencing of the human genome, a project that just a few years ago seemed so dauntingly far away (if not temporally, then at least in sheer volume of effort) as to be an end in itself, is today very much conceived of as just the end of the beginning, at a moment when a working draft sequence of the human genome is already complete. Genomics today therefore is largely what might have been called "post-genomics" even a year ago. And by "corporate" I refer not just to the enormous number of what are called genomics corporations that have sprung up in the last five years, but to the entire nature and agenda of genomics writ large.

There is a specific, busy and under-studied intersection that is marked by genomics. Firstly, there is a general (public and academic) absence of understanding of biotech and its specific forms of value. The approach of theorists of the information economy (such as, for instance, David Harvey [1990] with his sector economy approach) misses the points where

science and industry intersect Life as opposed to Work.[64] I am starting from within biotech to understand its form of life, as described in Chapter 1. In other words, an approach followed by theorists such as Harvey would treat biotech as a sector / industry producing things. My emphasis on information is not to project genomics as an "information system" (in the way that "systems" have been theoretically propounded in such literature), but to show the specific roles that information comes to play. These include ways in which information:

- Affects / structures the entire dynamics of the drug development industry.
- Intersects with public culture. Particularly important in this regard are debates over ownership and privacy that adopt tricky shapes which mask the capitalist dynamics of even those modes of strategic action that present themselves as somehow altruistic or external to the market.
- Relates to the emerging notions of value specific to biotech as research / capital / life force, notions that require close ethnographic attention in order to be adequately made sense of.

In other words, the locus of analysis for understanding emergent drug development dynamics writ large is not information but the biological (which makes an analysis of biocapital something that's not just derivative of other information economic / late capitalism analyses), and what is considered constitutive of "genomic" information has itself been changing. In 1999-2000, for instance, genomics was about the selling of databases. Since the completion of the working draft sequence of the human genome in June 2000, however, a lot of information is in the public domain, and a lot of the best commercial sequence databases have already been sold or licensed. Therefore, in the "post"-genomic era that we are now in the midst of, there is a push even within the industry towards focusing on diagnostics and drug development, and "genomic" companies are being forced to reinvent themselves in various ways to contend with that. In other words, genomics is not about information as much as it is about the relationship between information and

[64] Meanwhile, literature in science and technology studies (STS) has not often enough engaged the question of political economy (science as corporate), though this is clearly an emerging field of emphasis within the

that downstream, material "something else" that is a consequence of its availability and use. In this relationship, information itself acquires materialities and types of value that are constantly morphing.

The larger project of understanding biocapital then is less about understanding the flow of information and more about understanding the circulation of various forms of biologicals, information being a particular type of biological that creates and operates in particular circumstances through particular modes of action. This isn't just about understanding a particular type of information economy in which information happens to deal with "life", but is rather about trying to understand the various inaugural moments in the process of life sciences constructing and articulating different forms of meaning and value, in the realm of political economy and otherwise.

Secondly, it is not possible to do justice to understanding biocapital without, firstly, understanding the commodity status of the human biological, and secondly, inserting that understanding not just into a political economic understanding but into understandings of how new subjectivities get created – value in all the senses of the word have to be understood, as do the modes of abstraction that are peculiar to the inaugural moments that biocapital marks.

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(1) A breathless rhetoric of speed, implying seamless flows of information, tempered by speedbumps in the form of ownerships through patent protection...

One of the features of sequence information flow in genomics is the remarkable speed at which DNA sequences are being generated, a consequence of considerable automation and investment in technological hardware in the form of new DNA sequencing machines. The pervasive rhetoric surrounding such rapid information generation is, not surprisingly, one of

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discipline.

speed – almost one of breathlessness, conveying a sense of being overwhelmed with a huge amount of (presumably) valuable data that is virtually impossible to keep up with. As I will try to show, this isn't merely rhetoric (though it's all rhetorical), because it is true that there is a huge amount of data being generated, and while nobody quite knows the biological significance of even a fraction of it, any piece of information in this haystack could turn out to be extremely valuable, therapeutically and commercially.

Speed is also of direct material value, since a delay in the production and marketing of what turns out to be a blockbuster drug could well cost a drug company in excess of a million dollars per *day*. Speed manifests itself in two distinct ways: both as qualitatively massively compressed research and production time,[65] and as a number of emerging segments that contribute to or feed off speediness. In other words, "speed" in genomics is not just important because change is fast, but because "speed" is a material-rhetorical fulcrum used to lever first the government, and then the public and other companies, into responding to "hype" and thus further entangling themselves in biotech.

In order to stake a claim to the potential value of genomic information, there is a desire (amongst private genomicists, for sure) to own it. Ownership, however, puts fetters on the seamless flow of information, which is the desired condition in order to enable information to be transformed into that valuable "something else", which is often a pharmaceutical or agricultural product. I will unpack this dynamic in greater detail as the chapter proceeds, but this is the central

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[65] The idea of "qualititively compressed time" might seem anachronistic, but in fact reflects the actual difference in modes of production -- to the extent that new ways of doing science emerge -- from an increase in speed. This is reflected in the rapidly emerging high throughput industries, which require battalions of advanced automated instrumentation that itself gives rise to new instrumentation industries. A particularly striking example of the qualitative effects of time compression can be seen in the business model and R & D activity of the new San Diego based company Syrrx. Syrrx is a high throughput proteomics company, that seeks to automate all the steps of protein documentation and analysis from the get-go. In the process, it claims it has robots that can actually crystallize proteins. Protein crystallisation has always been one of the hardest things to do in biological research, and is often considered more of an art than a precise science. That Syrrx believes it can automate such an intricate and unpredictable process is a testament to how drastically high-throughputness (or its desire) can change the nature of scientific practice as much as it is to the rhetorical powers of a company capable of dynamically selling itself to investors.

theoretical problematic that I'm trying to contend with: the breathlessness manifested through a speed surrounding information flow, tempered by the speedbumps installed as a necessary consequence of an institutional regime that allows information to be owned. This leads to a frictioned process. I use the notion of friction rather than that of noise (which has commonly been used in information theory to denote obstructions to information that, if overcome, can lead to a seamless flow of information),[66] because such obstructions are not externalities waiting to be subsumed in a seamless flow, but are, rather, internal to the dynamics of the flow itself. Friction is both the product of things rubbing against each other and suggestive of conflict; it is not just obstructive, but productive. Speed, speedbumps and friction, therefore, are all inherent to the circulation of genomic information in contemporary capitalism.

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(2) Mobile and unpredictable strategic terrains of conflict and co-operation between different companies and types of companies as well as between companies and public-funded scientists and institutions...

The broad terrain of the two types of genomics enterprise, one NIH-funded / academic, the other industrial, can, for initial purposes, be set up as a dichotomy, though hopefully as the chapter progresses the dichotomy will blur somewhat.

In order to start the mapping, I need to say a little bit more about Craig Venter.

"Craig Venter", says *Time* magazine in an issue devoted to the Future of Medicine (January 11, 1999) "is a man in a hurry, and now all the genome mappers are operating on Venter time". This one sentence encapsulates the multiple embodiments of hastened temporality in the contemporary world of Big Biology, where fast technologies are mirrored by fast CEOs. In May 1998, Craig Venter threw the genomics community into turmoil by announcing that his private

[66] For the essay that "fathered" information theory, see Shannon (1948).

sector labs would sequence the human genome far before the deadline of 2005 set by the public-funded HGP.

Time continued to articulate the speeded up genomics enterprise in terms of Venter's own characteristics, as it proceeded: "Driven, impatient, demanding, irritating, Craig Venter has a knack for making the rest of the world run at Venter speed".[67] This is not an unusual description for the contemporary maverick of Big Biology: indeed, *Time's* character history of Venter – high school discipline problem, life of surfing, sailing, beach bum, but lots of "raw intelligence" – is uncannily similar to the popular character sketch of that other maverick-genius who has revolutionized biology in the last decade, Kary Mullis.[68] In the same article, Venter's wife and fellow genomicist Claire Fraser is quoted as saying: "Vietnam changed him. It impressed on him the idea that time is precious, that you have to make every single minute of every single day count." Even two decades after the war?

Perhaps Big Biology isn't just a race though. Perhaps it *is* a war.[69]

Venter's history is controversial. He was at the NIH in the early years of the HGP, and was involved in an NIH attempt to patent DNA fragments from brain tissue in 1992 (Cook-Deegan 1994: 311-325). The NIH burnt its fingers in the process and Venter left the NIH. Not surprising then that much of the ire of the HGP scientists towards Venter today is (at least on the face of it) not just a fear of being upstaged, but the knowledge that Venter will patent the DNA sequences that he generates. If the genomics enterprise is a race, then it isn't just a race for credit, it is one for ownership as well.[70]

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[67] See also M. Fortun (1999b) for an analysis of speed in genomics.
[68] Through his development of Polymerase Chain Reaction (PCR). See Rabinow (1997).
[69] Indeed, as Sun Tzu has said, speed *is* the essence of war.
[70] It must be remembered that it was not just Venter, but the NIH itself, which quite staunchly defended Venter's 1992 patent applications, which were backed strongly by the then Director of the NIH, Bernadine Healy. Therefore, this particular polarization into "public" and "private" is a particular contingent outcome of a set of situated politics, perspectives and priorities, and is by no means a "natural" falling out of public versus private roles.

In 1999, the Human Genome Project was clearly haunted by the spectre of Venter. Much as the HGP researchers insisted that the media overplayed the Venter story, he was referenced everywhere, in often thinly veiled taunts ("combative entrepreneur" and "worm genome detractor" being amongst the more colorful ones). So it is perhaps worthwhile to narrow in on the dynamics of the HGP v. Venter race for a while, to see just how high the stakes indeed were for the former, and how irrational their involvement post-Venter might seem to be.

I would like to mention here that much of the following perspective was obtained from talking to students and post-docs, who feel less compelled to quote the Party Line that their more illustrious seniors adhere to. A general consensus amongst younger public scientists at sites in 1999 seemed to be that the winner in the race, irrespective of who sequenced the genome first, was always going to be Venter;[71] that he was in a win-win situation simply because he always had the NIH project's sequences to draw upon as soon as they were done (since they get immediately released into the public domain), while he didn't need to divulge his sequence to the Project. So effectively, the millions of dollars of taxpayers' money going into the Project has all gone into the Venter project as well, without his having to lift a finger; and there's nothing anyone could have done about it. Also, there really is a differential concern about quality between a project that is essentially scientific, and one that is a means towards a commercial end.

The people who have undertaken all the risk are the NIH people. They've already spent too much public money to pull out, and need to spend much more to win the race;[72] and the more they spend, the higher the stakes become.[73]

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[71] As it happens, both the HGP and Celera have generated a working draft of the sequence at roughly the same time, though Celera insists it got there first.

[72] The "race" of course gets constantly redefined; now that the working draft sequence of the human genome has been completed, the "competition" between the NIH and the private sector shifts to other types of information, such as annotated sequence information or information about genetic variability. This competition, after all, isn't just about finishing first and getting the credit for it – who generates information first has huge implications for whether that information goes automatically into the public domain or becomes the property of particular companies. As I will try to show later in the chapter, however, this opposition between the public and private sector is expectedly more complicated than it seems at first sight, from the "race" to generate the working draft sequence.

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(3) The establishment of new forms of contractual alliance such as consortia that destabilise the commodity status of information while instantiating the gift regime as a logical, strategic and ethical mode of corporate functioning...

I now want to spend some time telling a story about the interactions between "public" and "private" genome worlds that will hopefully complicate the opposition between the two that I have just set up, while simultaneously unraveling the "private" genomics enterprise as something infinitely more complicated and heterogenous.

Signals magazine, an online magazine that analyses biotechnology for executives, has the following quote:

> Coming soon: A global genomic map of single-nucleotide polymorphisms (SNPs), the tiny differences between two people's DNA that largely determine everything from who's the natural athlete to who's the klutz to who's likely to get lung cancer from smoking and who's not. In the not-so-distant future, scientists will also be able to tell who's at risk for cardiovascular disease, whatever their lifestyle, as well as who will respond, or not, to this drug or that. But the techniques now used for discovering or mapping SNPs are costly, tedious and Ph.D.-intensive. The real mark of a SNP-detection

[73] Of course, the "official" summaries of this extremely contentious history are predictably formal and dyspeptic. For instance, Francis Collins, the head of the National Human Genome Research Institute, in a review article co-authored with Victor McCusick, a leading public genome researcher at Johns Hopkins University, written for the *Journal of the American Medical Association* summarizing the implications of the genome project for medical science phrases this history in the following terms: "By 1996, the complete sequencing of several bacterial species and yeast led to the conclusion that it was time to attempt sequencing human DNA on a pilot scale. The introduction of capillary sequencing instruments and the formation of a company in the private sector promising to sequence the human genome for profitable purposes added further momentum to the effort. By 1999, confidence had gathered that acquiring the majority of the sequence of the 3 billion base pairs of the human genome could be attempted. In June 2000, both the private company and the international public sequencing consortium announced the completion of 'working drafts' of the human genome sequence" (Collins and McCusick 2001: 541).

assay scale-up will be its downward mobility: For characterizing huge numbers of SNPs among large populations, cheap, fast and easy is the way to go.[74]

Genomics is not just about the Human Genome Project, even though the Venter challenge that turned genomics into a major media event was about sequencing the human genome more rapidly. The HGP, however, will not yield any information about genetic *variability* between individuals and populations, which has become an area of increased interest for scientists and the biotechnology industry. The ultimate pharmaceutical aim of studying human genetic variation is to generate individualized therapy – what is called pharmacogenomics. Determining human genetic variation is a much more daunting task than sequencing the human genome, both because the sample of humans required to be sequenced is much larger, and because a truly meaningful correlation of genetic sequence and individual / population disease trait would involve identifying the person from whom the sample came, which raises ethical concerns about genetic privacy and informed consent. As the HGP has progressed, however, an increasing amount of interest has been paid to informational and technological tools that may help study human genetic variation, and conflicts and alliances have begun to arise around these tools.

The major informational artifacts in this emergent battlefield are called single-nucleotide polymorphisms or SNPs (pronounced "snips"). SNPs are single base variations in the genetic code that occur about once every 1000 bases along the 3 billion base human genome. Knowing the locations of these closely spaced DNA landmarks both eases the sequencing of the human genome and aids in the discovery of genes variably linked to different traits. A map of all the SNPs in the human species would provide the basic database to perform association studies, which compare the prevalence of particular genetic markers in individuals that possess a certain

[74] From *Signals* magazine, an online magazine that analyses biotechnology for executives. www.signalsmag.com/signalsmag.nsf/0/DEC74B56C34589DC882567D1006C676E. The genetic determinism in this quote is particularly striking: while not directly relevant to this chapter, it is interesting to see how it is precisely such deterministic language that is shed in, for instance, the promotion of cloning. It is also striking to note how SNPs simultaneously seem to represent information about individuals, populations and the "globe".

trait (which may be a disease trait, a predisposition to a disease, side effects to certain drugs, whatever) to those who don't. Association studies are a potential goldmine through the insights they might provide in unearthing obscure disease-related genes or in helping preventive diagnosis. SNPs, therefore, have a potential value as tools leading to therapy, in a more pinpointed and versatile way than a random DNA sequence. Pharmaceutical companies, not surprisingly, are extremely interested in SNPs.

A brief taxonomy of some involved "types" of companies in the drug development marketplace may be useful to reiterate from the previous chapter at this stage. A crude distinction may be made between a "genomics" company, whose business is to sell genetic information, and a pharmaceutical company, whose business is to sell drugs. This is, of course, a simplistic distinction. Nevertheless, a broad distinction can be made between the relatively small, new, information-selling genomics companies and the relatively larger, older, information-buying and drug-selling companies. Certainly, a common mode of operation for genomics companies is to license their information to big pharma, which is often more convenient for the pharmaceutical company than setting up an extensive genomics facility (see Figures 4.1 and 4.2).

In the autumn of 1998, the NIH allocated $30 million to the National Human Genome Research Institute (NHGRI) to enter the race to identify SNPs. This itself was a more than slightly breathless undertaking (or as Francis Collins, head of the NHGRI put it, an undertaking of "some urgency"). The basic strategy that was decided upon in December 1997 involved the collection of at least 100,000 SNPs from DNA donated by 100 to 500 people in four major population categories: African, Asian, European and Native American (Marshall 1997b). Collins first started promoting this project in September 1997, in response to the danger that SNP information would get patented and "locked up" by genomics companies (Marshall 1997a). In November 1997, Collins co-authored a Policy Forum piece in *Science* with Mark Guyer and Aravinda Chakravarti that argued that SNP data will get locked away in "private collections" if it

Figure 4.1

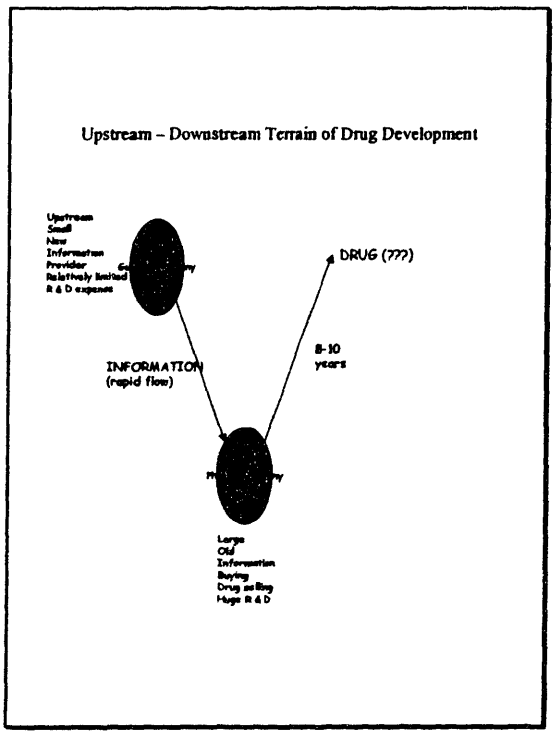
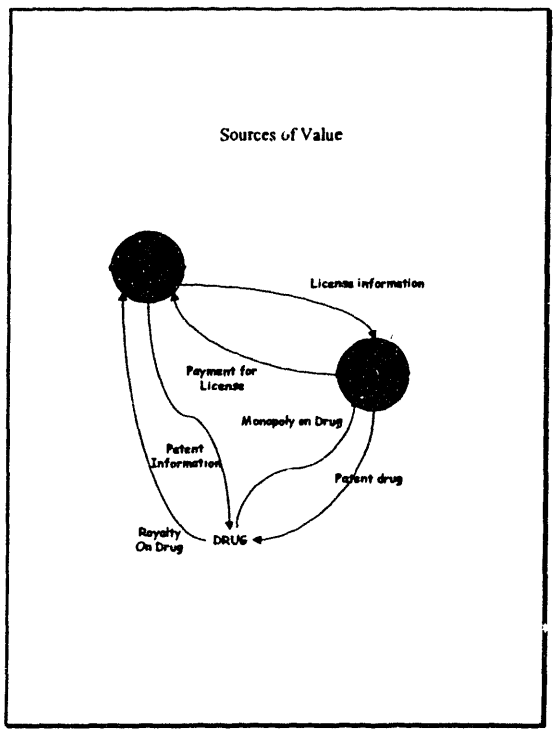

Upstream – Downstream Terrain of Drug Development
DRUG (???)
8-10
years
INFORMATION
(rapid flow)

Figure 4.2



doesn't get public support (Collins et al 1997). Chakravarti has also argued for co-ordinated data gathering with public support not just for reasons of unfettered access, but for reasons of *ordered* access, saying that "we will lose information if we don't combine it all in one place" (Marshall 1997b). In other words, researchers like Collins and Chakravarti have been well aware since before the Venter challenge that owning DNA sequence information slows down information flow. What is interesting in the SNP story is the strategy that the public researchers have devised to get around this, and the speed with which the strategy was employed. This is a speed that potentially sacrifices some of the scientific quality of the data, an accusation that has ironically been leveled by the public-funded scientists themselves against Craig Venter's sequencing *modus operandi*.

In April 1999, the NIH strategy grew into a $45-million consortium funded by the British non-profit Wellcome Trust and ten of the major multinational pharmaceutical companies. The

objective of the consortium was to generate a full-length SNP map within two years of starting and to place the results into a free public database. The members of the consortium read like a Who's Who of big pharma combined with the major players of the HGP.[75] The objective is that the public databases will be filled with enough SNP data to get around anybody's patent. According to SNP consortium chairman Arthur Holden, "Everybody will be able to do this sort of work without being held hostage to commercial databases".[76]

While The SNP consortium database is not a commercial *database* (in that it isn't being established as a commodity in itself), its setting up is without a doubt a commercial enterprise. In the rhetoric of contemporary capitalism, this is framed not as altruism, but as "win-win". Indeed, the setting up of the consortium, which was largely encouraged by the pharmaceutical giant Merck, itself has its genesis in corporate battles, as Merck hoped thereby to challenge the hold that its rival SmithKline-Beecham had over expressed sequence tag (EST) information as a consequence of an exclusive agreement with Human Genome Sciences (See Davies 2001: 100). The move for a SNP consortium, in terms of connections and networks, has to be seen as a hegemonic move. Firstly, it recognizes and aims to remove the inherent contradictions tied in to the commodified / regulated circulation of information that I have argued for above. Secondly, it ensures that, by immediate release of information into the public domain, the major pharmaceutical companies do not have to go through tedious or expensive licensing procedures with smaller genomics companies. And finally, it gives an aura of legitimacy to the big pharmaceutical firms, both in the eyes of public-funded scientists (especially when compared to institutionalised Enemies like Venter) and in the eyes of the "public" at large, since it can be profitably projected that consortium members have foregone patent rights on SNP information in

[75] The academic centres involved are the Whitehead Institute for Biomedical Research, Washington University School of Medicine, the Wellcome Trust's Sanger Center, the Stanford Human Genome Centre and Cold Spring Harbor Laboratory. The list of pharmaceutical members of the consortium is even more impressive, and comprises AstraZeneca, Bayer, Bristol-Myers Squibb, Hoffman-la Roche, Glaxo Wellcome, Hoechst Marion Roussel, Novartis, Pfizer, G. D. Searle and SmithKline Beecham.
[76] Quoted in www.signalsmag.com/signalsmag.nsf/0/DEC74B56C34589DC882567D1006C676E

order to facilitate cheap, fast and easy public access to it. A wonderful example of, to use Edward Grefe and Martin Linsky's term, new corporate activism (Grefe and Linsky 1995).[77]

The SNP consortium is not the only corporate collaboration out to hunt SNPs, and it is by no means the first. In 1997, Abbott Laboratories seeded the French genomics company Genset to the tune of $42.5 million in order to construct a SNP map.[78] This is considered to be the first "strategic alliance" (as Genset calls it)[79] in pharmacogenomics. Like many other genomics – pharma alliances, and unlike The SNP consortium, this is an *exclusive* alliance, and the division of labour in this alliance is quite typical: while Genset's job is to develop a proprietary map of the human genome with relevant markers and genes associated with responses to particular pharmaceutical compounds, Abbott's job is to "develop, produce and market diagnostic systems derived from these genes and markers to clinically test patient response to specific drugs".[80] The SNP consortium therefore replaces the direct contractual agreement of the Genset – Abbott type with something that is more "communal" in nature, and at first sight counter-intuitive to "market logic". What is evident however is that The SNP consortium is less an attempt to negate market logic as much as it is to redefine the terrain in such a way that "market logic" is dictated by the strategic interests of the consortium members (whose aims are by no means identical or even co-terminous).

A major figure in The SNP consortium (officially referred to as TSC) is Alan Williamson, former vice-president of research strategy at Merck. It was he who called the April

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[77] In *The New Corporate Activism*, Grefe and Linsky provide a blueprint and strategies for political action on the part of corporations actively influencing the outcome of issues affecting their organisations. While at one level this is just a public relations manual, Grefe and Linsky's call for combining democratic values, human psychology, grassroots organizing and modern technology into a winning corporate strategy draws explicitly on Saul Alinsky's (1989 [1971]) templates for grassroots activism in the late 60s and early 70s, and translates easily into a call for hegemonic corporate praxis. Even the key metaphors utilized – "setting a strategic approach", "framing the message", "mobilizing the troops", "dealing with crisis", and "targeting communications for maximum impact" – are clearly metaphors of the battlefield and come straight from Alinsky.

[78] http://www.signalsmag.com/signalsmag.nsf/0/799C47CDCD7A924788256609004E0503.

[79] http://www.genxy.com/About/abt_history.html.

[80] http://www.genxy.com/News/Releases/abbott.html.

99 meeting. According to him, "Some companies have a very positive attitude towards the idea of supporting a public database".[81] What statements like this *imply*, in the rhetoric of New Corporate Activism, is that some companies are inherently open to sharing of information, while others are nasty little spoilers who want to own it all themselves; what it hides is an element of corporate subjectivity that shows all the nuances of social subjectivity, except that the playing field is unquestionably of billions.[82] And this is where the genomics / pharma distinction comes to the fore again – even major genomics companies that might fancy themselves as pharmaceutical companies, at least in the future, do not have the history of pharmaceutical R & D and regulatory infrastructure that the big multinational pharmaceuticals have, and drugs are neither their primary nor an assured product. For TSC members, however, any possible profit they might make on a SNP patent is small compared to the profit they can make on a drug, and it is in their interests to remove the necessity of sharing that profit with a genomics licensee. As Williamson says, "I don't think a SNP patent per se is going to be worth much. It's the clinical significance that really counts. Each SNP has to be evaluated epidemiologically or pharmacologically".[83]

Therefore, while The SNP consortium is purportedly against the ownership of DNA sequence information, it is very much in support of owning biologicals *per se* – while speedy and free access of information to a large number of researchers will undoubtedly be an outcome of the TSC database, at another level it increases the monopoly of the big pharmaceutical partners in the consortium on any therapy that might accrue, at a lower cost to the companies involved. In other words, it isn't ownership itself, but the *modes* of ownership, that constitutes the terrain for hegemonic struggle in genomics.

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[81] http://www.signalsmag.com/signalsmag.nsf/0/799C47CDCD7A924788256609004E0503.
[82] As Pierre Bourdieu insightfully remarks: "[W]e need to be able to recognize as such the strategies which, in universes in which people have an interest in being disinterested, tend to disguise strategies" (Bourdieu (1999 [1975]): 35).
[83] http://www.signalsmag.com/signalsmag.nsf/0/799C47CDCD7A924788256609004E0503.

These disputes highlight issues of corporate subjectivity. While unobstructed access and speedy progress of research remain the stated goals of all parties concerned, clearly for each party research progresses "speedily" only when *they* have unobstructed access, combined with the right, whenever they feel appropriate, to slow down and charge everybody else – the inherent logic of *ownership*, after all, is that the owner can decide what to do with the object owned.

Big pharmaceuticals have indeed been complaining for years about what are called "stacking royalties", which are the fees that they have to pay out to various other upstream providers that stake a claim on the downstream drug product – indeed, something like a SNP consortium is precisely a way out of having to deal with upstream information sellers who own information. Pharmaceutical companies have for a long time used "anti-stacking language".[84] An article in *Signals* magazine titled "Is the alliance deck becoming "anti-stacked" against innovators?" describes the Big Pharma argument for anti-stacking language as follows: "If Big Pharma licenses a lead compound from Biotech and that compound is later blocked by another party's patent, it is Biotech who should bear the responsibility for that occurrence and shoulder the burden of crediting Big Pharma for the amount due the third party."[85] In the 1980s, biotech companies themselves incorporated anti-stacking provisions in their dealings with universities. Since the late 1980s, however, biotech companies have increasingly gone upstream, providing a range of utilities and services to now downstream pharmaceutical companies, and thereby have increasingly found themselves subject to similar anti-stacking agreements drawn up by pharmaceuticals. The justification for anti-stacking is further increased as the number and range of upstream providers increases.

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[84] This term and much of this analysis draws upon an excellent article in the online magazine for biotechnology analysis, *Signals*, and is available at http://www.signalsmag.com/signalsmag.nsf/657b06742b5748e888256570005cba01/ffd2cf3f7f7ea56f8825661200697ce3?OpenDocument&Highlight=2,anti-stacking.

(4) The emergence of forms of symbolic capital through confluences of advertising excess and ethical embodification...

Two questions are central to the analysis of value in genomics: first, the question of where value resides, in the various "informations" and for the various actors, and second, what agencies are required to create and maintain the values and their directionalities.

Let us start by looking again at the actors involved in the contestation. There is, broadly speaking, the "NIH", an umbrella term for an institution of the state that has sequencing under it various generally academic research institutes; there are upstream companies, which may be genome companies that sell information (either by simply sequencing, or after annotating the information), or tool companies like Affymetrix; and there are downstream companies, of which pharmaceuticals (and invariably big multi-national pharmaceuticals) are the most downstream. Tied into the differentiation of upstream and downstream companies is the upstream – downstream relationship of information itself to its "ultimate" product, the pharmaceutical (which of course need never actually be realized, but, as I will argue further in chapter 6, its existence as a future goal is vital to the operation of the entire dynamics of the present).

Now the NIH doesn't want information to be owned because it has a commitment, as an institution of the state generating information with public money, to release the information into the public domain.[86] In other words, for the state as represented by the NIH, information has the status not of commodity but of public good.[87] The downstream companies do not want information to be owned because their locus of surplus value generation is in selling the drug, and the less they have to dish out to upstream companies on the way the better for them. However, by

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[85] *Ibid.* "Biotech" here refers to an upstream service provider for Big Pharma. I shall use "Biotech" in the same context for the rest of this argument.

[86] "Public", of course, is as vexed a term as information or commodity, but this chapter isn't the place to go into that.

[87] Of course, while the state, *as represented by the NIH*, and *in the case of DNA sequence patents*, defends genomic information as part of a commons for the public good, it is also the state that constructs the

framing this rather narrow self-interest in terms of a "relinquishing" of patent rights on DNA sequences in order to enter into a "partnership" with the HGP to allow "free and rapid" flow of information, the New Corporate Activism of the pharmaceutical companies shifts the nature of information from the realm of commodity into the realm of gift.

The idea that information is a gift on the part of big pharmaceutical companies is well in keeping with the tenets of New Corporate Activism. As Marcel Mauss (1990 [1954]) has shown, the gift has attached to it cultural obligations both to receive and to reciprocate.[88] The field of gifting / reception / reciprocation is much less clearly delineated in genomics than in the "archaic societies" of Mauss, and encompasses that extremely diffuse and undefined and constantly recruited arena of the "public domain". As Jacques Godbout and Alain Caille have argued, the gift economy is central to the dynamics of the market and the state, with the market absolutely dependent on the existence of gift exchange (Godbout and Caille 1998).[89]

There is, therefore, a tension between a linear race towards commodification and the changing status of information from commodity to gift. In other words, the linear race towards commodification has instabilities inherent to it, instabilities that push actors to take recourse to mechanisms outside the sphere of commodification, mechanisms that it turn facilitate the "linear" (now purposefully in quotes) race towards commodification. This is an instability that is a consequence of the particular structures of biocapitalist knowledge production, especially its upstream-downstream terrain, that are particularly well demarcated in the US context. Here,

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boundaries between public and private goods in ways that, especially in the US, favour the appropriation of the commons by private companies through intellectual property protection.

[88] Equally important and often overlooked however is the obligation that Mauss emphasizes to gift in the first place. A realization of such obligations when exported to the corporate cause may not cause New Corporate Activism to seem less cynical, but certainly points to a much more constrained agency for these corporations. A difference between obligation and constraint is also important to tease out concomitant to their causal equation -- by "constraint" I mean the limitation of strategic fields with the ultimate aim of maximizing profit, and therefore use it specifically in order to define capitalist relations. By obligation I refer to a more intangible system of socio-moral pressures that operate as strongly in the societies Mauss describes as they co-exist with the market in capitalism. A standard utilitarian move is to collapse all obligation into constraint.

academic research is at least discursively (and sometimes in actual fact) designated as contributing to the "public domain".[90] But also, public research is naturalized as being the *enabler* of private research, but a silent one. In other words, the mantra that innovation comes from the private sector hides one of the fundamental conditions of possibility that makes private innovation possible, which is the naturalized assumption that public institutions exist to enable private research.[91]

Now let us look at where else and in what other forms the value of information might reside. Clearly, information has some use value, in being the "raw material", if you like, that provides the knowledge and therefore the conditions of possibility to create a drug. But the reason why any information needs so much work in order to be turned into a commodity is not just because there are conflicting interests among the various institutional actors involved, but because by its nature, the exchange value of information is entirely dependent on the context and framing of particular transactions.

As soon as information is released into the public domain, it falls out of the system of commodity circulation and its "ownership" is of no further value. In order to stay within the sphere of commodity circulation, information needs to be circulated through specific transactions of exchange between the seller and buyer. Even in these transactions, any exchange value for an information seller like Venter's Celera is only obtainable, for each transaction, at the moment of first sale – once the information gets bought, it reverts to being a pure use value for that particular buyer-seller pair, and cannot be recommodified.[92] Information can only retain exchange value if the ownership rights on information are tied to downstream ownership rights on any product that

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[89] Indeed, as Georges Bataille (1998 [1967]) would argue, the importance of gifting in capitalism is not just strategic but in fact a fundamental capitalist "impulse".

[90] Academic research labs often aggressively pursue intellectual property protection. It is just that, in the context of DNA sequence debates, they have generally avoided doing so, thereby framing themselves as committed to the "public domain".

[91] See Comroe and Dripps (1976), Maxwell and Eckhardt (1990) and Stallings et al (2001).

[92] Though it can be encumbered, though contractual and legal devices such as non-disclosure agreements.

might accrue. Which is why for an upstream company, it is vital to patent information and tie that patent into downstream royalties.

Information, however, has a third form of value, a "moral" value that operates in the realm of symbolic capital. This comes from two sources – one, as a primary good that the state distributes or as a could-have-been commodity that the (downstream) company relinquishes as gift, information acquires a decommodified status through a mechanism of rhetorical abdication that suggests that its *natural* state is as commodity, and the *decommodification* is an act of virtue – whether by the state or by the (downstream) company, which gets portrayed as a willing partner to the state in maintaining the unfettered flow of information, and therefore of science. There is, however, another more direct manner in which genomic information is virtuous, and that is its extensive linkage, rhetorical and real, to therapy – a linkage indeed that is made real by the rhetoric. There was this wonderful moment, for instance, at the very end of a 1999 industrial genome conference, when Randy Scott, Chairman and Chief Scientific Officer of Incyte, raised a toast, to "the genomic community. Because they aren't in genomics for themselves, they are in it for Life". Mirroring, indeed, Incyte's own logo, which is Genomics for Life™.

It is very evident that the production of value in genomics is to a large extent a discursive act, whether it be through advertising, the selling of futures or the rhetorical creation of *a* genomic community committed to Health, or of many competing companies relinquishing property rights for the common good. Indeed, the creation of this single genomic community has as internal to its logic the existence of multiple competing actors all of whom try to propagate their particular informational value at the expense of their competitors'.

What is evident is that information has to perform active work, work that may be variously material, discursive and performative, in the process of which the genomic community is created as a homogenous entity, but one that is simultaneously an *ethical* entity, an entity represented (and encompassed) by the Incyte logo, Genomics for Life™. It isn't just the subject

within the genomics profession who gets in-formed at this moment; equally in-formed is the subject (as in discipline / endeavour / venture) *of* genomics and the corporate subject such as Incyte, as ethical subjects that are in the business of saving lives.

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(5) The emergence of new biosocialities and subjectivities that are always-already embedded in the logic of the market – a logic which is itself very much at stake in the ad-ventures of biocapitalism...

In this section, I want to analyze the continuing unfolding of the dialectics (powered by social contradictions) of history, against the ideologies of the "end of history" or the viewing of a "post-capitalist" era as a resolution of capitalist contradictions into a structurally stable eternalism. Social formations are composed of several modes of production, with the dominant one providing constraints on the others. The challenge is to figure out the contours of which contradictions really create a new generative dynamic that will emerge as the governing or hegemonic mode of production, and then, as I explore in the following section on labor, to see how that social formation produces new actors and new subjectivities. I take inspiration in this latter endeavor from authors such as Ulrich Beck (1986), who shows how toxicities affect tourist sectors and heavy industry differently and can cause a realignment of regional politics than that of the 19th century political economy, and Adriana Petryna (2002), who shows how access to new healthcare welfare systems acts as a new status and citizenship order.

To show how genomics provides a window into contemporary capitalism analytically involves going beyond reading texts, doing data analysis and reacting to pre-existing theorizations of the information economy with fresh data. It involves, simultaneously, figuring out where the access points are and analyzing ethnographic data in a scene that is changing rapidly even over the course of particular research projects. It is easy to become confused about whether genomics is simply a puzzling, fast changing and really important set of objects and

practices in the world, or a system whose understanding will contribute to general debates about capitalism, which, in at least some sites and some ways, does not anymore depend on land, labor and capital in the classic sense. To the extent that I attempt the latter, I do so through the route of the former.[93] Before moving further, I will review the arguments that I have made, namely:

(a) Genomics can provide a window into contemporary capitalism, which itself is different from earlier industrial capitalism.

(b) The contradictions of producing genomic knowledge are creating new legal and economic structures, which are transforming not only the way knowledge is produced and money is made, but also way the medicine will approach therapeutics and society will interpellate individuals as bundles of genetic variations that can be targeted, tested, monitored and changed in new ways. These contradictions, that arise around the contested commodity status of information, include business models that must be followed; the ordering procedures (and strategies) for demarcating what is in the public domain from what is available for proprietary ownership, and the re-ordering procedures of re-accessing previously proprietary information.

"Good genomics" is judged not by truth and falsity as much as by efficiency or its lack, an efficiency that is manifested through speed.[94] What makes speed – efficiency not just legitimate but desirable is the element of virtue that is associated with a seamless downstream flow of information towards a drug product, and the actual material value at stake.

What is important here is to see how in genomics the "classical" scientific binaries of truth and falsity are *articulated* with those of efficiency and inefficiency, justice and injustice –

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[93] Indeed, a Marxian analysis of biotech cannot simply be an attempt to slot biotech into a political economy framework. Marx's own analysis of political economy was itself not the application of a pre-existing framework as much as it was an exercise in coming to terms with and critiquing an entire epistemic framework that attempted to explain how money and capital mediated and in-formed the way people lived the lives they did. Understanding biocapital, therefore, involves understanding the epistemic framework that is created, a framework that obviously has an economy embedded in it.

[94] Indeed that this "efficiency" is often at odds with the quality of the data produced, and is likely to swamp scientists with a deluge of "useless" information, is evidenced both by the criticism of many public-funded

articulations of non-economic forms of socio-moral values that the sociology of science in its earlier Mertonian guise regarded as separate.[95]

In order to understand what is unique about genomics, it is not sufficient to analyze it merely as a set of knowledge producing practices. These practices need to be positioned in a particular framework of contemporary capitalism.

Genomics can be simply defined as an informational science, but of a particular sort, where information is one of many biologicals, and indeed a precursor to other biological objects of commodified circulation such as drugs. Many of its attributes, therefore, can be studied by studying the social lives of the various forms of information (raw DNA sequence data / function of a gene / SNP / protein information / information as database, and so on). I started this section by analyzing the friction inherent to the flow of information in a regime in which private ownership in general is considered the natural state of society, while *its own* ownership is extremely contentious.

A fundamental question both of politics and of method, that has haunted at least dialectic analyses of political economy since Marx, is: what implications does the unearthing of contradiction have for understanding social practice, in the case of genomics the creation and inhabiting of certain strategic terrains that inscribe a particular political topography onto a system that economically can still be described away as "capitalist"? The question for this thesis then becomes: how do the contradictions that are inherent to genomic circulations of information create new forms of knowledge politics, and what do these contradictions imply for the stability of the (capitalist) system that institutionalizes and sustains such contradictory flows? The

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researchers of Venter's *modus operandi* as well as by the skepticism of some towards the public-funded SNP project's urgency.

[95] Indeed, it could be argued that in the rhetoric of New Corporate Activism, truth and falsity themselves have no meaning -- even if science is about truth and falsity, corporate PR is rather about credibility and incredibility. A triangulation could therefore be made for the contemporary biotechnology corporation, in which speed still mediates the linkage of efficiency and inefficiency to virtue or its lack, but it is credibility rather than truth that is the "ultimate" aim to start with.

uniqueness cannot manifest itself merely in the analysis of information as an object (of knowledge / currency), but in the articulation of the social life of information with the social lives who in-form and get in-formed by it. In this chapter, I have looked at the social lives of the scientific – corporate actors of genomics. Understanding genomics as both a system of knowledge and as a window to contemporary capitalism involves looking at how contradictions inherent to information are articulated to specific modes of strategic response – modes of response that, I shall argue, redefine some of the parameters of "capitalism" itself.

This section, then, is about flows, of information and of capital, the former flowing "downstream" from raw DNA sequence information through annotated and more "meaningful" forms of information into the in-formed drug. The flows are constrained and enabled by legal regimes and technological advances, but, intuitively at least, by that most nebulous and over-arching of entities, "market logic". Market logic plays a similarly obstructive role to the analysis of capitalism that scientific method plays in the analysis of science – these are terms that are at once the ultimate signifiers of the boundaries of actions which the market and science respectively can allow in order to be the market and science, and yet precisely because of that they assume an almost transcendental position, impervious to analysis themselves. I have not analyzed market logic as a single entity, but have tried, through an analysis of information and scientific – corporate actors, to tease out elements of market logic as it gets played out. In the process, I have tried to argue, firstly, that information can mean many different things in genomics, but is never at any point without meaning, even if it is raw "meaningless" information. Secondly, information is not a finite mathematically representable entity, but is, on the contrary, overwhelming. This overwhelming nature of information is not just a consequence of its quantity, but results from the speed with which it is generated. The speed with which it is generated is indeed consequent to technological development, but is equally an intuitive outcome of "market

logic", whereby the speedy progress of science is commercially beneficial. That it is therapeutically beneficial lends speed further legitimacy.

This much is apparent and intuitive. What is hidden from the process is that the very same "market logic" (which in this case is the possibility of private ownership of information for its producer) has inherent speedbumps to the circulation of information; and this dialectic is not unique to information, but to any intellectual property in biotechnology. Various institutional strategies get devised either to perpetuate or to get around this impediment.

The crucial point is that both the perpetuation of ownership and its obstruction can be argued as being "sound market logic": in the former case, ownership is the reward that functions as incentive to innovation, whereas in the latter the regulation of ownership (or its strategic elimination, as in the case of The SNP consortium) allows maximally efficient and rapid circulation (which itself can be an incentive). Clearly, therefore, the contestation here is not between market logic and "something else", but is over the very definition of what constitutes market logic, the outcome of which has considerable implications for the overall terrain of co-operation, conflict and value generation. Neither one nor the other alone *can* represent an uncontradictory market logic.

Furthermore, sound market logic goes much beyond a quantitative generation of maximal surplus value – it needs to generate other forms of symbolic capital, that in the case of biotechnology already exists in the rhetorical and real construction of the biotechnology industry as an industry that is in the business of Food, Health and Hope (to borrow this time from Monsanto's logo). Meanwhile, there is the NIH, an organ of the state, that has its own interests and constraints as a consequence of being an institution that is funded by the public, and that thereby needs to have a commitment to the public domain – a commitment that again gets justified through "market logic" at a contemporary historical moment when market logic is perceived to greatly exceed the bounds of the market. Such a formulation of market logic as

exceeding its boundaries however implies that it simply takes over the new terrain it encroaches upon (such as that of the state or the university) while itself remaining immutable. "Market logic", however, often (indeed necessarily) draws upon strategies that are external to the process of commodity exchange, the gift regime being a major one. The SNP consortium, a wonderful example of such a gift regime, therefore manages simultaneously to espouse "sound market logic" (by allowing "cheap, fast and easy" circulation of information, leading ostensibly to cheaper, faster and easier drug production) while gaining symbolic capital as a consequence of the abdication of property rights on information, that can be projected as a self-sacrificial *abdication* of market logic in the public cause. In the process, by the simultaneous holding up of "market logic" while it is being negated, market logic as a terrain of hegemonic contestation gets redefined. While the strategies of the various actors redefine the terrain of contestation, they simultaneously redefine their own value as actors, as well as the value of the information they produce.

This analysis tries to provide an insight into capitalism's adaptive mechanisms, adaptations however that question the fundamental mechanisms of capitalism themselves while at the same time upholding them. As Slavoj Zizek says: "The 'normal' state of capitalism is the permanent revolutionizing of its own conditions of existence: from the very beginning capitalism 'putrifies', it is branded by a crippling contradiction, discord, by an immanent want of balance: this is exactly why it changes, develops incessantly – incessant development is the only way for it to resolve again and again, come to terms with, its own fundamental, constitutive imbalance, 'contradiction'" (Zizek 1994: 330). This incessant development is brought about not because of the superiority of the indices – efficient production, competition, market logic, surplus value generation and so on – but because of its willingness to constantly abandon / redefine / mutate many of its own fundamental conditions of existence in ways that are contested, unpredictable, but most importantly *still* the fundamental conditions of *its* existence.

It would be hasty to conflate the specific logics of the enterprise of genomics with *the* logic of capitalism – indeed, one of my attempts is to destabilize the notion that capitalism has such a singular logic, and further, to show that it is the absence of such singular logic that is a major source of its sustenance. Nonetheless, its peculiarities can show up the explanatory categories through which contemporary capitalism is understood as complicated and mutable. In particular, I have shown how the boundaries of commodification and commons / gift shift according to the logics of upstream – downstream profit calculations. In other words, the important point to remember is that these contradictions manifest themselves in *institutionally specific ways*, and at specific strategic conjunctures. Therefore, the "gifting" seen by The SNP Consortium has everything to do with the upstream – downstream terrain of drug development. Similarly, start-ups and "grown-up" corporations, as I show in the next section while talking about the San Francisco based e-learning start-up GeneEd, often need to exhibit different strategic rationalities that are often at odds with one another, but are both always "capitalist". To reduce one institutional, conjunctural exhibition of capitalism to *the* fundamental dynamics / impulse / rationality of the capitalist system is a mistake.

Equally mistaken is the idea that one can diagnose an epochal shift in capitalism *as* a somehow definitive historical moment, when capitalism is always marked b*y* contradictory currents and logics, though perhaps marked by different contradictions, in different ways and to different degrees, at different historical moments. Which leads to a fundamental tension in an analysis such as this, which I return to in my reflections at the end of this thesis, while talking about notions of revolution and conjuncture: how is it possible to acknowledge something like genomics, that undeniably is co-produced along with shifts in scientific understandings, technological possibilities, normative understandings and institutional and political terrains, as a "revolution" of quite dramatic consequence, while still remaining attentive to the historicity of these shifts, to the ways in which shifts of such dramatic consequence do *not* indicate by any

means that historical processes of transformation that have brought those shifts about have somehow come to an end?

This danger, of somehow "sacrificing" history at the altar of making a point about fundamental epochal change, however, is central to a certain Hegelian methodology that in fact Marx did not remain faithful to, but which has been faithfully employed by prominent neo-liberal thinkers such as George Gilder and Francis Fukuyama. Jean-Joseph Goux (1990), for instance, reading Gilder, points to the "forever incalculable" nature of the future in Gilder's writing (see for instance Gilder 1981, which is what Goux critiques). In the process, both Gilder and, one suspects, Goux reading Gilder, fall prey, in Hegelian fashion, to a recognition of the "end" of Enlightenment and modernity, marked definitively by the transition a welfare state capitalism to an entrepreneurial, risk-taking capitalism. This is a binary, of "modern" to "postmodern", *as* equated to "socialist / welfare" *versus* "entrepreneurial" capitalism, that assumes, again in Hegelian fashion, that a "postmodern capitalism" is in fact an end of the dialectics that created "modern" capitalism. This is the flaw, ultimately, that resides in a "reading" of the future by taking recourse to a belief in the *historical* existence of the dialectic that has *now* resolved itself into a determinate form, and therefore needs merely to be described (this, as Kojeve [1969 {1934}] points out, is Hegel's method, which *in itself* is not dialectic, but descriptive, as if he is seeing the ultimate resolution of historical contradiction). Of course, this *a*historical attribution of resolution involves resolving the dialectic into a binary – a dialectic whole constantly has its contradictory components in tension with one another, but a binary can be posited in terms of a "present" form of capitalism *in opposition to* the "past", "contradictory" form. This is the method that Francis Fukuyama (1992) also adopts, and of course it is not insignificant that authors like Gilder and Fukuyama are favorite ideologues of a Reaganite neo-liberalism. Therefore, the move

to describe *the* logic of capitalism is also a move to deny its continuing historicity and contradiction.[96]

But more than that, I am putting forward an idea of capitalism, as a risky enterprise of Deep Play that, as I will elaborate in a later chapter, is deeply embraced by a performative rhetoric of ethics in the present and therapeutics in the future. The notion of biocapitalism, further, draws explicitly upon theorizations of biopolitics – Foucauldian notions of biopower built upon by Rabinow's ideas of biosociality – and argues that such biopolitics must be encountered with the understanding that it is always already positioned in the multiple frameworks and logics of capitalism. It is precisely these multiplicities that need to be further explored and theorized, and which I analyze in the later chapters of this thesis.

The Cold Spring Harbor meetings in 1999 afforded a window into the animosity of public researchers towards the patenting of gene sequences. This was enabled by a site of speech whose genesis is at least partly cynical and legitimatory. At the beginning of the Human Genome Project, a small proportion of funds was set aside to discuss Ethical, Legal and Social Implications (ELSI). The idea was that ELSI would provide a forum of visible rumination on many of the issues that the public might become concerned with in regard to genomics, but equally therefore enable genome researchers to get along with the "real" science, unfettered. ELSI proceeded to occupy an increasingly marginal space in the calculus of the HGP, especially after Francis Collins took charge of the project from Jim Watson. And yet, almost as ritual, every year's Cold Spring Harbor genome meetings had a session devoted to ELSI, with a different "ethical", "legal" or "social" (and in some spheres, they're so easy to compartmentalize thus, aren't they?) issue up for discussion each time.

[96] This argument is also of central importance to me in Chapter 7, when I talk about envisioning "India Inc ", the attempt by certain Indian entrepreneurs, policy makers and politicians, based in both India and the US, to change India into an "entrepreneurial culture". Such a framing, as I have argued above, is a similarly ahistoric resolution of current contradiction, rather than a recognition that any process of economic, institutional and social change is always a process of continued, contingent, irresolute, historical and historicising contradiction.

In 1999, the ELSI session was far from mere ritual. Rather, it afforded a space for the public articulation of the concern public researchers had with the patenting of gene sequences in general, and the Celera sequencing project in particular. Of course, the framing of the session indicated that it was indeed gene patenting writ large that was the topic for discussion. It was impossible, even within such a generic framing, for the participants to avoid Craig Venter, and the implicit and explicit references to him were everywhere.

The whole critique of patenting gene sequences in the formal presentations of the session was completely structured around the four requirements for patentability (novelty, utility, non-obviousness and enablement). The concern, in this formal formulation, centered around how allowing gene sequences to be patented, for one reason or another, goes against one or the other of these criteria. In other words, this was *not* about a larger critique of the rationality of patenting *per se.*

Perhaps the most interesting talk was not by the "expert" patent lawyers, but by Randy Scott, founder and Chief Scientific Officer of Incyte Genomics (then Incyte Pharmaceuticals). That Scott was the genomic industry's "representative" in this session was itself an interesting insight into the way the public researchers' animosity towards gene patenting was at least a some level conflated with their animosity towards Venter. True, there wasn't a lot of warmth towards Scott amongst the conference participants. But at some level, the critique of gene patenting wasn't *about* Incyte in the same way as it was about Celera. This is especially ironical given the fact that Incyte has more DNA sequence patents that any other private company. One reason for this differential animosity is historical: as I mentioned earlier in the chapter, Venter does have a contrary history at the NIH, and was involved in an attempt by the NIH to patent expressed sequence tags (ESTs), an attempt that by and large was an embarrassment for the NIH. A second reason has clearly to do with the respective personalities of Venter and Scott. Venter is the archetypal anti-hero, and thrives on his maverick image. Scott, on the other hand, is a master rhetoricist, as I will have occasion to show at other moments in this thesis. An example of his ability to frame his agenda in ways that invited at least participation if not necessarily agreement was on evidence at this session as well.

Scott started off with his talk with the central presumption, stated in so many words, that "biology is information", and proceeded to justify patenting gene sequences from that presumption. This is a presumption that lies at the heart of the epistemic shift that genomics marks, and lies at the heart of the reason why I believe genomics to be fundamentally an emergent form of life science. It is also a presumption that was particularly naturalized between late 1998 and early 2000, when genomics was about *generating* information, rather than making sense of it. So biology, in this presumption, stops being actual living cells and organisms: it becomes abstracted, reified, not even into material commodity but dematerialized commodity, without any questioning or contestation.

Scott then talked about the high-throughput patenting race, which, according to him, was really between Incyte and Human Genome Sciences, suggesting again that the ire of public researchers towards Celera had to do with more reasons than simply opposition to an aggressive patent strategy. Scott went on to justify patenting by using prisoner's dilemma logic *vis-à-vis* HGS: how if they didn't go on and patent gene sequences as aggressively as they were doing, then HGS would. There were some interesting discursive mutations here: "utility", one of the four fundamental conditions that needs to be met for anything to be deemed patentable, was all about *commercial* rather than *biological* utility. Anything that is potentially profitable, in this rhetoric, becomes patentable, irrespective of whether it has actual *material* utility. He then went on to outline the arguments of the opponents of patenting, and much of his definition of the problems of patenting was in terms of the possible *barriers to innovation* that gene patents would create. He then quickly dismissed them as problems as far as Incyte was concerned, because "Incyte wouldn't do that" (suggesting, perhaps obliquely, that Celera would, while suggesting at the same time that one needn't be worried about barriers coming from patents as long as it was Incyte who was doing the patenting). So as far as Scott was concerned, questioning or touching patents itself wasn't even an issue, and any concerns around patenting could be addressed simply by sorting out and encouraging "good" licensing – which, no doubt, would automatically be the *modus operandi* of "good" companies like Incyte.

The real interest in the panel however was in the question and answer session, when the formal presentations wound down and the conference participants were able to have their say. Here it was Francis Collins, head of the HGP, who took center-stage. His question was more of a statement, in which he insisted on the importance of sequence accessibility and the unfetteredness of the public domain. He attacked the Incyte patents, and was clearly, almost, *angry*. He talked about (and I'm quoting) how patenting gene sequences was "applying principles in related but really different fields", about "the P[atent and] T[rademark] O[ffice]'s role (as being) reading the law and what's there rather than benefiting the public", and "why haven't we decided to do something about the law"? This was a really interesting ask for a radical solution, and much more than the genteel word-playing that even the "opponents" of patenting were indulging in on the panel. Indeed, the lawyer on the panel, a rather unmemorable man called John Barton from Stanford, was all about procedural rather than substantive legislative reform, and it was Collins who was actually voicing concerns that this is something that is fundamentally *wrong* that needs to be set right.

Here then was this cleavage between the academic and industrial scientific community actually manifesting itself in an undisguised fashion, and here clearly were a group of extremely famous scientists who were thinking and acting in a concerted and openly *political* manner against the interests of "industry". As I have argued in the body of the chapter, however, what gets framed as "private industry" by public researchers in settings such as these is in reality just upstream genome companies, and in actual fact the complicities between public and private worlds are much more complex. The purpose of this set of field notes is to amplify how that complexity can be rhetorically shed in certain sites of speech in order to create a terrain that *does*, in some way, become one that opposes public and private, in ways that are impossible to dismiss as *simply* rhetorical.

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4.3. Labor

I now move away from talking just about genomics, to talk about labor in drug discovery and development worlds writ large. It is, however, an analysis that is undergirded to a significant

extent by factors that, as I argued in Section 4.1, fundamentally make genomics possible: speed and information, as themselves made possible by automation and high-throughputness. I would like to situate this, however, in the context of the labor practices necessary, both in genome worlds themselves and in other nodes in the life science / drug development enterprise.

I do this not by making any coherent argument for the structure of labor practices across different components of the drug discovery and development enterprise, but instead by putting forward a series of vignettes, about labor practices, and the importance of different forms of labor, in different institutional settings, both in the United States and in India. This is an acknowledgment, as much as anything else, of the fact that a complete picture of biocapitalist lifeworlds cannot even begin to be obtained simply from studying the more glamorous sites of production and decision making, which ultimately is what much of this dissertation does.

Analyses of the pharmaceutical industry, indeed, often fall prey to this blind spot, as supporters and critics alike tend to focus on research and development (R & D) on the one hand, and sales and marketing on the other. The paucity of this set of foci, of course, is evident when one tries to study the Indian pharmaceutical industry, which, as I have shown in Chapter 3, has only recently gotten into R & D in the first place, and, bar the odd exception, really is not into aggressive sales and marketing (the latter itself being an outcome of a certain sort of brand valuation that emerges most evidently from patented rather than generic drugs, and therefore not so central to the Indian pharmaceutical industry pre-WTO). What this misses, then, is manufacturing.

This rather profound blind-spot is not limited to outside analysts of the industry. Indeed, G.K. Raju (1998) cites the following quotes from people within the pharmaceutical industry on the (perceivedly limited) role of manufacturing in pharmaceutical company strategy:

"Manufacturing is basically costs of goods sold. That is insignificant."

"Manufacturing is really not that important in the organization. How many people from manufacturing are on the board? I haven't seen any. Manufacturing is simply not one of the top five things a CEO has to worry about. It's very difficult to get his attention".

"Manufacturing does not determine time-to-market. It is usually R & D, validation and the clinical trials that do".

First of all, however, clinical trials have to operate in parallel with scaled up manufacture. Phase III trials, for instance, require large quantities of drug, that can only be made in a scaled-up plant constructed to (for marketing in the US) FDA specifications. Further, FDA approval depends not just on the review of safety and efficacy of the products, but also on a review of the data relating to manufacturing processes. In India, pre-WTO, of course, the process has even more significance, since the Indian Patent Act of 1970 grants process, but not product, patents. Further, the "product" of a manufacturing process is not simply a drug, but a huge amount of information, known as batch records, that are central to the regulatory process. Much of the current industry documentation process is entirely manual (see Sander 2000).

On the one hand, then, is the fact that much high-technoscience in the (especially upstream, drug discovery components of the) biotech / pharmaceutical industry proceeds alongside much manual documentation work that is central to the production of essential bodies of information accompanying a therapeutic product. On the other hand is the possibility of manufacturing becoming a bottleneck in the generation of therapeutic product itself, which could especially be a problem for smaller biotech companies as compared to big pharma, and be an acute problem if the drug in question is a blockbuster drug with a huge market. This point was most dramatically made in the case of the blockbuster rheumatoid arthritis drug Enbrel, made by the Seattle based biotech company Immunex, who haven't been able to make enough of the drug to keep up with its demand.

Let me start my vignettes, then, with an account of the manufacturing facilities of Dr. Reddy's Laboratories (DRL), the Indian pharmaceutical company I described at some length in Chapter 3. DRL has three plants. One, that is still not quite up and running, is for biotech research and diagnostics. Then there is a plant for bulk drugs and formulations for a primarily domestic market, and for exports to some non-US countries. The third is an acquisition, of an export-oriented company called Cheminor, and is for the manufacture of bulk drugs and formulations for export to the US, as the Cheminor plant manufactures to FDA requirements. The domestic plant, which manufactures to the requirements of the South African medical council, is therefore much cheaper to run and maintain.[97]

As I argued in Chapter 3, therefore, just as FDA guidelines operate as a bigger barrier to biotech companies than big pharmaceutical companies, they in this situation operate as barriers to entry for "Third World" pharmaceutical companies into US marketplaces. In other words, regulatory environments quite literally regulate capital flows, setting up a political economy of drug – subject – capital circulation that is completely intertwined: the "Third World" becomes porous, especially as a site for recruitment of subjects, while US borders become more rigid. It is in such a political economic regime of differential circulation that the "homogenizing" effects of global trade as instituted through multilateral fora such as the World Trade Organization (WTO) need to be situated and read.

Entering the (domestic) plant involves covering oneself from head to toe, in a lab coat, overalls, cap and disposable shoes, because of course maintaining purity is of the essence in a

[97] I was only given a tour of the domestic manufacturing facilities, so do not actually know how exactly it differs from the Cheminor facilities in ways that make the latter more expensive to maintain. I was also unable, for proprietary reasons, to get an actual estimate of the cost differential in maintaining the two facilities. I did however get the following response from A. Venkateswarulu, one of DRL's corporate managers (correspondence with the author, June 21 2002): "The Cheminor plant...is a 100% export oriented unit that opeartes with rigorous SOPs [Standard Operating Procedures] conforming to cGMP [current Good Manufacturing Practices] standards which are accepted and followed internationally (especially, USA and other regulated markets). Although the manufacturing process and technical know-how remain essentially the same, the documentation, validation protocols, quality systems and some

pharmaceutical manufacturing plant. The structure of the plant sees the core manufacturing in the core of the plant, surrounded by a corridor, outside of which, on either side, are respectively the area where raw materials come in, and the area where the finished product is packaged and sent out. The raw material comes in trucks, but there is no open access between the trucks and the inside of the plant, so the material is delivered through a shaft. It goes through various quality control checks, sifts and winowings, and is finally sorted into material that is accepted and that is rejected at the outset. There are four core manufacturing facilities, which means that four batches of drugs can be manufactured at any given time. If the volume of manufacturing needs to be scaled up, therefore, more shifts will be run.

Each of the four parallel facilities is distinguished from the others in visibly marked ways, so that there is no chance of any crossover of laborers or products between the facilities. The color of the floor in each of the parallel facilities differs, as do the colors of the workers' gowns. Also, the air pressure in the core facilities is highest, ensuring that there is no inflow of impure air from outside. Indeed, the structuring of the air ducts is one of the most crucial aspects in the maintenance of purity.

The most labor intensive part of the process is the last part, which is packaging. This is not automated, and a large number of the packagers are women. Most of the workers have passed tenth grade, after which they are sent to an industrial training institute. Their wages on an average are about 5000 rupees a month.

The floor manager, Prahlad, who showed me around this plant had himself earlier worked in a multi-national company, in the manufacturing plant of Pfizer in Bombay, and told me that there were huge differences in the scale and work practices of the two places. Companies like Pfizer, in countries like India, mainly concern themselves with massively parallel high quantity

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technical specs / operations required in a US FDA qualifed plant are much more rigorous than those applicable to plants operating for non-regulated markets".

production, so there is a much larger plant, much more automation and a much greater centralization of facilities. Prahlad felt that in a smaller environment like DRL, there was greater room for manouverability for people like himself. In other words, that managerial flexibility that marks the upper management of DRL also translates down to the middle management on the shop floor.

From a manufacturing plant alongside a highway outside Hyderabad, I move to a company near a freeway in Palo Alto. Incyte Genomics, whose founder and CSO Randy Scott I introduced in the previous section, has been one of the big corporate players of the genomics "revolution".

Incyte was the first genome company to go public, in November 1993. At that time, their short-term business strategy was "to commercialize our catalog of human genes and proteins, transcript imaging analysis, and biology 'in silico' approach by creating a software / database business targeted at pharmaceutical companies and eventually the scientific community" (*Incyte Annual Report* [henceforth *IAR*] 1993). The early trope they used was that of Gray's Anatomy, the definitive textbook of human anatomy since 1858. While in 1993 Incyte was trumpeting the experience of its team in both the new genome technologies and in biopharmaceutical development, by 2000 the company's name had been changed to Incyte Genomics from Incyte Pharmaceuticals, and it had become a full-fledged information provider.

Even in 1993, though, Incyte's explicit goals were still stated in terms of databases: the biopharmaceutical discovery component seemed an almost obligatory descriptive category that had to be included in a document for investors such as an annual report, at a time when "biology *in silico*" was still a relatively novel and untested concept. Incyte got their first database subscriber, Pfizer, in 1994. Their gene expression database, LifeSeq™, turned into their core technology platform for many years, and emerged as the industry standard gene expression database. They entered into both exclusive satellite agreements and non-exclusive multiple

licensing agreements to LifeSeq™ with many of the major pharmaceutical companies. By 1996, Incyte recorded their first profitable quarter, and acquired two other companies as a sign of their diversification. Combion, based in Pasadena, was a microarray company, while Genome Systems, based in St. Louis, was a company offering customized genomics services. This latter function becomes central to the vignette that I now hope to project.

Incyte's success with LifeSeq™, while dramatic in the medium-term, has turned out not to be a long term driver of the company's growth. This is firstly, as I explore in Chapter 8, because of the *success* of genomics, a success that has very quickly shifted the bottleneck from being one of inadequate information to being one of too much information. Databases that simply identify potential targets are no longer useful for pharmaceutical companies, and the onus has shifted towards strategies that can help characterize and validate the existing targets – effectively strategies that can help sift through and make functional sense of the mass of genomic information available rather than simply generate more. Secondly, having become the industry standard, Incyte already had subscriptions to LifeSeq™ from most major pharmaceutical companies, which meant that it had become hard for them to grow their market any further. Thirdly, with the working draft sequence of the human genome in the public domain, there was less of an incentive for researchers and companies to buy an expensive database, when they could get information, albeit perhaps of lower quality, for free in the public domain. At least some of these reasons have fed into the trouble that Incyte's major rival Celera has faced in the last couple of years as well.

Incyte and Celera however decided to respond to these similar troubles in opposite ways. While Celera has decided to reinvent itself as a diagnostic and drug discovery company, Incyte decided to stay upstream, and rename itself Incyte Genomics. The reason for this, according to one of their senior managers whom I talked to, was that they wanted to give out a clear signal that they weren't trying to get into a business situation where they would be seen as the potential

competitors of their major customers, big pharmaceutical companies. Indeed, there is more than an element of pragmatism in this move, and as I have indicated at a number of points in Chapter 3, the power differential between even relatively entrenched biotech companies such as Amgen and a big pharmaceutical company is so great that it is very hard for biotech companies to sustain themselves as competitors on the public markets, which after all judge the two sets of companies by the same yardsticks and expectations. Indeed, there is every indication that the reinvention of companies like Celera into drug discovery companies is going to be a painful and arduous process, not least because such a reinvention basically boils down to the hiring of a virtually new workforce, with employees exhibiting different skill-sets.

What this meant, however, was that by late 2000, an increasingly significant portion of Incyte's revenues were coming not from their informatics work, but from the contract services that they were offering other companies; services now that were being performed not just in St. Louis, but in Palo Alto as well. One of the major services that they were performing was contract sequencing, which meant that they had a whole laboratory full of automated sequencing machines that would run 24 hours a day, seven days a week. The sequencing machines they ran were not Applied Biosystems' 3700s, but MegaBace, made by Applied Biosystems' competitor Amersham. While the reason I got for this was the predictable one that it was because MegaBace performed better, I couldn't help but believe that the real reason was that they didn't want to buy the machines manufactured by the sister company of their major competitor Celera.

What this further meant was that it was absolutely crucial for Incyte's revenue that their automated sequencers worked all the time, and well. So that by the end of 2000, the key employees at Incyte were not the programmers as much as they were the engineers who kept the sequencing machines running. Indeed, the supervisor of the Incyte sequencing facility who showed me around told me with pride that the engineers at Incyte who tended to the MegaBace

machines were even better than Amersham's own engineers whose job was to service the machines.

What the story of Incyte indicates, of course, is that the configurations of which sorts of labor become dispensable and which indispensable in a particular company at a particular point in time are intimately related to larger structural issues relating to the marketplace, but also to the more contingent strategic choices that get made by a company. While Celera, in a bid to itself become a drug discovery company, has had to retool its workforce away from programmers and towards wet lab biologists, Incyte's contrary decision to stay an "informatics" company has seen it rely more and more on providing customized services that themselves are not necessarily just informatics based, making engineers the crucial cogs in the wheel.

Indeed, bioinformatics is the buzzword in India these days, and the bioinformatics facility is the cornerstone of the activities and strategies of the Centre for Biochemical Technology (CBT), India's flagship public sector genome lab. The Director of CBT, Sameer Brahmachari, indeed, sees bioinformatics as one of the routes to India becoming a global player in genomics. This is a view echoed by the hype around bioinformatics in the Indian business press as well, and is reflected in the entry of many major Indian software companies, such as Satyam and Tata Consultancy Services (TCS), into bioinformatics in a big way, at least in name if not in substance. The reason for that, unsurprisingly, is India's vast software potential, which it is assumed will translate automatically into bioinformatic prowess. Such a view sees bioinformatics as just another exercise in writing code.

And yet, almost without exception (and CBT is perhaps the closest there is to an exception in this regard), bioinformatics in India is hampered by the absence of trained humanpower. This is to some extent even the case still in the US, where graduate courses in bioinformatics have just begun, but is particularly acute in India, where there is hardly any training in bioinformatics. GVK Bio, which calls itself a bioinformatics company and which is

based in Hyderabad, started offering three month courses in bioinformatics, both in Hyderabad and in Delhi. This was modeled on similar extremely successful software courses that were offered by companies such as the National Institute of Information Technology (NIIT), courses that were both very lucrative for NIIT and that produced a generation of Indians trained in software without a formal engineering degree, who ended up quite often getting employed in the US on Y2K related problems. Perhaps predictably, many people who take such courses find three months an impossibly short time in which to grasp something as complicated, and indeed as mutable, as bioinformatics, and GVK Bio has already shut down a center in Delhi that was offering such courses.

Even at CBT, the training of bioinformaticists becomes the key issue, a training, further, that has to happen in ways that enable programmers quite often to work with wet lab researchers to tackle complex genomic problems. The person who is most responsible for this training at CBT is Debashis Das.

Like many of the young scientists at CBT, Das comes from small-town India (in this case, from Orissa), testifying to the sorts of access for people from all over the country to work in the most cutting-edge institutions that only the scientific disciplines in India really provide. His background was in chemistry, testifying to the range of inter-disciplinarities that often go into the making of a "bioinformaticist": that she be a programmer is by no means a given, as I am sure many Indian companies who are pinning their faith on bioinformatics as the next logical step in the evolution of the software industry will discover. As a graduate student, Das found that he was much more interested in physical rather than organic chemistry, because the former involved more computational activities. At this point (mid-1990s), there was no such thing as formal bioinformatics in India, and even the computers available at Delhi University, where Das had started his Ph.D. work in biophysical chemistry, were low end 386s. Das was often asked to help a number of people who were having computing problems, as his skills with computers started

getting recognized and acknowledged. His supervisor suggested that he join Brahmachari, who had just moved to head CBT from the Indian Institute of Science in Bangalore, and was looking for post-docs. This provided Das with a chance to do bioinformatics, and he was given the task of setting up CBT's bioinformatics facility.

Das points to the difficulties inherent in the interaction of bioinformaticists with those who work in wet labs. According to him, wet lab researchers have a problem, in his opinion, with knowing what questions to ask, and how to ask them. There are, he says, differences in language between the two groups of people. What the wet lab person says has to be converted into a tool, and then into a statistically significant figure. He feels, therefore, that generally wet labs create problems, and informatics solves them, rather than the other way around.

The biggest bottleneck, according to Das, is that all the smart IT people went into solving the Y2K problem and other such things that were not of interest to bioinformaticians. Therefore, the availability of really good students is a problem. It is only now that Das feels CBT is beginning to get students with a domain knowledge of high end IT. The need, according to Das, is for people who can translate scientific problems into puzzles. Getting biology students to approach problems in this manner, he feels, is quite hard. He would like to get biologists to learn how to "spell out" their problems, in algorithmic form.

I mention Das here not just to point to his specific diagnoses regarding bioinformatics humanpower in India, but also to point to his place in the scientific hierarchy of CBT. As I will explain in greater detail in Chapter 5, CBT was for many years a delapidated center selling biochemical reagents. When the Indian government decided in the mid-1990s that it wanted to "do" genomics, it asked Brahmachari, India's best known genome scientist, to head up the public genomics initiative. The government's idea was that Brahmachari would build a new genome center. Brahmachari however felt that India was already far behind the genomics curve compared to the West, and that by the time a new genome center was built, the human genome would

already be sequenced. He instead chose to retool CBT into a cutting-edge genome lab. The reason why he chose CBT, at least partly, was its location in Delhi, close to the corridors of power, but also perhaps because it *wasn't* already a cutting-edge lab. What this meant was that Brahmachari had a free hand to restructure the center, and imprint it with his direction, in a way that he just wouldn't have had at a center that was already performing cutting-edge science.

As Brahmachari candidly admits: "In India, the new never replaces the old, it just adds on to it".[98] In terms of CBT, what this means is that there are still a host of scientists who do very different work, with very different priorities, to Brahamchari's scientific agenda (genomics) and his strategic agenda (becoming a global player). For Brahmachari to enforce his strategic will on CBT, he has had to do exactly what Celera has to do in a similar situation: hire a whole host of people who have skills compatible with his vision. Young scientists like Das are a consequence.

There are, however, many other hires that need to be made other than scientists running labs, and a major lab that is at the interface of bioinformatics and wet lab facilities at CBT is their genotyping center, where they sequence clones for themselves, and (on a limited non-commercial basis) for their collaborators.

Brahmachari only hires women for the genotyping facility, and this, according to Mitali Mukerji, the scientist in charge of the facility's operation, is a conscious decision, since according to her: "We have not taken any guy over there.... You know in India, boys want to move on faster, look for more prospects, because for them, this would be a very stagnant kind of a job. It is very routine, everyday. But for girls, it is an experience. The moment we put a guy in any of the facilities, he would decide to go abroad and then quit".[99]

Of course, the "fact" that boys "go abroad" while girls don't hasn't prevented CBT from hiring many men in the bioinformatics facility, which has a fair share of women as well, though

[98] S.K. Brahmachari, interview with the author, 3 January 2002.
[99] Mitali Mukerji, interview with the author, 7 January 2002.

fewer (approximately 30-35% of the bioinformaticists at CBT are women). Nonetheless, the gendering that underlies the decision to hire labor, whether of the graduate student variety or to staff various facilities, is evident and barely disguised. Indeed, Brahmachari at one point quite explicitly told me that it is a fact that men are genetically suited to be better informaticists, because they are more analytical than women, while women are genetically suited to be better wet lab researchers, as they are more careful and precise than men.

Another example of an inter-disciplinary workspace that sees changing configurations of labor practices and values attached to different forms of work comes from the e-learning company in San Francisco where I did some of my fieldwork, GeneEd. While GeneEd is not a bioinformatics / biotech / pharmaceutical company in its own right, it is worth telling their story at some length, because the structural causes underlying their changing priorities, as indeed has been the case with Incyte, has everything to do with their changing customer base, that is rooted in the political terrain of drug development as it manifests between biotech and big pharmaceutical companies.

There are two "labor" stories I want to tell about GeneEd. The first has to do with the management structure of the company, which, when I first spent time there in 2001, had only one woman in the management team. The second has to do with the graphic designers who design GeneEd's e-learning courses, the "workers" of the company.

The management team of GeneEd, as of mid-2001, was pretty much its founding management team. Its co-founders, Sunil Maulik and Salil Patel, were the Chief Executive Officer (CEO) and Chief Scientific Officer (CSO) respectively. Paul Eisele, a more senior person with years of experience in the entertainment industry, was the Chief Operating Officer (COO), while Barry Giordano, an old friend and once boss of Maulik's, was both an investor in the company and its Vice-President of Sales.

Directly reporting to Patel was Cynthia Kilroy, who had joined a few months after GeneEd had started operations, and who was in charge of product development. While Patel's job was to actually develop course content, Kilroy's job was to co-ordinate the development of that content into a visual, online e-learning course by the graphic designers, in consultation with the client if the course in question was a custom course. Kilroy had started her career as a software developer, went on to manage projects for health care organizations, and then spent five years doing consulting at Arthur Andersen.

Being a project manager at GeneEd in 2001, of course, was very different from consulting in one of the "big six" firms, because one of the defining features of working in a start-up is that it is impossible to rigidly enforce a strict division of labor: it is often essential for everyone in the company to multi-task. In these early days of GeneEd, therefore, Kilroy saw herself as a "chameleon", doing whatever needed to be done on a particular day: a job description that fitted most of the GeneEd employees, from Maulik downwards.

The fact that Kilroy was the only woman on the management team, of course, was quite significant for her work situation at GeneEd. Most difficult for her at the time was her relationship with the two sales people, Giordano and Mark Greenbaum, both experienced at sales and feeling that Kilroy needed to prove herself. Of course, there was a certain amount of territoriality involved, in the very way GeneEd strategized selling its product. GeneEd constantly makes "sales and science" pitches. Their idea is that one of the salespeople always be accompanied by either Maulik, Patel or Kilroy, both to lend a certain amount of gravitas to the impression they convey, as a "serious", "scientifically oriented" company, and also because their products are technically quite complicated, making it useful to have someone who is involved in product development explain it. Follow up with the client also involves a delicate division of labor, where it's the product developers who have to interact with the client to ensure that the courses (especially if they are customized to the client's requirements) are developed to their

specification and satisfaction, while the sales people have to stay attentive to closing the deal, and opening up other possible deals with the same clients and with others. The potential for one group of people stepping on the others' toes is significant, especially if issues of seniority, experience and gender are superimposed.

Kilroy was very attentive to the gender dynamics in her interaction with the sales force, as she said:

> This is the first place I have ever worked where Salil and Sunil came to me and said we don't like the way X is treating you and we're going to take care of it. I don't want it to sound the way it's going to, but it's probably because I'm the only woman on the management team and I think some of the sales guys probably get away with things and treat me like crap, and I just have no respect for that.... And I think I played into some of that because I let those guys fight for me. I'm pretty outspoken and stuff but I can go nervous and sit at the back, and when I get more nervous, I get more spelling mistakes in my e-mail and I wasn't taking the time and then they didn't have the respect.[100]

Nonetheless, there was no doubt in Kilroy's mind that a start-up still provided a more egalitarian system that what normally prevails in big companies like Andersen in the American corporate world:

> Like I said, I come from a huge consulting house that was very male-dominated. It was plain they strategically picked all women to interview me and had a partner that I was reporting to that was a woman. The problem is that for me when I look back now, while I had made the decision to go there because there were a lot of women, it's definitely still an old school, old boys network, and the fact was that the women that were in the management positions were like the woman that heads H[ewlett]-P[ackard]. The fact is that she's not a woman that I want to be like or emulate because she doesn't have a family. She got married later in life, her husband is a stay-home husband who hasn't

[100] Cynthia Kilroy, interview with the author, 24 May 2001.

> worked. He's 20 years older than her. She's not dealing with the issue that a woman that potentially wants a family, that doesn't feel that she needs to act like a man to be in a man's world. And I think that we look at these women and say, "Wow! Look at where they've got!" But in reality, they are really just men dressed as women. Look at the Massachusetts governor [Jane Swift]. She just happened to have twins, but her husband is a stay-home husband. They have already determined that the governorship is not a full-time job, and people want her to quit because they think she can't do it. What's the rationale of that? I mean, someone's staying at home to take care of your kids. Why is it that it's the woman that has to quit the job? As someone said the other day, nobody said anything when Bush was out campagning, no one told him he's not taking care of his kids.[101]

Kilroy's opinions are hardly atypical, and they have recently become the sorts of opinions that have been the center of conversation in corporate America, consequent to the publication of economist Sylvia Ann Hewlett's (2002) survey *Creating a Life*, which argues for the incompatibility, for women, of having a high-powered corporate career with having a family. Kilroy's own way of dealing with this situation is to:

> [J]ust prove myself and simply claim I've been smart enough that I've always wound up being able to do a good job. And then sometimes there is an opportunity, where you're kind of joking around the table and you can make a joke of what people know, that you know what they are about and then hopefully then they will look at their behavior and then realize.[102]

Of course, as a manager, Kilroy has to herself be sensitive to people-management issues, especially since she, more than anyone else, forms a direct bridge between the management and

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[101] *Ibid.* Sure enough, Jane Swift has decided that she won't run for governor in 2002 because of the pressures of family.
[102] *Ibid.*

the designers who design the courses. And here too, the situation at GeneEd has undergone a change as the company's clientele has changed.

GeneEd, as I mentioned in Chapter 2, started off primarily as a company that would offer online e-learning courses on various life science related topics to people in the industry. They designed a series of what were called catalog courses, that were basically generic textbook courses on a number of aspects of emergent life science, such as, for instance, bioinformatics or microarrays. They also designed custom courses to meet specific needs for specific companies. Initially, these custom courses were often animated presentations that would go onto the company's web site, such as Celera's genomics "tutorial", which was designed by GeneEd to highlight Celera's achievements for its website. Predictably, custom courses were proving to be more of a revenue earner than catalog courses, when the target market was largely people who were in the industry already, and GeneEd spent most of its time designing these customized courses. It was Kilroy's job to allocate responsibility for the courses to the designers, and to ensure proper execution.

By mid-2001, it was clear that the designers were the indispensable labor force for the company. Indeed, there wasn't a group of what could be called "workers" independent of them. All the content was provided almost single-handedly by Patel, Kilroy's job was to ensure follow through on projects, there were two sales people who handled the West Coast and the East Coast respectively, there was one systems administrator who made sure the computers were working properly, Eisele ran the nitty-gritty operational aspects of the company, there was an office manager who would assist with whatever tasks needed help, and Maulik went out and sold the vision of the company to prospective investors and customers. It was the group of (at the time) four designers who really executed on the creation of the courses.

Kilroy, indeed, felt that her job at the time was very much that of a mentor to the design team. Further, whole courses were allocated to specific designers, which meant that each designer

was able to imprint his or her artistic style on the course. Course allocation was indeed a strategic exercise for Kilroy, as she tried to match each designer's artistic temperament to the requirements of the client. This meant that there was lots of room for artistic creativity. For instance, one of the graphic designers, Cyane Rollins, described her work, and the division of labor, to me in the following terms in mid-2001:

> We have a project manager who keeps an eye on of all our schedules and an eye on projects down the line and then she'll allocate these projects to us and watch our schedules and keep tabs on our progress. We as developers work under her and work for Sunil, and because we're so small, it's not obviously very hierarchical. We have me down here and Salil and Sunil up there and which is great because I have plenty of room for feedback and they listen to our feedback which I think is great on their part. It's great because I feel they listen to us and then make changes or whatever or help us out but also it's good for them too because we have ideas. They are sort of looking at the more business and marketing side and we are looking at the more technological side – what's out there, how can we improve, what we're doing, that sort of thing. So that we have this little ecology. That's why I think this is a little ecological system. And that's pretty much the main thing – there's the management and then there's the project manager and then there's developers and then there's the IT Department and then Robin and I think that we're also working side by side.
>
> [W]e [developers] critique each other and rely on each other for feedback, but when we get a project, we pretty much work on that from start to finish ourselves and its good because it's good to know... you know you're beginning to know this stuff from the top, you're beginning to learn and we know how to do animation and how to load it, what flaws and bugs might happen. The downside of that is that I know a lot about bio-informatics and drug-design but I know nothing about microarrays or the other courses that other developers are doing and it takes a while to learn those courses. So that's one downside and I don't know, I mean, it seems like...we're all seeing I think in the future we'll see our goal because we all have different strengths which is great...you know like

Jill has her 3D modelling and Jerry and Jill are very into the action scripting and Tara has traditional animation which she brings to the table and I have the educational background and then I have video stuff, so that's something that I could use. So we all have the different things that we're interested in and we can bring them together to the table. And between us...maybe it'll be in the future that I don't know...I'm thinking that it could be really cool if one of us becomes a real expert in one area and then we start dividing up in that way.

But right now its working perfectly well the way we have it.

KS:

So do you see a more defined sense of rules and responsibilities since you have joined?

CR:

I think it's very defined now. I think it is very defined now.[103]

In other words, even in 2001, a year and a bit into the functioning of GeneEd as a fully operational company, the designers were beginning to see a certain amount of streamlining in the company's operations, but it was a streamlining that still left considerable agency to each designer to design their course. There was also a perceived sense of collegiality, what Rollins referred to as an "ecology", whereby, let alone the middle, even the upper management was accessible not just to mentor the designers but to actually receive feedback from them that could drive the company's decisions.

A number of things have changed for GeneEd structurally since then. The biggest event that signalled this change was their signing on as a customer the big pharmaceutical company Astra Zeneca in the summer of 2001, for a series of courses for in-house use (such as sales force training). Astra Zeneca is a company of 55,000 people, orders of magnitude larger than any of the biotech companies they had developed courses for until that time. This meant three things for GeneEd.

[103] Cyane Rollins, interview with the author, May 14 2001.

First, that there was the possibility of a sustained buy in. A successful execution on their initial assignments, they knew, could lead to GeneEd being given other assignments by other divisions of the company. There was a chance to grow their market even within a single company, in a way that had never existed when GeneEd was developing courses for their biotech clients. Second, that there was a possibility of gaining brand recognition within the pharmaceutical industry. Even though the GeneEd brand was visible on many biotech web sites, for instance, that was hardly enough of a selling point to ensure that big pharmaceutical companies would be interested in giving them business. As Maulik always liked to point out, the difficulty – and the challenge – of selling a company like GeneEd's products is that one has to not just convince the customer that GeneEd offers the best product on the market, one has to convince them that it's a product that they need in the first place. Getting the Astra Zeneca project gave GeneEd a toe-hold into the big pharma market. Third, the quantity of work that would have to be done, to do the Astra Zeneca courses, continue their custom courses for existing clients, and come out with improvements to their existing courses, meant that it became essential to further streamline the process of course creation.

The way they did this was to develop what they called "learning objects": modules or vignettes of courses that might already have appeared in their other courses, that could exist as independent objects in a searchable database, that could then be pulled out and inserted into a new course. In other words, GeneEd was shifting away from being a design company that would craft individual customized courses as if each was the creative product of a single graphic designer, to being a *knowledge management* company that would generate courses by an assembly line cutting and pasting of existing course modules (with, of course, the development of new course vignettes or modules as and when necessary).

Once a course becomes a collection of independent assembled objects, of course, it becomes vitally important to standardize those objects. One just couldn't have a course that was put together by objects from previously designed courses that each had a distinct artistic

signature. Very quickly, therefore, the role of the graphic designer stopped being one of artistic creation, and became one of industrialized assembly. This didn't even need a conscious strategic change of direction: it was simply the consequence of scaling up the enterprise and growing the company.

In the process, however, Maulik realized that the very assemblage of learning objects, and the software infrastructure needed to support them and make them searchable was, independent of the *content* of the objects, itself a set of software applications that had value. In other words, while GeneEd, as an e-learning company, could sell courses to clients, it could also, as a *knowledge management* company, sell software applications to other e-learning companies. What this led to was an increased dependence on programmers.

Therefore, largely as a consequence of selling courses to downstream big pharma companies instead of upstream biotech companies (who, as more big pharmaceutical companies indeed became interested in GeneEd, became less and less a source of significant value), the entire work structure changed within a year. Suddenly it was the programmers who were doing the glamorous work, while the designers were merely assembling content.

Robin Lindheimer, who had been hired as a systems administrator in 2001, had by 2002 been promoted to being manager of IT. Just the challenge of automating processes as the company grew was for him a major programming challenge. While earlier, Lindheimer felt his role was "just that of a plumber", he felt he was now "dealing with the technology of GeneEd rather than with the technology of the world that helps you run an office".[104] He sees the company moving in a direction where the selling of courses becomes incidental to the development of saleable software.

Indeed, GeneEd in 2002 had the sort of glamor – of doing something "cool" while doing something "good" – for programmers, that it had held for graphic designers in 2001. Chris Palmer, a programmer who chose to come to GeneEd ahead of two other job offers, compared it

to choosing to work at Apple rather than at Microsoft, where "Microsoft is just another job. Whereas Apple is a mission that people believe in, a community of far-thinking researchers that are a part of the business culture. That means a much better product – a product in which the labor of love has been put into it. It's a product that's better than good enough, it's actually great, that has an economic effect and a personal effect".[105]

Conversely, and unsurprisingly, the graphic designers by 2002 felt increasingly stifled and unenthused, as evidenced from the following quotes (all kept anonymous):

1. It's harder now for each designer to express herself. There are tensions between the individual creativity of graphic designers and the requirements of a corporate structure. Therefore, working here is not that creatively fulfilling.... I rarely see Cynthia on a day-to-day basis.
2. The content is much more modular. We are more conscious of the process now. It takes a lot of energy to keep people interested and motivated. From the developers' side, our creative license as artists is missing. Earlier, we could create entire projects ourselves.... I don't know what Cynthia does.
3. A change to bigger projects has meant a more streamlined process. We're not responsible for whole courses now. Streamlining and efficiency means less creativity for the artist. It's not good for the artists because the job isn't artistic anymore. I think most of the artists would have left if the economy was better. The company has become more hierarchical. Earlier, there was a pancake structure, anyone who had an idea got listened to. Now that's not the case anymore.... We'll probably get funding, get bigger, and have more growing pains.
4. There is considerable freedom in terms of how I want things to look in terms of graphics themselves. But in terms of the interface, templates have been created which can't be redesigned. As an artist, I get bored really easily. I'm a *graphic* designer rather than an *instructional* designer. I try not to let the boredom show but it

[104] Robin Lindheimer, interview with the author, 28 March 2002.

> does. There's not a lot of interaction with the other developers. I miss that.... There's no communication with management, and rare interactions with Cynthia. The instructional designers are the bottom of the totem pole. We were really important when the company was a start-up. [The designers] pretty much made or broke the project. I enjoyed smaller scale projects more, because I had more freedom, I could bring more design sense to bear.... The biggest frustration is being held down by management.[106]

In other words, the loss of artistic license, felt unanimously and without exception amongst the graphic designers at GeneEd, was accompanied by the loss of a non-hierachical involvement and contribution to the management structure of the company. It was also accompanied, not surprisingly, by an increased dispensability of individual designers. Indeed, this was almost logical. As one designer told me, almost the only way the company could have motivated designers was by constantly hiring new and inexperienced designers who would be motivated because they would be learning how to design on the job. Of course, that would compromise the quality of design, a quality that itself was becoming increasingly incidental and pre-packaged. Sure enough, in May 2002, the company laid off two of its designers, one of whom had been with the company since its inception.

This dispensability was not just felt by the designers, it was echoed by the management. Therefore, Kilroy, who in 2001 was explicit about the importance of mentoring the designers, and about her own central role in that mentoring process, was by 2002 admitting that there was now a line between management and "staff" (in 2001, she was still referring to them as "designers"). But then, she felt: "That's not a bad thing. I don't think I have to be friends with the staff. Getting rid of people is not a bad thing.... I don't miss anything about the start-up phase. Now it's not just

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[105] Chris Palmer, interview with the author, 28 March 2002.
[106] Each of these was told to me by a different graphic designer, in a series of interviews conducted between 28 March and 2 April 2002.

about creativity but about software development. Possibly a lot of the present people won't work in the new model".[107]

There have been necessary changes in the management structure as well, as GeneEd has grown out of being a start-up and into being a "real corporation". What earlier used to be termed "sales" is now the much more grandiose sounding "business development". Heading that is a new middle manager, Glenn O'Classidy, who comes from a family steeped in the pharmaceutical industry (his grandfather had built a pharmaceutical business), which means he has many contacts in the big pharma world. In the process, GeneEd had to lay off their VP of sales, Barry Giordano.

This was probably one of the most painful moments for GeneEd as a company, not least because Giordano was part of the founding management team and an early investor. Perhaps even more, he was Maulik's old friend, a close friendship that has probably terminally ruptured as a consequence of the lay off, which Giordano took very badly. Maulik, who is very good at wearing the CEO mask when he needs to, expectedly rationalized the decision as inevitable, since GeneEd wasn't getting the customers it needed to stay afloat. Indeed, even after the Astra Zeneca deal, GeneEd's revenue situation stayed extremely precarious for much of Fall 2001 and early 2002, since they never had reserves of venture capital money to fall back on. Indeed, a number of people in the company feel that the exit of Giordano, who had difficult relationships with both Kilroy and Eisele, was both necessary and good for the company.

This was not, however, a uniform sentiment in the least. While Giordano had certainly not shown much sensitivity in dealing with fellow women managers, as in Kilroy's case, there were many others in the company, men and women, who felt that he was precisely the sort of mentor that they just didn't have anymore. They felt that O'Classidy was too immersed in business development to bother about fostering mentoring relationships with those who reported to him, and in any case, those were relationships that could best be developed by someone senior who had been in the company from the beginning.

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[107] Cynthia Kilroy, interview with the author, 1 April 2002.

Meanwhile, Patel had moved from San Francisco to start a new GeneEd office in New Jersey. This was necessitated by the fact that GeneEd was fundamentally involved in shifting its clientele away from biotechs towards big pharma, and the corporate headquarters of almost all the big pharmaceutical companies are on the East Coast. If the place of being in San Francisco mattered immensely to GeneEd's existence and identity as a start-up, as I argue it did in Chapter 2, then that too was completely at stake once big pharmaceutical companies became the major customers.

If Giordano's mentoring is missed by some, then that is nothing compared to the way Patel is missed. I did not speak to a single employee who, without being asked the question, didn't tell me that they missed having him around.

I talk about certain aspects of Patel's character as a manager in greater detail in Chapter 6. Suffice to say at this point that he is a corporate anomaly, driven by a system of personal values that refuses to lend itself to the sorts of hard-headed cynicism – what might politely be called "flexibility" – that is almost constitutive of what might be essentialized as corporate American "culture". This does not mean that Patel is romantic or naïve – far from it. What it does mean is that, firstly, as I explain at greater length in Chapter 6, he has a commitment to truth (which makes him uncomfortable even with sales forecasts and investor pitches, that by definition can't possibly be "truthful" events); secondly, he is deeply commited to teaching; and thirdly, he is deeply commited to fostering an ethical relationship with his employees. While this doesn't stop him from supporting management decisions to, for instance, lay off certain employees, it also means that he would never be caught talking about their dispensability as part of the changing priorities for the company. It is his position of pragmatic principle that has earned him such respect in the company.

This means, on the one hand, that he spent a lot of time mentoring the graphic designers. This wasn't simply because he felt that was important for their well being, or that of the company, but because, at the end of the day, the reason why he agreed to take the risk of leaving

a secure job to start this company with Maulik was because he loved teaching. Rollins, for instance, had this to say about Maulik's and Patel's teaching skills:

> Salil and Sunil are talented in that they know this science and can explain it and I didn't appreciate how much this talent was until I went to a custom client in San Diego and one of the scientists was explaining what they did and he made no sense whatsoever. He was using words that I could recognize, but the way he was explaining was just poor....I mean he just assumed that someone would understand crystallization. And of course when Salil explained it to me, it made perfect sense. I think that's the talent. And also the fact that they can story-board it out. Actually they are very creative and I think science is ultimately creative. It doesn't seem that way but they both have this creative way and then they would have interesting ways of showing us how it should be shown and how much should be shown.[108]

While Maulik was equally respected as a teacher, his job description as CEO ensured, even before GeneEd shifted its client focus, that he was more absent than present in the everyday running of the company. His job has always been to sell the idea of the company outside, especially to potential investors, and Patel, for as long as he was in San Francisco, complemented him perfectly by being the "resident" founder, translating the corporate vision into everyday work practices, providing precisely the inspiration and motivation that so many of the employees felt was lacking once he moved East.

But he also provided a certain managerial stability, often being the mediator in diffuclt relationships such as Giordano's with Kilroy or Eisele. He showed both sensitivity and even-handedness, and was a stickler for procedure. This made him easier for the middle management to relate to than Maulik, whose ability to sell the company outside the company came precisely from an absence of these qualities, came from his ability to think on his feet, act on the spur on the moment, make off the cuff remarks, take risks. As Eisele says: "Sunil jumps the chain of

[108] Cyane Rollins, interview with the author, 14 May 2001.

command all the time, which drives his managers crazy. It's a challenge not having Salil here. Sunil's mercurial; Salil's the Rock of Gibraltar".[109]

In other words, shifting their client base from small biotech to big pharma companies has had profound consequences for GeneEd as a company. It has changed the company from a content provider to a software company; from a "start-up" that was constantly bootstrapping to a "real company" that has more stable revenue flows; from a company with a bunch of gifted artists with a room for self-expression to one with a group of dispensable designers and excited programmers. It has changed the very critical mass of the company, which will increasingly have to depend on its New Jersey operation to leverage big pharma sales. It has changed the management structure of the company, and the way management interacts with employees. Indeed, in April 2002 I spent an afternoon at GeneEd where I read out some of my accounts of GeneEd's emergence from Chapter 2. After my talk, one of the employees told me: "I didn't recognize what you were talking about. I was saying to myself, this isn't GeneEd. And then I thought, maybe that was GeneEd a year ago. It seems so long ago, I've forgotten it now".[110]

What I want to emphasize, constantly, however, is not just an attribution of credit or blame to individual people or circumstances that have made GeneEd evolve in certain ways, but rather to a deeper structural logic, of a start-up "growing up" into a corporation, that leads to certain tendential outcomes. This is not to say that there this evolutionary path for GeneEd was in any way necessary, or not the outcome of strategic, contingent, occassionally even lucky, events. It is to say that had those contingencies not occurred, the "alternative" GeneEd would not have remained a happy-go-lucky, selling-to-biotech, artistically expressive start-up, but would have run out of funds and ceased to exist. There is a logic of capitalism that pushes towards growth *in certain ways*, that necessitates streamlining, dispensability and standardization, and that pushes against all those qualities of exuberance, innovation and risk-taking that allow start-ups to start-up

[109] Paul Eisele, interview with the author, 1 April 2002.
[110] I keep this employee anonymous. Interview with the author, 2 April 2002.

in the first place, and also to create a certain type of community that everyone, management and employees alike, can buy into and feel a part of. It is this logic, perhaps, that explains the managerial inertia of big pharmaceutical relative to small biotech companies, an inertia that is often hugely profitable, and that also perhaps explains why successful entrepreneurs, such as, most famously, Jim Clark (the founder of Silicon Graphics and Netscape), become "serial" entrepreneurs instead of staying on to manage and grow the company they have founded. It is, most starkly, a logic that in its acting out *shows* the alienation of the worker from the products of her labor, as Marx diagnosed as fundamentally symptomatic of capitalism a century and a half ago.

A crucial labor question, especially as companies grow, then becomes the question of loyalty. If employees in a start-up are able to "buy in" to a start-up vision (especially if, like Apple, it attracts a certain amount of symbolic capital along with it – GeneEd for instance certainly does because of it being an "education" company, and therefore in a "worthwhile" business), then why is it that employees who are part of a corporate structure that strives to increasingly grow out that adolescent idealism as they become "real" corporations often equally express certain forms of alliegance to their companies, in certain ways, at certain sites of speech?

In order to explore this question somewhat, I turn to one such site of speech, the industrial genome conference organized by The Institute of Genomic Research (TIGR) in Miami in 1999. In the process, I want to hint not just at affective manifestations of corporate loyalty (and lack thereof), but also, some more, at the role of performance and excess in fashioning certain sorts of corporate presence, and corporate presents.

If the show was stolen by any company in 1999, it was Incyte (whose presence I referred to earlier in the chapter in my reference to Randy Scott, and will refer to again in the context of this conference in Chapter 6). For starters, they were platinum co-sponsors of this conference, equal status with Celera (which, at the time, was run by Craig Venter, who had founded TIGR; and which was also Incyte's major and most direct genomics company rival). And they were the visible co-sponsors, having sent out letters and pamphlets beforehand and having gone to great lengths to make that status apparent. Incyte TV, which was

a closed circuit TV channel that the company had arranged in the rooms of all the conference attendees, was giving them added visibility.

In terms of actual products, I think it bears emphasizing here that, as mentioned earlier, Incyte at this time was generating a *range* of products – it is a genomics company, in that it is one of the major companies involved in high-throughput sequencing; and it is a bioinformatics company. So they produced and sold databases, did sequencing for themselves as well as contract sequencing for other companies, did microarray and SNP work and developed software. Again, speed is very much a central theme here. A lot of Incyte's consumers (like with many other genomics / bioinformatics companies) are other companies, and Incyte's claim is that they "speed your genomic research". And their motto, I think, is interesting to mention again: Genomics for Life™.

A central event at which this conference crystallized as an "Incyte" conference was at the concluding party. I was with Puneet,[111] who was an Indian graduating with a Master's degree in computer science, and who had spent much of this conference looking for jobs in a bioinformatics / genomics / pharmaceutical company. At the party, he was in his final frenzy of collecting and collating job offers. Earlier in the day, he had been offered a job by Pangea, and over that evening Pangea's main rival Neomorphic had come up with an offer too. Puneet had actually done an internship with Neomorphic earlier in the year, and had many friends and attachments there, which made him ambivalent about going to work about Neomorphic's direct competitors. Nonetheless, he was now saying that he would rather join Pangea because they're a bigger company.[112]

But further conversation had to be restricted as this extremely loud brass band started playing, and the festivities really began. We met James Kirk, an employee at Incyte, and Puneet endeared both of us to him by telling him with unabashed enthusiasm how Incyte had completely stolen the thunder at the conference. This was clearly a feeling that the Incyte people shared, and it was evident from the multitude of

[111] Not his real name.
[112] Look at the early part of this chapter for the starkly differential eventual stories of the two companies, with Neomorphic getting acquired by Affymetrix in a deal widely understood to have very lucrative for the former, and Pangea (later renamed Doubletwist) going out of business after running through all its money.

cheerful light blue t-shirts (it's *very* easy in these settings to tell who's from which company) that they were feeling extremely cocky about the way things had gone. Indeed, the relative performances (in both senses of the word) of Incyte and Celera at the conference was evident just from their relative presences at the party. At this point, there were hardly any Celera dark blues to be seen against the Incyte light blues. And Venter didn't even stay till the end, having been "called away to the White House".

The rest of the evening was dance, music, spectacle – and what a lot of it! This really was a *big* party, and there was clearly a sense of celebration, abandon, confidence, aggression about this group of people. These were powerful and happy people, and they knew it. In the middle of an extremely crowded dance floor, Puneet met the one Incyte person he'd been looking for throughout the conference: a friend of his brother's, Sid ("Squid") Collins. And for all his efforts, all his anxieties, all his attempts to woo the Incyte people with his accomplishments and his background, all he really needed to do was meet Squid – the minute Squid realized that Puneet was his friend's brother, he offered him a job at Incyte.

Was Puneet happy. *This* was what he'd been waiting for. Neomorphic and Pangea and Curagen are all very well, Roche and Millennium are enticing and worth thinking over, but this moment was all about Incyte, and Squid's offer had made Puneet a part of that moment. And indeed, the party seemed increasingly to be about Incyte – they were the ones present and taking over.

So there's my little sub-story of Puneet, new friend and graduating student. He'd come here and met up with his of Neomorphic friends, a group of friends who'd become so close to him when he was interning with them that they let him stay in their rooms and sit in on their meetings; he'd impressed others into friendship, and in some cases case even a certain degree of fondness; his qualifications were good enough that he'd had a couple of other offers purely on professional merit; but with Incyte stealing the show, none of that mattered anymore, not even that he hadn't managed to make contact with the Celera people (who would probably have been his dream choice coming into Miami). But that brings me to the issue of brands: how is it that a company's name can be so attractive that it makes people forget individual relationships and principles just to be a part of that name? How is it that people can be so completely a part of a name that they can mold their actions and characters into the actions and characters signified by that

name (and here the question of these multiple corporate "cultures", at once individual and yet totalizing, comes up)? And yet shift allegiances so easily that when they get a better offer from a better name they shift not themselves not just physically but in so many other intangible ways as well? How is it that Puneet could change sides so many times, in two days, between companies that were mutual rivals, just at the *prospect* of belonging to one side or the other? So somehow, in some intangible way, value had been added to the Incyte brand In pure Marxian terms, this is surplus value of a sort, but it's not easy to completely capture in simple Marxian categories of value either. What is this value, that is borne of the fetishization of intangibles, of excess, of visions, of futures, that is located neither in persons nor in things, but in trademarks and company names?[113]

The final set of announcements was a public acknowledgment of the shadow boxing between Celera and Incyte throughout the conference, as a woman representing the absent Venter took digs at Scott, which Scott, now in complete control, rebutted with ease. Now the finale was clearly Randy Scott's moment of triumph, and the moment when he could strut his triumph. As he walked onto the stage the air was filled with chants of "Randy! Randy!" On the other side, the few brave darker blue shirts were mustering a few half-hearted taunts and jibes. Puneet was by now very much a part of the light blues, swept away by the Incyte frenzy, a chanting and completely homogenous fragment of the corporate collectivity that Incyte at this moment, in this place, was...

Scott gave a toast. To the genomics community. Because, as he said, "There is not a single person in this room who's in genomics for themselves. They're in genomics for Life". Mirroring, indeed, Incyte's logo, Genomics for Life™.

As I walked away, I passed Scott, being led out onto the dance floor by a young blonde woman, a floor that was now almost exclusively packed with light blue Incyte t-shirts. My last glimpse was of Scott's

[113] Bataille would argue that this mode of excess is a fundamental playing out of what he calls "general economy", which he argues is marked by expenditure as a sign of the surplus consumption that is the fundamental logic and driving force of capitalism. See Bataille 1988 (1967). See also Coombe 1997 for the ways in which corporate brand names, trademarks and similar images create certain types of popular imaginaries as a consequence of their lack of place, that often mirrors the diffuse, despatialized territorialization that epitomizes (at least big, multi-national) corporations.

ginger dance steps, hands clasped behind his back, a light blue handkerchief sticking out of his back pocket. A happy, powerful and triumphant man.

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There was, however, also a very different sort of relationship of employee to corporation that I witnessed at this conference, and that had to do with another informant (kept anonymous), who was working at the New Haven based company CuraGen. CuraGen was in the business of bioinformatics and data mining, making it a competitor of other genome companies such as Celera, Incyte, Millennium and Hu man Genome Sciences. One way in which they emphatically marked themselves out as being different, in terms of their labor practices, was in forcing their employees to sign a non-compete agreement, which would contractually ensure that no employee could after leaving CuraGen work for one of its direct competitors for a stipulated period of time.

Non-competes are agreements that base their rationale in the fact that employees might take with them proprietary knowledge to a direct competitor to the detriment of the original company. And yet they are agreements that, while possible to enforce on the East Coast, are virtually impossible to enforce in California, simply because of the profusion of high-tech jobs in close physical proximity to one another, and the competitiveness of the job market. There is hardly any lawyer at a California-based high-tech company who will draw up a non-compete agreement as a part of the employee's working contract with the company. This means, of course, that proprietary knowledge is constantly moving from company to company as employees shift jobs. Not only has it not decimated the high-tech industry in places like Silicon Valley (far from it), it has, according to a number of people I have talked to there, fostered greater innovation because it has enabled a more rapid diffusion of ideas. Whether it has actually done so or not, it has undeniably fostered a more open corporate culture, by and large, than there is in at least biotech companies on the East Coast, as I indicated in Chapter 2. Here is one way in which "corporate cultures", which are, after all, forms of accepted and normative behavior that are sanctioned and / or encouraged in specific workplace contexts, get co-produced by legal constraints or their absence.

My informant, another Indian whom I shall call Vipender, was extremely unhappy at CuraGen, which he felt was a company with little direction and an unhappy work environment. He had done everything he could to avoid signing his non-compete, though he couldn't get away with his avoidance beyond a certain point. And yet now, he had received a job offer from Millennium. The only way he could make the transition without getting into a lot of trouble was by completely keeping his move secret from CuraGen, to the point where he proceeded, over the next few months, to even cut off contact with those of his acquaintances whom he knew had friends at CuraGen. Apparently, CuraGen was in the process at that point of taking action against another former employee who had left them to work for Celera, and he didn't want to face the same fate.

CHAPTER 5: OWNERSHIP AND ETHICS

> The fundamental faith of the metaphysicians is *the faith in antithetical values*.... [I]t may be doubted, firstly whether there exist any antitheses at all, and secondly whether these popular evaulations and value-antitheses, on which the metaphysicians have set their seal, are not perhaps merely foreground valuations, merely provisional perspectives, perhaps moreover the perspectives of a hole-and-corner, perhaps from below, as it were frog-perspectives.[114]

> Ethics has become the dominant mode of public conversation about emergent biosocial situations.[115]

5.1: Banking (on) Biologicals

I have already touched upon some of the ownership issues that arise out of genomics in the previous chapter. In this chapter, I will expand upon some of those issues. In the process, I will also ponder the role of institutionalized bioethics as an increasingly legitimate arbiter of disputes surrounding the ownership of biologicals.

I will use two controversies as starting points for this analysis. The first is a court case, *Moore v. the Regents of the University of California* (1990; henceforth the *Moore* case), and the second is the controversy surrounding the patenting of DNA sequences. In the former case, John Moore, a patient afflicted with hairy celled leukemia, had his spleen cells excised. The researchers belonging to the University of California were able to convert these cells into a unique cell line (which they named Mo, after Moore) and were able to patent the cell line. When Moore found out that derivatives of his spleen cells had been made without his knowledge and

[114] Nietzsche (1973 [1886]): 16.
[115] Cohen (1999): 146.

consent and had been patented, he demanded a share in the property rights. The case was finally decided in the California Supreme Court, which while upholding Moore's claim that the UC researchers had shown a breach of fiduciary duty and had not obtained proper informed consent, denied him any property rights in the cell line, which it was claimed was the researchers' "invention". In other words, in the words of critical legal theorist James Boyle, Moore was "the author of his destiny, but not of his spleen" (Boyle, 1997: 107).

In the DNA patenting controversy, however, as mentioned in the previous chapter, the exalted status of intellectual property law has looked slightly more crumbly, and many groups with specific interests are trying to devise strategies to get around IP in these areas.

Both of these controversies surround the ownership of human biologicals, in an era in which "biological" increasingly functions as a noun. The general moral tone that inflects these controversies -- and that is particularly stark in institutionalized bioethics discourse -- is that the human biological should be "respected" by being kept outside the realm of commodification.

There is, however, a key difference between the moment of *Moore* (1990), and the current controversies around DNA patenting a decade later, because, as described in the previous chapter, it has in the intervening years become increasingly easy to *informationalize* human biologicals. Therefore, the controversy surrounding the patenting of DNA sequence information is essentially about the ownership of genetic *information*. Now why is this significant?

Actually, this difference is often not seen as significant, and sliding over this difference is not without consequence. A recent 60 Minutes show on American TV for instance explored DNA patenting and critiqued it as something that horrible biotech companies were doing in order to stake property claims on something that is supremely human and for that reason outside the realm of commodity circulation. Now, if genes *are* information -- which is what molecular biologists and bioinformaticians tells us -- then patenting information about our genes is equivalent to patenting our genes. But is it really? It is important, I will argue, to tease out the difference

between the patenting of human biological *materials* and human biological *information*. In other words:

Human genetic information is a new type of human biological material that the genomic revolution has made increasingly accessible to annotation and analysis.

Let me tease out further the different social lives of material and informational biological. Even though these are different "things", a continued relationship exists between them. This relationship is primarily one of *temporality*. Biological information helps to rationalize wet lab experiments. Therefore, one can use bioinformatics in sequence homology searches in order to determine the probable function of a protein encoded by that particular sequence. The tissue from which information has been extracted then has two functions: it could serve as a continued "repository" of future information whose extraction isn't even anticipated at the time of the initial experiments. Further, there is often a need to go back and do wet lab experiments on these tissues to actually validate what the information from the tissue suggests about molecular activities within the tissue. In other words, information is detached from its biological material originator to the extent that it does have a separate social life, but the "knowledge" provided by the information is constantly relating back to the material biological sample. The database plays a key intermediary role in the transition of "information" to "knowledge": in this case specifically knowledge that is of relevance to therapy. It is knowledge that is always relating back to the material biological that is the source of the information; but it is also knowledge that can only be obtained, in the first place, through the extraction of information from the material biological. The abstraction of information away from the material biological has a very specific function in making therapeutically relevant knowledge. This is also why it is so easy to intuitively conceptualize the generation of information as "inventive", and therefore ownable.

Therefore, it is important not to collapse analyses of human biologicals into one category without teasing out the different (if related) social lives of material and informational biological.

What is really new here is less the fact of human genetic information as something that can be obtained, accessed and made "thingly", as much as it is the sheer volume of information that is now available. At the same time, this is also not something that is synonymous with other types of human biological material, such as the cell lines that were patented in *Moore*. The question to be asked is how different forms of biological -- material and informational -- *interact*, and how overlapping or different the politics around their respective ownership is.

The nature of interaction depends on the type of work that is performed in different cases. The working draft sequence of the human genome that was published in June 2000, for instance, does not document genetic *variability* between individuals and populations, which is of increasing importance in generating information relevant for diagnostic and therapeutic development. For that, one needs DNA from different individual, patient or population groups. The development of, for instance, pharmacogenomics or personalized medicine, which many people claim is the ultimate aim of genomics, is vitally dependent on getting large collections of DNA samples (usually obtained as blood samples, occasionally as tissue samples depending on the disease being focused on). The market terrain that manifests this logic is represented in Figure 5.1.

Now in this model of genetic research, you obtain human biological material from different, often clearly identified, patient or population groups that are strategically selected and then genotype them (i.e. find out their genetic sequence). Through such large-scale analysis, especially when situated across multiple populations or patient groups, it is possible to obtain information on that genetic *variability* that centrally underlies specific traits or diseases of interest. The human biological material -- *not* information -- is usually obtained from hospitals with which researchers draw up specific agreements, though other sources are also occasionally tapped. The Iceland-based genomics company DeCode Genetics, for instance, obtains material from the general population. That material is stored in a tissue repository of some sort. These

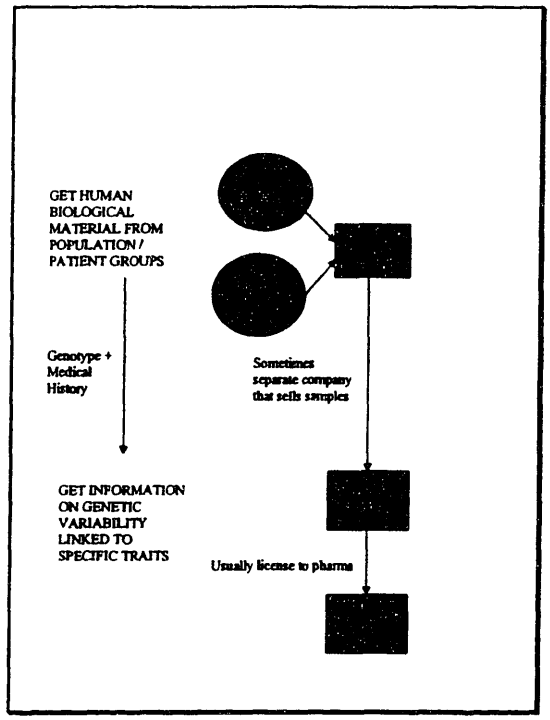
GET HUMAN BIOLOGICAL MATERIAL FROM POPULATION / PATIENT GROUPS
Genotype + Medical History
Sometimes separate company that sells samples
GET INFORMATION ON GENETIC VARIABILITY LINKED TO SPECIFIC TRAITS
Usually license to pharma

Figure 5.1

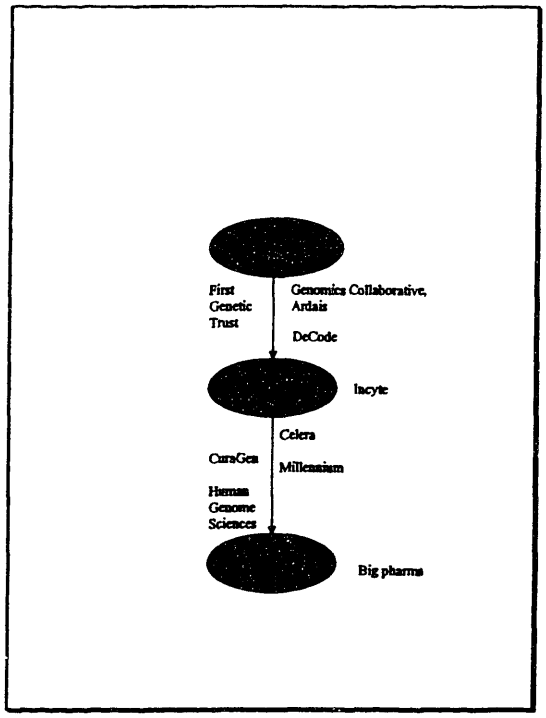
First
Genetic
Trust
Genomics Collaborative,
Ardais
DeCode
Incyte
Celera
CuraGen
Millennium
Human
Genome
Sciences
Big pharma

Figure 5.2

repositories could be within the company that is planning to perform subsequent research (as it is in the case of DeCode), or in a public domain tissue collection, or, with increasing frequency, in specific companies who base their entire business models on serving as such repositories. The information that is generated from this material is often converted into databases. These databases are (or so it is hoped by the companies developing them) the precursors of therapy. In an ideal world, the company that generates the database would like to hold the information and use it in its own drug discovery program. In reality, taking drugs to market is so heavily capital intensive that most database companies license their information to big pharmaceutical companies (again, in the case of the Icelandic example, you see that DeCode has licensed its database to the multinational pharmaceutical giant Hoffmann-la Roche). In this way they try to ensure that information pays off. Now the key footnote in Figure 5.1, which I will get back to later, is that genotyping alone is not enough to generate meaningful information about the genetic basis of disease: *there is an absolute importance of medical history that can be correlated with the genotype. It's only in the correlation of the two types of information that true meaning can be extracted.*[116] Having in addition information about family medical history is even more valuable, but is very rare except in cases like Iceland. Now the dream for any company that is indulging in this business is that they can do all three of the above steps: collect the DNA, generate valuable information and then develop a drug. In reality, as I've already mentioned, different companies end up concentrating their business models on specific points of this value chain. Some examples of this are shown in Figure 5.2.

Therefore, you have companies like Genomics Collaborative and First Genetic Trust, which are (at this point at least) primarily DNA repositories. You have DeCode, that is a DNA repository but is using that repository very much as a means to develop its own database reflecting the genetic information of the Icelandic people. Then you have the archetypal database

[116] One could conceptualize this by the relationship: R_x Genomic Info = genetic material + genotype

companies, what I call "first-generation" genome companies that sprung up in the heart of the race to sequence the human genome. Incyte Genomics continues to firmly resist the market pressures to become a drug development company and is remaining a database company.[117] Various other database companies have moved to a greater or lesser degree towards drug development.[118] Therapy is still very much the domain of big pharmaceutical companies, though there are some older biotech companies such as Genentech who have developed drugs that might be called "genomic", though these companies were not making databases as part of their business model as Incyte or Celera were.

Controversy around DNA patenting has really only involved the part of the value chain that leads from database downstream to therapy. However as I hope is clear, issues surrounding ownership that most closely resemble the *Moore* controversy have more to do with the part of the chain between repository and database. The field upon which intellectual property debates in biotechnology take place is framed by these two sets of debates. Before I move onto the latter set of issues, I would once again like to go over the actors in the DNA patenting controversy and mention what each actor's stakes are.

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As suggested in Chapter 4, there are broadly speaking three groups that oppose DNA patenting. The first are public researchers, who believe that information should be in the public domain. This is both for reasons of logic (generating sequence, they say, is not particularly inventive) and of ideals (an adherence to a certain Mertonian ideal of communism, as reflected in conventions that involve depositing sequence information into a public repository before it can be published by a journal). It must also be remembered that the American state through the National

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information + medical information.

[117] Though like any other struggling company, Incyte's business model has been oscillating rapidly in the past few months.

Institutes of Health (NIH) has been a major enabler of private research. Further, the NIH itself has a historical relationship to gene patenting that it would rather forget, having burnt its fingers trying to patent DNA sequences from brain tissue in 1991 (see Cook-Deegan 1994: 311-325).[119]

Then there is the general public, at least that section that is agitated about DNA sequences getting patented, and who get represented through media interventions like the 60 Minutes show I mentioned earlier. This type of opposition seems to stem mostly from a gut ethical or moral opposition to the idea of human genetic information being in the realm of commodification. Such a position, as I've tried to argue until this point, does not make much distinction between material and informational biological -- human DNA information, in this point of view, becomes "living matter" in the same way that cell lines do.

The third group that is opposed to patenting DNA sequence information however is in my opinion the most intriguing, and those are pharmaceutical companies. As is evident from the value chain that I outlined earlier, database companies are the ones who try and patent DNA sequence information so that they can sell / license it. Pharmaceutical companies usually have to pay upstream licensing fees and subsequent royalties on any therapy they may discover to these database companies. They would, therefore, much prefer information to be accessible in the public domain. Therefore, even public / private debates are over-coded by corporate fights. In other words, and this is crucial:

What distinguishes the genomics / drug development marketplace from, say, the software industry is its peculiar upstream - downstream terrain. Drug development is such a capital-intensive process that there are very few companies with the muscle to actually take drug to market.[120]

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[118] Celera, perhaps the best known of these "first generation" companies, is actually much more tentative in its movement towards drug development than rivals such as CuraGen, Millennium and especially Human Genome Sciences.

[119] The person who filed that patent application was actually J. Craig Venter, CEO of Celera, which controversially raced the public Human Genome Project to sequence the human genome.

[120] One might think, however, that the state, were it so willing, might have the muscle to bring drugs to market. Historically however the state, and not just in the United States, has been very good at initial

Remember, also, that none of the DNA sequence patent debate touches upon the desirability or otherwise of 20-year drug patents, which are still unthreatened. Therefore The SNP consortium (which, as described in the previous chapter, is an alliance of public researchers and ten of the world's biggest multinational pharmaceutical companies to keep information of nucleotide-level genetic variation in the public domain), is very much in the interests of the big pharma partners as well. (Of course, it is often projected that big pharmaceutical companies are entering into willing alliances with public researchers and relinquishing patent rights on DNA sequences in order to facilitate cheap, fast and easy flow of information towards therapy. This is not untrue; what gets hidden from such rhetoric is that is isn't these guys who're in the business of leveraging sequence patents for profit in the first place. See Chapter 4 for an elaboration of this argument). What I want to emphasize at this point is that the different approaches to DNA patenting between, say, Hoffman-la Roche and Celera is not because Celera is inherently evil or a nasty little spoiler while Roche realizes the benefits of free downstream flow of information. It is because pharma companies and database companies occupy fundamentally different market niches that dictate how they approach DNA patenting. All companies are aggressive protectors of intellectual property *when it benefits them.*[121] It is this particular upstream - downstream terrain that distinguishes the drug development industry from, say, the internet or finance industries.[122]

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capital outlay that enables the development of private industry, but has been very bad at successful long-term execution on capital-intensive projects. Therefore, while the idea of a "public-sector" pharmaceutical company might be tempting to those who believe that the state should invest heavily in the development of accessible therapeutics, this is likely to remain out of even the spectrum of options that states generally explore. Further, in the United States, there exists an extremely strong pharmaceutical company lobby in Congress. Therefore, the US state has very close relationships with big pharma.

[121] It is important here to keep in mind, as suggested in the previous chapter, the parallels between property (as, in this case, enshrined in intellectual property rights) and territoriality, both of which are based on the *right to exclude*. This becomes relevant in the context of the Indian state's efforts to negotiate themselves into intellectual property agreements, that I discuss later in the chapter.

[122] The analogy of the upstream-downstream terrain of drug development with the software market is interesting for me to think through further. I have suggested that the capital intensitivity of drug development makes it very unlikely that small biotech companies will ever really compete with and displace big pharmaceutical companies. Such a capital intensive environment as a competitive advantage for large companies doesn't really exist in industries like the software industry. In other words, I have suggested that the very *nature* of drug development makes it that much harder to alter the fundamental power relations between small and big companies. Having said this, the fact remains that in the software

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For the rest of this part of the chapter, I want to focus on ownership issues that arise when one deals with the first half of the value chain I showed earlier: the bit concerning itself with creating databases from corporate DNA repositories. What sorts of ownership barriers underlie the business models of the companies that concentrate on this part of the value chain? I will specifically talk about one company, a commercial DNA repository based in the Northeastern United States that I shall refer to as Repository X (Rep-X).[123]

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industry, few organizations have seriously tried to go up against Microsoft's core business. There have been many that have tried to compete with one or two products or services that Microsoft has offered, but the only significant challenges have come from those companies that have fundamentally tried to change the rules of the game (such as Netscape or AOL). The costs of bringing any big product to market, regardless of industry, are likely to keep the number of competitors low. Nonetheless, the time the biotech industry was just beginning (in the late 70s) was the time a little start-up called Microsoft was challenging such established computing giants such as IBM and Wang. Even if Microsoft has an impenetrable hold on the software market today, there has historically (as seen in Microsoft's own case) been the room for the sort of emergence of a small company into a giant corporation that has just never happened in biotech. I am grateful to Alexander Brown for conversations that have helped me think through these parallels.

[123] I have wrestled with the issue of whether to name this company or not, and am still not sure that my decision to keep it anonymous is the correct one. However, there are a number of reasons why I have chosen to do so, and I think this extended footnote is of some consequence in thinking through methodological questions surrounding the ethical choices that one makes while doing corporate ethnographies.

Joseph Dumit ponders these questions very seriously in his recent work on venture science (still unpublished), where he names two biotechnology companies and has therefore consciously decided to avoid interviewing people at these companies. In this case, however, I had already interviewed two people at Rep-X (one employee and one manager, one on-tape and one off-tape) before I learnt of the company's controversial situation in India that I discuss in this chapter. At no point in this chapter do I draw upon these conversations. As Dumit has shown, it is both legitimate and a challenge to do corporate ethnography by working from the public record in order to reserve the right to "tackle" certain actors. While that is precisely what I have done in this chapter (using not just the public record, but public documents that Rep-X has had a significant hand in "spinning" to its own advantage), the problem of how to "forget" my conversations at Rep-X is a lingering one. I have decided to keep Rep-X anonymous until I have resolved it for myself.

This is, as much as anything, an acknowledgement that anthropology is different from journalism, and one of the lines of difference is the relationship with informants. Journalism is adversarial by nature: the work is to "get" a story out of a subject, even if there is a long-term relationship involved. The challenge for an anthropology such as this is to be ethical and non-adversarial, which is not to say non-critical. At the end of the day, anthropologists write, in part, to their subjects, not just to their colleagues and beyond.

Corporate ethnography involves writing about what is fundamentally a culture of secrecy. It is possible to be fascinated by how and why things get made secret, without necessarily feeling the obligation to make public what the subjects want kept secret. This is precisely the opposite of the investigative journalist. On a basic level, the journalist wants the "truth" that is "out there", while the anthropologist wants, at least as one set of perspectives without which one cannot understand the motivational or intentional side of social action, something like the subject's truth, or truth in Foucault's sense of "the system of ordered procedures for the production, regulation, distribution, circulation and operation of

In its corporate description, Rep-X calls itself "a functional genomics company with a comprehensive, clinical approach to discovery, focused on developing high value, proprietary intellectual property for its own account and in collaboration with major biopharmaceutical companies. Rep-X maintains the [Rep-X proprietary repository][124], an unparalleled, large-scale resource of clinical research material, including human DNA, serum and snap-frozen tissue samples, linked to detailed medical information collected from patients worldwide. To date, Rep-X has recruited more than 100,000 patients in its effort to build the [Rep-X proprietary repository], and collections continue".[125] In other words, what Rep-X wants to become is the world's largest commercial DNA repository, collecting DNA samples from all over the world, genotyping them and then leveraging them for profit.

Now obviously a business model such as this can be deemed by many as ethically somewhat fraught, as indeed the controversies over DeCode and the Icelandic genomic database have shown (though the key differences have to be borne in mind here: two of the major reasons why DeCode is so controversial is because they presume consent rather than obtain informed consent to use medical information; and secondly, because they have been given exclusive rights

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statements...linked in a circular relation with systems of power that produce and sustain it" (Foucault 1980: 133).

One strategy I considered was going to Rep-X's Investor Relations department to ask for their comments on what I heard in India, but I decided against that journalistic tactic as well. My sense is that if this really is a public relations disaster that is waiting to happen for Rep-X, then there are strategies that can be employed in conversation with the involved representatives of the Indian state -- who are, after all, extremely articulate and media savvy -- in making that happen.

Finally, I believe that a number of people invested (in all senses of the word) in the world I am studying will read this chapter with an eye that will see through most anonymizations. Also, any agreements I have with companies that I have done longer-term work with (this not applying to Rep-X, where I only had a couple of conversations, and no long-term agreements) make it clear that I have the option of using the companies' names unless they would explicitly prefer me not to. Until shown otherwise, I adopt the methodological rule that the anthropologically interesting issues do not resolve into "dirty secrets" but are structurally interesting dilemmas.

I feel, in spite of that discomfort, that the story of Rep-X will be illustrative of situations I want to explain even if I don't directly locate it. This is a common dilemma for medical anthropologists working in hospital settings, who often choose to report medical mistakes with clinical consequences that they observe through official channels which are not public. When they write about such situations, they tend to severely anonymize them so that the account can't be pointed back at all.

[124] Name of repository anonymized.

for their database by the Icelandic parliament. Rep-X does adopt an informed consent procedure, and in theory at least any company could base itself on Rep-X's business model and compete with them for sample collection). So clearly bioethics is a key area in which Rep-X takes an interest, which is not unusual for a biotech company these days. Indeed, Rep-X has its own in-house bioethicist, a bioethicist being a peculiar breed of individual who professes "expertise" in the ethical issues that surround new biotechnologies.[126] In fact the CEO of Rep-X says of hiring bioethicists: "I'm surprised more companies don't do it. It doesn't cost us anything, and in the end it may save us [money, time or reputation]. I mean, the whole idea of it is so reasonable. We've always said that if we are going to be on the front page of the *New York Times* we'd better make sure we get it right".[127]

Rep-X haven't yet made it to the front page of the *Times*, but they have made it to the business page of the *Boston Globe,* testifying to the enormous amount of generally favorable publicity they have been getting in business and investor circles in the US. The *Globe* article is typically celebratory, and paints a picture of dynamism, speed and incessant progress, none of which is an unusual character sketch of a young biotech company. Let me quote a little from this article:

"When the FedEx driver rings the bell on the loading dock at [Rep-X], it's a call to action. The driver unloads bundles of special envelopes marked with the biohazard symbol: fresh samples of tissue and blood from patients nationwide. Within minutes, technicians scurry to open individual plastic kits. Glass vials of blood, each identified only by a bar code, are quickly

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[125] This quote is obtained from the Rep-X web page. However, in order to preserve anonymity, the exact citation cannot be provided.

[126] The fact that even the ethical questions are unclear seems to be lost on most bioethicists, who further believe they have most of the answers to these unarticulated questions. But that is well in keeping with the American institutional desire to have systems run by bodies of experts rather than through genuine public participation, and that is a whole topic for another day. Nonetheless, see *The Romance of American Psychology* (Herman 1996), a disciplinary study of the rise of "mind sciences", which becomes perceived as officially an expert discourse. This is a general post - World War II development in the US. Thanks to David Kaiser for pointing me to this reference.

scanned into the computer – like a giant grocery checkout in reverse. Processing the samples is a carefully choreographed blend of tedious hard work and blazingly fast robotic automation".[128] And so it goes on: the combination of speed and genius combining to create value from a novel business model, the seamless rhetoric reflecting the seamless operations of an aggressive young company.[129]

Now the big "ethical" issue that Rep-X confronts, a la *Moore*, is not the fact that it can own samples, but the fact that it should collect them properly – as their CEO suggested in the quote I read out earlier, "doing it" isn't the question as much as "doing it right" is. In other words, like the judges who constituted the majority opinion in *Moore*, Rep-X is most worried about getting proper informed consent. It knows that in the US at least getting exclusive property rights on the samples doesn't really constitute the bottleneck. This is reflected in Rep-X's fascinating statement of what it calls "Rigorous Ethical Standards", which states:

"[Rep-X] is committed to maintaining the highest ethical standards possible, and to that end, meets quarterly with a distinguished Bioethics Advisory Board that has been invaluable in developing innovative solutions to the range of ethical problems posed by genetic research. In addition, [Rep-X] has created a proprietary system for anonymizing collections while ensuring data quality and protecting patient confidentiality. Informed consent and patient rights are key to [Rep-X]'s operations, and ensure sample quality while maintaining pristine ethical standards. Working with international leaders in the area of informed consent for genetic research, [Rep-X] has developed consent procedures appropriate to the repository context".[130] Not only does Rep-X in statements like this espouse itself as the embodiment of ethical practice, it also sets up the idea

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[127] This is also a quote linked to Rep-X's web page, and therefore will not be cited in order to preserve anonymity.
[128] Exact citation not provided to preserve anonymity.
[129] I am particularly intrigued by the way in which this article makes DNA sample delivery sound like groceries being delivered. This could, from the tone of the article, be a description of such online grocery stores as homeruns.com or namaste.com. This is not merely an interesting discourse: it is, I believe, a strategic one. After all, making controversial activities seem mundane is key to naturalizing them.

that an institutionalized bioethics provides expertise that can transcend national boundaries and contexts, in the same way that the genetic samples Rep-X collects do. Indeed, Rep-X's statement is quite typical of the disclaimers that are central to many of the companies that occupy the part of the value chain between repository and database, and concerns itself with proper informed consent procedures for sample collection, privacy and confidentiality. Of course, what is notably missing in this statement is anything to do with ownership rights, which, as in the case of *Moore*, are deemed non-negotiable. This is because it is the company that's doing the genotyping that's deemed to be the "inventive" work; where samples come from merely constitutes source, which is always written out of intellectual property agreements.

Unfortunately for Rep-X and the retinue of "expert" bioethicists who profess transnational and universal problem-solving capabilities, the expertise of institutionalized bioethics, professing as it does primarily American (and sometimes European) codes for ethical governance – such as we worry about informed consent and privacy, but sharing ownership is not even an ethical question – doesn't translate very well into other socio-political and geographical contexts.[131] My last set of points therefore is going to have to do with the friction that Rep-X's

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[130] Yet again, I will not provide the exact citation, which is taken from Rep-X's web page.

[131] The question of why bioethics concerns itself so little with questions of ownership is an interesting and important one to address. A major reason is disciplinary and pedagogical: institutionalized bioethics, especially in the US, draws largely from analytic philosophy, which engages normative questions much more readily than questions that are more explicitly "political". My suspicion, however, is that *Moore* has served as more than just a legal precedent: it has further served as a normative precedent, that suggests somehow that ownership issues are "settled". This is why challenges to intellectual property regimes come much more often from that messy and unpredictable space of the public domain, and through the messy and unpredictable routes of politics, than through institutionalized spaces that, at some level, do exist to channel and regulate this messiness through the "sanity" of expert mediation. In other words, it isn't just the *content* of bioethics that I find problematic. It is the bioethicists' mediation in such debates *as experts*, to the exclusion of other participating voices, that makes institutionalized bioethics such an undemocratic institution, even when it manages to be an "ethical" one. There is, however, a substantive underlying conceptual question at stake here, which is that, firstly, bioethics therefore ends up representing particular interests, and, secondly, sets itself up as a universal discourse. In other words, I do *not* argue here for a relativist position that somehow reifies an "Indian" bioethical position that ought to be regarded as pristinely distinct from a "Western" one, and therefore left untouched or unquestioned. What I do argue is that this posing *as* universal what is in fact a reflection of very particular, situated interests makes institutionalized bioethics a supremely ideological enterprise, in the sense in which Marx (1963 [1845]) critiqued ideology as being in opposition to materialist understandings of the world in *The German Ideology*. Further, it must be remembered that bioethicists, when deployed in the corporate cause such as in

seamless rhetoric encounters in the practical context of collecting genetic samples from India: a friction of course that is completely left out of the narrative that institutionalized bioethics, the business press and Rep-X's own public relations apparatus construct for it.

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India occupies a particularly interesting and ambiguous space in global technoscience writ large, a space that is particularly accentuated in areas relating to biotechnology and drug development. At one level very much a Third World country with some of the lowest human resource indices in the world, India has always privileged science and technology as levers into globally competitive playing fields. Presently, India's technoscientific establishment is undergoing a profound period of change, as the institutional socialist model of primarily state sponsored R & D is giving way to a more market oriented approach. However, some of the most aggressive market players in Indian biotech are not companies, which are still by and large reticent and risk-averse, but Indian public sector labs.

Genomics is an area that the Indian government has been particularly interested in. India did not get into the Human Genome Project in the early 90s, a fact that its scientific policy establishment was rueing by the mid-90s when it became evident that genomics was where the action -- and the fame and money -- were at. Therefore, the Centre for Biochemical Technology (CBT), which for the past 30 years had been a dilapidated centre that has housed biochemical reagents, became reinvented as India's cutting edge public genome lab. Typically for these new market oriented public institutions, CBT is very interested in protecting its intellectual property.

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the case of Rep-X, act not simply as what Donna Haraway calls "value clarifications specialists"; they also serve as value *creation* specialists, creating value in all senses of the word. They both lend legitimacy to the corporation and structure which questions get asked as ethical.

The question that is left hanging for me then is what a genuinely transnational bioethics would look like, since I do believe that biotechnology as a global regime needs transnational, democratically accountable systems of governance and regulation. I think one good place to start would be by acknowledging, in what would be a classical Marxian fashion, that bioethics ought to be about *social relations* rather than about *morality*. One direction to look for this is towards patient advocacy groups such as PXE International, that I mention in a later footnote.

CBT's primary research focus is population genetics, because India's population is one that can be leveraged for genetic information in two ways. Firstly, there exist a number of indigenous populations that are considered genetically homogenous, and that might therefore be interesting groups upon which to perform the sorts of studies DeCode has in mind for the Icelandic population. Secondly, even India's general heterogenous population is a very good candidate population for genetic studies, because the prevalence of large families with very little genetic counseling will allow the family genetics of disease to be traced in a way that's very difficult to do in the West.[132] CBT therefore is aggressively involved in these studies, with patient samples largely collected from public hospitals with which it enters into collaboration.

Public labs in India such as CBT, therefore, see Rep-X's sample acquisition in a very different light from Rep-X.[133] They maintain that Rep-X's samples are worthless, even if extensively genotyped, without detailed medical records. These medical records are collected along with the samples from Indian hospitals. Therefore, this argument goes, the Indian hospitals should have a share in the IP. Indeed, some American companies do draw up extensive legal arrangements with the hospitals they obtain samples from, such as Ardais, which has an extensive agreement with the Beth Israel Deaconess Medical Center in Boston. This argument therefore says that if Rep-X shares IP with Indian hospitals, it can have all the samples it wants. But if it doesn't, then it is theft. What complicates this analogy is that many of the best known research hospitals in India are public institutions, whereas in the US, most such hospitals are private and function as corporations. Therefore, this argument of the Indian state paradoxically frames the state as itself a corporate entity. This is very much in keeping with a post-1990s ideology of economic liberalization that has been prominent in Indian elite and policy circles and whose idea

[132] Of course, neither of these are obvious or intuitive outside the constantly expanding rationality of population genetics as a discipline and enterprise that discursively constructs populations as units that "naturally" exist to be genetically studied.

[133] This section is based on conversations with Indian scientists and policy makers. Instead of directly quoting specific conversations, I have summarized their general content, and will keep specific informants anonymous.

of India is as India Inc. In fact, these are demands that have been codified in a set of ethical policies relating to the human genome, genetic research and services put forth by the Department of Biotechnology (DBT) of the Ministry of Science and Technology (DBT 2001).

The DBT guidelines explicitly mention intellectual property rights in an "ethics" document, an incorporation of ownership as an ethical concern that I constantly point to in the next section as well. It also claims that intellectual property rights are in the "national commercial interest" (DBT 2001: 2), a rather odd combination of terms normally associated with clearly demarcated "public" and "private" spheres. The various ways in which benefit sharing is incorporated as ethical guidelines are enunciated in Article VIII.5 of the document (DBT 2001: 12, which says: "It will be obligatory for national / international profit making entities to dedicate a percentage [eg. 1% - 3%] of their annual net profit arising out of the knowledge derived by use of the human genetic material for the benefits of the community"); Article IX.1 concerning DNA banking (13: "If any commercial use is made of the samples in the Repository, appropriate written benefit sharing agreements, consistent with the policies stated earlier, must be jointly signed by the donor, sample collector and Repository Director"); Article X. 3 concerning international collaborations (15: "In international collaborative research, when genetic material from India forms the primary basis of such research, intellectual property rights should be protected with a majority share of the patent, if any, being held by the collaborating Indian institution / organization. At least 10% of the benefit accruing from such a patent should be used by the individual institutions to develop better services for the population(s) that provided genetic materials. A minimum of 10% of Intellectual Property Rights should be held by Indian institution / organization in any international collaborative research").

With Rep-X so far unwilling to draw up IP sharing agreements with Indian hospitals, all the samples that they have collected from India since October 1999, under the authority of the Indian Council for Medical Research (ICMR), have been prevented from leaving India.

Who could have guessed from the *Globe* that a significant outcome of Rep-X's "careful choreography" involves rotting blood samples in a Third World customs shed?

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To summarize this part of the chapter:

* Ownership debates relating to human biologicals tend to confuse the ownership of human biological *material* and human biological *information*. The difference between these two forms of ownership is not something that is in the intangible realm of bioethics, but is directly related to different upstream business models that are trying to realize value off of different biological things (that often, indeed, translate into different types of biological information).

* All of these issues must be situated in the understanding of the drug development marketplace, which because of the capital-intensive nature of the enterprise, has a very few, very large companies that are positioned to actually take drugs to market. Most of the upstream innovation therefore leads ultimately to licensing agreements with big pharma companies. Therefore, it is much harder to envision a situation in drug development where upstart companies take on the Microsoft-like giants. What they can primarily do is encumber the marketplace for big pharma, by developing proprietary knowledge that big pharma has to license.

* When the proprietary "stuff" that is at issue is genetic information that might otherwise have been in the public domain, it is obviously as much in the interests of pharmaceutical companies as it is of public researchers to remove the playing field of those patents. Also, the notion of the "dubious" patent here is very much framed and limited by an ideological notion of research (drug patents, and their advisability or otherwise, aren't even deemed an issue). Therefore you see arrangements such as The SNP consortium, which sees the alliance of public researchers with big pharmaceutical companies to facilitate unfettered release of genetic information into the public domain.

* Business models dealing with biologicals further up the value chain, between DNA repository and database, however, have a different set of ethical issues and ownership politics tied around them.

Bioethics, which is supposed to be providing the space for ethical and political discourse, does not believe that central to these issues is ownership -- as an institution, it is more concerned with informed consent and privacy issues, just like the judges in *Moore* were.[134] There is, however, a lot of varied resistance to IP laws as they exist surrounding the ownership of human genetic material, and this resistance takes various forms depending on the stake-holders involved.[135]

The resistance from the Indian state is of a particular order. It doesn't want IP because it thinks source should be valued. It wants IP because it realizes that generating medical records is part of the inventive procedure. In fact at first sight the argument that it is public *hospitals* and not *patients* (which is what a model such as PXE International's might suggest) that should share in IP might seem rather peculiar. Nor is it the Indian state as represented by the ICMR that wants to share IP, as an institution that can distribute those rights through *all* hospitals, regardless of where samples are obtained, as public good. All that the ICMR wants is that the same market principles for licensing and ownership sharing that get applied in arrangements between hospitals and

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[134] This institutionalized bioethical position is not hugely different from the positions adopted by biotech "activists" such as Jeremy Rifkin (see, for instance, Rifkin 1998), who fail just as spectacularly to situate their critiques in any way. I am writing as much against this particular, unsituated mode of "activist" antagonism towards biotech as I am against institutionalized bioethics, or certain biotech corporate practices.

[135] You have, for example, the Human Genome Diversity Project, a public project of the NIH, that has met with fierce opposition from Native American groups, who simply do not want to participate in the genetics revolution because they don't expect to be the beneficiaries of it. A very different stakeholder is PXE International, a patient advocacy group founded by Pat and Sharon Terry, who believe they *will* be direct beneficiaries of the genomics revolution if they can have some control over research agendas. So they have negotiated IP agreements with companies in which they share in the IP -- a model that completely overturns an IP rationale that has always valued "invention" while simultaneously devaluing "source". PXE International, however, believes that PXE patients who donate their samples through the organization are not merely "source", since the organization has significant control, through the use of the IP rights, in charting the inventive agenda. See www.pxe.org for more information on PXE International, and the

research institutions in the West be reapplied in the Indian context -- a position, as I mentioned above, that can be deemed problematic both from the point of view of a distributive justice argument and in the way a public institution frames itself as a corporate entity.[136] In the global (South → North) travel of genetic material, the South / Third World gets framed as "source" -- and this is of course a framing with a colonial legacy, that even anti-imperialists in countries like India buy into, often legitimately. The Indian argument here is that Rep-X taking samples from India and patenting it is not colonial expropriation, but industrial theft.

There is a larger contradiction which is embodied in the stance of the Indian state, one that is not merely conceptual but also strategic. As mentioned above, on the one hand, the Indian state is framing itself as a market entity engaged in "corporate" fights with a Western corporation over intellectual property rights. On the other hand, however, the impetus to do so comes largely from a nationalist indignation about "neo-colonial" expropriation, that is not merely the position of activists on what might broadly be called the Left, but is very much the motivation for scientists involved in the science policy establishment in India who have some say in charting the state's responses to situations such as the one that I have outlined here. This at a moment in Indian history when nationalism as an unproblematically secular anti-imperialist gesture has been seriously called into question by Hindu nationalist postures that script a much more aggressive and exclusionary cultural nationalism. The fact that the Bharatiya Janata Party (BJP), the political wing of the Hindu nationalist movement, is the party leading the coalition government that is currently in power in India, is not insignificant for scientist policy makers such as S.K. Brahmachari, Director of CBT, since that makes the BJP their political masters. Therefore, there

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Indigenous Peoples Council on Biocolonialism web site, www.ipcb.org, for a Native American organization's perspective.

[136] The question of what constitutes "source" and what "invention" is, of course, a central one in IP debates writ large, and isn't just confined to biotech. The question of what, if anything, is distinct in the blurring of source and invention in biotech -- other than the obviously different and dramatic political contexts that some of these biotech controversies operate within -- is of central importance, and something I'm very much grappling with.

is always already inherent a tension in the articulation of a nationalist position as an anti-imperialist gesture in a situation such as this.

Perhaps the more acute tension for the purposes of understanding biotechnology as an integral part of phenomena of globalization, however, is that Indian state actors are, firstly, only able to take recourse to anti-imperialist postures by coding them as "corporate" fights; and secondly, that this posture, while effective to the extent of preventing Rep-X from exporting samples from India, is still partial and fragmentary. While the Indian state, and certain Indian state actors, are keen to negotiate IP sharing agreements with Western companies, there is a reluctance to aggressively push for such models at international fora, because it is felt that such a move might jeopardize foreign investment into India, which is eagerly sought after in the current climate of economic liberalization, regardless of the ideological persuasions of the parties in power.[137] In other words, nationalism is completely imbricated in the phenomenon of globalization, both as a contradictory component, and indeed as an outcome as well.

It is, however, the corporate over-codings of "the nation" that are of particular interest to me here, and I mention this because both later in this chapter and in Chapter 7 I look at the other side of this dialectic, at the nationalist underpinnings of the Indian technoscientific endeavor. Brahmachari, for instance, in a presentation to the United Nations Educational, Scientific and Cultural Organization (UNESCO), claims that natural resopurces are the *property* of the nation-

[137] I make these claims, again, based on conversations with Indian scientists and policy makers that I feel delicate about attributing directly to specific people. I do, however, wish to acknowledge one person by name who has helped me greatly both as an informant and in helping me think through some of the conceptual issues at stake here. Manjari Mahajan is a student of science policy, who was briefly employed by S.K. Brahmachari at CBT in order to help him think through some of the science policy issues that emerged from genomics as a global practice, particularly as they pertained to IP issues. Mahajan has been particularly keen that the Indian state assert claims for intellectual property rights, rather than simply request benefit sharing agreements with Western companies (which is the model adopted by most Latin American companies, and which is a model that Brahmachari, regardless of his personal feelings on the matter, feels might be the more strategic model to pursue because it risks antagonizing foreign investors less), because, regardless of the possibly paradoxical framings of state-as-corporate entity that this might lead to, intellectual property rights are precisely that: they confer proactive rights *to* exclude others from using "Indian" genetic material as they please, and they protect against Western companies obtaining

state, a framing that both denotes legal and contractual commodification of the resources in question, and the nation-state itself as a quasi-corporate entity (Brahmachari 2001). Such framings, therefore, raise fundamental theoretical questions regarding the relationship between territoriality, citizenship and property.[138]

As mentioned in the body of this chapter, one of the early and more controversial population genetics companies is DeCode Genetics, based in Iceland. DeCode is already the subject of controversy amongst American anthropologists (see Palsson and Rabinow 1999 and M. Fortun 1999a for opposing positions in this controversy), and has been too extensively "fieldworked" for me to repeat the details too extensively. Suffice to say at this point that DeCode has received exclusive rights from the Icelandic Parliament to create a "national" (albeit privately owned) genomic database of the Icelandic population, combining DeCode's genotyping of population samples with Iceland's national medical records, which are in existence since 1915 and are amongst the best and most comprehensive public medical records anywhere in the world. The ability to tap into these records, combined with Iceland's purported genetic "homogeneity" (a claim that is ironically already looking a little shaky as a consequence of DeCode's own genotyping work -- clearly Icelanders are only as "Icelandic" as DeCode is!), makes this a potentially extremely useful, and perhaps uniquely comprehensive, population genetic database.

The CEO of DeCode is Kari Stefansson, and he was in Boston in March 1999 for a conference on Genetic Technology and Society organized at MIT. This was an interesting and unusual conference, as it got together a range of people who would normally not appear together -- scientists, entrepreneurs, bioethicists, religious leaders, Republican senators -- on the same panel. This was clearly an uncomfortable site of speech for many of the scientists who were invited to talk, as this wasn't the sort of group that they were normally used to presenting to or with.

precisely such rights. Benefit sharing agreements, on the other hand, engage a terrain of (usually Western) corporate philanthropy rather than of rights. Many thanks to Mahajan for these insights.

[138] See Sunder Rajan (2001b) for an exploration of some of these themes.

Before the conference, I had e-mailed Stefansson and asked if we might be able to meet, to which unsurprisingly he had not responded. The day before his talk, I met him at a conference reception. He is an extremely tall and stately man, his silver-gray beard matching his perfectly fitting Armani suit. I had told him about my e-mail, and he was immediately apologetic about not responding, but said we must talk. He suggested meeting for lunch the following day, which would be just after his talk.

At his panel, Stefansson gave his extremely sculpted presentation on DeCode's business model, and took great pains to talk about how ethical it is, and how baseless the controversies surrounding it are. He had clearly worked his pitch out to perfection. One of his co-panelists, a gentle and soft-spoken man called Martin Teitel from the Council for Responsible Genetics, intervened and responded with the standard criticisms that have been made of DeCode's business model. At this, Stefansson blew a fuse. He told Teitel that as Teitel was not a scientist, he was not qualified to talk about DeCode's science, and since he was American, he really had no authority to pass judgement on what is an Icelandic matter. Teitel gently responded that if he can't talk about the science without being a scientist, or about Iceland without being Icelandic, then Stefansson had no right talking about ethics, since Teitel was a trained ethicist and Stefansson wasn't. Stefansson clearly realized he had made a *faux pas*, and dramatically shook his head, buried his face in his hands, patted (rather patronizingly) Teitel on his back, and publicly apologized to Teitel, admitting he had been way out of line in his outburst.

After the talk, I stood hovering in the vicinity for the promised lunch together, but Stefansson just whizzed past me to a crony who was seated nearby, grabbed him by the arm, and whispered "We need a bioethicist!"

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5.2: "Ethics" in Post-Colonial Context

I have argued in Section 5.1 both that a universalizing enterprise of "expert" bioethics, that originates largely from American analytic philosophy, is poorly suited to negotiate the ethical-political complexities of biocapitalism as a global system, and that there is nonetheless an

urgent need to come up with trans-national, democratically accountable systems of bio-ethical governance. In this part of the chapter, therefore, I attempt not to suggest how, but to provide a situated perspective of genomics and biocapitalism as it plays out in India, in order to better locate, in historically and ethnographically sensitive ways, the sorts of ethical-political emergences that I hinted at in my analysis of the Rep-X controversy.

Let me start with two quotes. The first, from India's first prime minister, Jawaharlal Nehru, speaking at the Indian Science Congress in 1938: "It is science alone that can solve these problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste of a rich country inhabited by starving people." The second, from the manifesto of the Congress Party for the first national government, as declared in 1945: "Science in its instrumental fields of activity, has played an ever-increasing part in influencing and moulding human life.... Industrial, agricultural and cultural advance, as well as national defence depend on it. Scientific research is, therefore, a basic and essential activity of the State and should be organized and encouraged on the widest scale" (both cited in Krishna 1997: 236-237).

As is quite clear from the above quotes, Nehru and the Indian National Congress, the major nationalist party in the anti-imperialist struggle (and the party that has ruled post-colonial India for 44 of the 55 years since India's independence), accorded a huge importance to science and technology in India's development. Indeed, one of the central features of the Congress-led struggle for independence had been that it was very much tied into an intellectual struggle for independence against colonial science policies that stifled the growth of local technoscientific institutions. V.V. Krishna explains colonial science in India as being a "planned activity from the metropolis" (238), where "[t]he colonies were assigned the subordinate tasks of 'data exploration' and application of existing technical knowledge, while the theoretical synthesis took place in the metropolis. Devoid of its intellectual essence, the goal of scientific practice in the colony was not

the advancement of science...but the exploration of natural resources, flora and fauna to feed to intellectual and industrial 'revolution' in the metropolis".

Two things emerge from this: the first, that the "ethical" concerns of the Indian state over what it sees as expropriation of genetic resources from India for commercialization in the West, which I describe in section 5.1, is not simply the reframing of ethics in a local Indian context in order to somehow "incorporate" ownership and intellectual property as an "ethical" concern, but is, rather, an ethical-political issue of sensitivity that has its basis in firm historical, material colonial relationships. It is a historical materialism that must be acknowledged if one is to understand at least one facet of the nature of the Indian response to companies like Rep-X. Second, that another part of the colonial political terrain that re-manifests itself in post-1990s India with its accent on economic liberalization and globalization, is the emergence of India as a major contract research site for Western corporations, especially in software, data mining and back-end corporate activities – a labor dimension to global ethical-political questions that exists beyond simply biocapitalism, but that is a central part of contemporary global relations between the industrialized West and rapidly industrializing "Third World" countries like India and China.

These are not just issues that manifest themselves in structural relations of production, but also do so in the everyday lives of scientists in Indian molecular biology labs, who still feel slighted that only "me-too" work that reproduces conceptual advances already made in the West gets accepted for publication in top Western journals, with novel conceptual work invariably getting looked upon with suspicion. A scientist at the Centre for Biochemical Technology (CBT), where I did some of my fieldwork, for instance, has this to say:

> Getting things accepted in the international community is a problem.... Anything new, I think they feel we are not competent to propose a hypothesis or...they would be more demanding in terms of data, in terms of amount of work done.... It is very disheartening actually.

> [W]e had a person...who works abroad on schizophrenia and he works with a professor who I think is from South Campus.... He came to our lab and he was trying to find out whether we could work together with them. He comes to our lab, he sits over here and he says, "Whatever you are doing, you give us your samples, we will reproduce the same work abroad and then you will have an easier way of communicating your paper because nobody will aceept any of the data that you send from here". And he is taking samples from India and doing the same analysis abroad. He has a cheek to come in our lab and tell that we will not believe your data unless we produce the same thing abroad.[139]

The perceived bias doesn't just have to do with the acceptance of cutting-edge results in academic publications abroad. It also has to do with the quality of materials and reagents that Western companies supply Indian researchers, thereby setting up a vicious cycle, whereby Indian labs produce less legitimate results partly because they (at least sometimes) have reagents and kits of spurious quality sold to them, and become a dumping ground for such kits because the work is less legitimate and powerful than work emanating from Western labs. The same researcher at CBT, which is engaged in the sorts of high-throughput genome research that many Western labs perform, had the following disclosure to make:

> [W]e went for a kit that Amersham had come up with..., which was a resin-based kit, and what we were finding was that for four months we struggled and we were thinking...and at that time our sequencing facility was also getting set up and every time we would set up the reaction, we found that their results were very inconsistent. That at times the system worked, at times half of it worked and at times nothing worked. Then one day we did it with Qiagen and we found that whenever we were using Qiagen columns, it was much better than the Amersham column. Then we found that the Amersham kit actually kills the sequencing reactions and Amersham people knew about this and they were not selling this in UK and they sold it to us here.[140]

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[139] Interview with a scientist (kept anonymous), Centre for Biochemical Technology, January 7 2002.
[140] *Ibid.*

In other words, getting work evaluated in objective, unbiased ways, and being sold reagents of the same quality that get sold to researchers in the West, are, quite explicitly, "ethical" questions from the get-go for work that gets done in a post-colonial molecular biology lab in a country like India.

At one level, then, are ethical articulations as they emanate from and manifest themselves in everyday work practices; at another level are the ethical-political articulations of the post-colonial Indian state, often manifested through policy statements and initiatives. Some context on the framing of science policy in post-colonial India, albeit very brief and sketchy, would be informative in shedding light on the ways in which biotechnology policy today gets shaped by institutional actors such as CBT, and scientific-political actors such as CBT's Director, S.K. Brahmachari.

Science policy in post-independence India was initially an outcome of close personal relationships between Nehru and some of India's premier scientists of the time.[141] Under Indira Gandhi (who ruled India from 1965 to 1984, except for the period from 1977-1980), science policy became more institutionalized. However, the importance of tacit relationships between scientific and political leaders, established during Nehruvian times, remains important to the present day. Further, political "push" can be an important driver of science policy and institutional change, and the setting up of the Department of Biotechnology (DBT) in the mid-1980s was itself a consequence of the political interest taken in it by Indira Gandhi and her son and successor Rajiv. This leads to a constrained playing field for the head of a public institution like Brahmachari, who needs to depend at least partly on forging such tacit relationships with politicians in power to get his agenda heard at a larger policy level. It also means that it is impossible to understand the actions of actors like Brahmachari as isolated from political contexts or currents.

[141] This summary draws largely upon Krishna's (1997) account.

One of those political currents, that has been explicitly prevalent since 1991, has been the faith placed by the Indian state in economic liberalization and globalization, in which protectionist policies that depended largely on import substitution and focused largely on attaining self-reliance for industry have pretty much been abandoned in favor of an aggressive embrace of the global market. This has not been the prerogative of one political party or ideology. The 1990s, in fact, has seen three different political fronts rule India for significant periods of time, and each one of these fronts had significant ideological tensions it had to contend with in order to sustain and forge ahead with liberalization policies. The Congress, which under P.V. Narasimha Rao ruled India from 1991 to 1996, was the prime initiator of neo-liberal economic reform, and thereby explicitly jettisoned the socialist ideology of a "mixed" economy that was one of the founding ideologies of independent India as envisioned by Nehru. The United Front, a coalition of federalist parties with predominantly local areas of support in specific regions of India and the Indian Communist parties, ruled from 1996 to 1998, and continued liberalization policies in spite of the fact that the Indian left saw economic liberalization as a part of a neo-colonial world order – a discomfort that kept the Communist parties on the fringe of the coalition, but that nonetheless saw them provide consistent "issue-based" support to precisely the sorts of policies that they claimed ideological opposition to. The Hindu nationalist Bharatiya Janata Party (BJP) has led a coalition government since 1998, and has continued on the economic course charted by the Congress and the United Front, even though the ideological wing of the BJP, the Rashtriya Swayamsevak Sangh (RSS), has openly and on many occasions adopted a virulent posture against multi-national corporations (the RSS has, however, been much more supportive of Indian private industry than the Left claims to be).

Actors like Brahmachari, therefore, would have had to chart a course that contended with the reality of India as a global player, regardless of what their own position on the issue might have been. It certainly makes it easier for Brahmachari that he is enthusiastic about India going

global, though this is not an unreflexive faith in global markets *per se*, or a desire to apishly imitate the West, as much as it is a strategic belief that the interests of Indian science, and Indian life sciences in particular, would at the present historical moment be best served by India becoming a global player.

Brahmachari's history at CBT, however, is a relatively recent history. As outlined in Chapter 2, Brahmachari was until 1997 a researcher at Bangalore's prestigious Indian Institute of Science (IISc), and was asked to take over India's until then relatively non-existent genomics initiative. The suggestion of the Indian state at that time was that Brahmachari start a new genome center. Brahmachari, however, felt that India was already way behind genomics initiatives in other parts of the world, and spending four to five years building a new center would ensure that India would never catch up. He preferred, therefore, to take over an existing center and retool it into India's flagship public sector genome lab.

One could conjecture two reasons why Brahmachari chose CBT as the center to retool, when at the time it was simply a dilapidated biochemical reagents distribution center. The first is its location in Delhi, close to the corridors of policy-making power. The second is precisely the fact that it was so dilapidated, that it *wasn't* already a cutting-edge lab doing cutting-edge molecular biology research. This meant that Brahmachari could pretty much chart his own course, without seriously disrupting what might be regarded as "competitive" research.

Of course, the reality is never so simple. On the one hand, the way Indian research institutions work, which, barring a few notable exceptions, is largely hierarchical and top-down, means that nobody can seriously express reservations about somebody in a position of direct power and authority over them. Therefore, even though Brahmachari was initiating changes that seriously altered existing power structures in ways unfavorable to the older scientists at the center, there was very little open dissent that could safely be expressed. On the other hand, it is true that Brahmachari's "retooling" brought in not just younger researchers and a desire for

efficient and cutting-edge science that was often lacking at CBT before 1997, but also a vision of Indian science as globally competitive that was significantly at odds with a very different vision, of Indian science as the means to self-reliance, and as a means to solve *local* problems at a *national* level, that many of the older scientists at CBT still believe in. This is then a fundamental tension within CBT, between those who see science as a tool to solve local problems, and those who see it as a tool to leverage global playing fields. And yet the latter is also envisioned by the Council for Scientific and Industrial Research (CSIR) as occurring through "applied" as opposed to "basic" research, in a policy environment where whether the distinction between the two is acutely kept alive or is collapsed matters immensely (as I will argue later in the section). "Applied", in the way that the current Director General of the CSIR Ramesh Mashelkar frames it, implies "industrially oriented". Therefore, on the one hand, scientists at CBT, Brahmachari included, chafe at "global" practices that often translate on the ground into expropriation, discrimination and dumping of sub-standard materials onto Indian labs. On the other hand, they are very much a part of the enterprise of becoming one of Them, Them being the powerful Western Other, a desire to be a global player that is at some level imposed by the current direction of the CSIR as well as by the larger political direction adopted by the Indian state, but also at some level embraced by Brahmachari, if not uniformly by all the scientists working for him.

Ethics and ownership in post-colonial context, therefore, is about *empire*. As Michael Hardt and Antonio Negri show (Hardt and Negri 2000), empire is not the same as imperialism. Rather, empire, as a diagnosis of the present state of the world system, asks the question of what sort of being imperialism is in the contemporary world. Biocapitalism is one frame, or vantage point, through which such questions might be asked.

Another part of the historical context that bears keeping in mind is that in Nehruvian, post-independence India, it was physics that was the most glamorous science, and it was the

atomic physicist Homi Bhabha who was the scientist most directly involved in general policy formulation.[142] But India also does have a history and tradition of molecular biology work, especially in biophysical chemistry.[143] India's relative powerlessness in genomics, therefore, can be traced not simply to an absence of conceptual rigor or of facilities, but at least partly to the fact that since the early 1990s the disciplinary power center of genomics in the West has shifted away from biophysical chemistry and towards genetics, where India has not been a traditional power-house.

The fourth historical frame in which to locate Indian genomics, especially at CBT, in addition to the institutional history of CBT itself, the history of Indian molecular biology and the larger political contexts that have co-produced Indian technoscience writ large, is the history of the CSIR, CBT's parent body. Much of the history of the CSIR has been a failed one, at least in terms of R & D productivity, and in terms of fulfilling its mandate, which really is the facilitation of technoscientific commercialization. Established in the 1940s, CSIR is a heterogenous behemoth of 40 research laboratories and institutes spread all over India. While federally funded, these laboratories constitute an autonomous structure, whose governance is under the Director-General of the Council, of individual Directors of each institute, and which is supervised by the Ministries of Science and Technology, Finance and Human Resource Development.

The CSIR has been a major vehicle for the transformation of Indian science and technology since 1990 into a body that is in tune with India's new project of economic liberalization and globalization (see Turaga 2000 for an overview of these changes). The

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[142] Indeed, India is still highly reputed in theoretical physics. For instance, my roommate, an American who is finishing a Ph.D. dissertation in string theory at Harvard, is going to do a post-doctoral fellowship at the Tata Institute of Fundamental Research in Bombay. While his move is at least partly motivated by a desire to live in another country that he hasn't experienced before, he also sees it as a sound career move. According to him, some of the best string theorists in the world are at TIFR, and at Harishchandra University in Allahabad.

[143] Perhaps the most famous early molecular biophysicist in India was G.N. Ramachandran, who worked on triple helical structures of collagen, and eventually came up with Ramachandran's ϕ-φ plots, that indicate the limits of three-dimensional conformations that different polypeptide structures can fold into. This work is considered fundamental textbook knowledge in molecular biophysics.

transformation of the CSIR began with the recommendations of a committee chaired by the current CSIR Director-General, and then Director of the National Chemical Laboratories (NCL), Ramesh Mashelkar (see Mashelkar et al 1993). A major change was the creation of independent marketing and financial management divisions within each CSIR institute. Of course, how these envisioned changes actually work on the ground is fragmented and context-specific. Thus on the one hand there is the NCL, which has been a pioneer in "going global", while on the other there are centers like CBT, which are still, as mentioned above, reflective of a certain amount of conflict and contradiction when it comes to aggressive globalization. The Mashelkar Committee also suggested changes in the incentive structure for CSIR scientists to provide them with explicit economic incentives that until the 1990s have been largely lacking.

Mashelkar's "global" vision for CSIR, then, involves generating external, non-federal revenue, increased annual earnings from overseas R & D, the development of licensable technologies (of which there were none in 1994), and an increased focus on getting foreign patents and using them to generate operational expenditures. Indeed, Mashelkar's mantra for the CSIR is an explicit replacement of "Publish or Perish" with "Patent, Publish and Prosper" (see Council for Scientific and Industrial Research 1996).

Uday Turaga, in his enthusiastic overview of the globalizing changes sweeping the CSIR through the 1990s, refers to its earlier, pre-Mashelkar Committee, *avatar* as a "wastrel", because it didn't link its research proactively to the marketplace. However, as I have mentioned earlier, this hides the still live tension between the Mashelkar orientiation (that Turaga subscribes to, and that Brahmachari at CBT follows) and another orientation that links research to "national needs" that explicitly get framed in more local terms.

Mashelkar's vision is not just criticized by those who would oppose the global to the national / local. Manjari Mahajan, for instance, is a science policy expert who was hired by Brahmachari to help him with the policy initiatives that he was involved in – the sort of

deregulated and imaginative hiring that indeed would not have been possible in a pre-Mashelkar era. Mahajan's criticism of Brahmachari is not a criticism of globalization *per se*, but a criticism of a *mode* of globalization that she feels will in fact lead to less effective global competitiveness.[144] Mahajan feels that Mashelkar is too focused on applied research without appreciating enough the value of basic research as it translates into applications (something that, in the case of drug development, is absolutely foundational, as I show in Chapter 3). Indeed, Mashelkar wishes to change the very name of CSIR, from the Council for Scientific *and* Industrial Research to the Council for Scientific Industrial Research. And yet, says Mahajan, the latter has *always* at some level been a better reflection of CSIR's mandate (rather than a new visionary articulation), and also the cause of CSIR's failures, because Indian industry has traditionally never been willing to take up the technologies CSIR institutes have provided them. What this accent on application at the cost of basic research has led to, according to Mahajan, is an ossified CSIR, with labs doing old work and not keeping up with advancements in the field. For example, many CSIR labs are still doing classical breeding experiments while the rest of the world has started doing molecular breeding. Mahajan thinks that this will be the disrepair that CSIR will continue to be if its focus doesn't shift on to basic research. Of course, institutes like CBT are not so ossified precisely because the CSIR is too heterogenous a body for any "vision" to apply uniformly across all its institutes. Therefore, even though Brahmachari believes quite strongly in Mashelkar's vision, CBT is one of the CSIR labs whose individual mandate is basic research, and which therefore is trying – perhaps almost too hard for some of its scientists – to keep up with the latest global advancements in molecular genetics and genomics.

Mashelkar himself sees his use of the "and" in a slightly different light from Mahajan (though she is correct in her diagnosis that what Mashelkar hopes to do is collapse the distinction between basic and applied research in ways that *basic research always already translates into*

[144] Based on conversations with the author, January 2002.

applied priorities – thereby putting under erasure the notion of basic research itself – and that those *applied priorities are naturally assumed as being commercial priorities*). He sees his erasure in the following terms:

> This name of Council for Scientific and Industrial Research. I do believe that it's got this message incorporated, that we're supposed to do scientific research, we're supposed to do industrial research. The only problem is of that "and". So we did pure scientific research which has no industrial relevance, or we did industrial research which had pretty little scientific base, because we were doing in a reverse engineering mode in a protected environment. So the other thing that I have tried to do is to remove that "and", by saying "scientific industrial research", where industrial research is done at cutting-edge science, and remove that confusion. Because I believe in what Louis Pasteur says, that there is science, and its application, there is nothing like "basic science" and "applied science".[145]

Mapping on to this collapse between "basic" and "applied" science is the collapse between "science" and "technology", which are often considered corresponding dichotomies to the "basic" / "applied" dichotomy mentioned above. While Mashelkar's collapse resonates with the STS coinage of the word "technoscience", Mahajan argues for the strategic importance of keeping that distinction alive. Indeed, the distinction between science and technology is very clearly articulated in India's 1958 Science Policy Resolution (Government of India 1958), which I talk about at greater length in Chapter 7, and which certainly sees the potentials for application of science, but also sees "technology" as something temporally distinct and following from basic "scientific" activity. What is at stake in this semantic game is not just a conceptual false dichotomy between science and technology that needs to be collapsed (which is the STS motive in troubling this binary), but also the fact that this dichotomy ties in to a host of others that arise from the perception of this dichotomy, and operate in certain ways as a consequence. Therefore, the way Mashelkar collapses science and technology, basic and applied, is a way that collapses

institutional demarcation as well, and suggests (as got suggested implicitly in the 1980 Bayh-Dole Act passed by the US Congress, thereby laying the grounds for venture science in the US) that the purpose and rationale for academic research is to generate knowledge that can be commercialized.

The case model of the Mashelkar approach as criticized by Mahajan, indeed, is not CBT but Mashelkar's own former institute, NCL, and its alliance with General Electric (GE) to provide contract research services: an arrangement that GE has declared as a model for its external R & D alliances (Mashelkar 1999). And yet, it is precisely this model, of doing contract work for foreign companies without sharing in their intellectual property, that mirrors Krishna's assessment of colonial science cited earlier in the section, whereby Indian labs exist primarily to perform work that has been designed in the metropolis, which again is where the maximum value gets realized. In other words, there is a fundamental contradiction between the Mashelkar Committee vision to generate external, non-federal revenue (which often gets generated through contract work) and its vision to generate intellectual property (which can only happen through work for which ownership resides with the Indian institute).

Some of these tensions are articulated by the current Director of NCL, S. Sivaram, who I interviewed in 2001 when he was still Deputy Director of the institute. Sivaram himself sees contract work not as an end in itself, but as a means, firstly, to get initiated into standards and work practices – such as, for instance, workplace safety conditions – that are established in other parts of the world; and secondly, as a means to enter into tacit networks that can subsequently be formalized into strategic alliances and collaborations. He is, nonetheless, acutely aware of the assymetries embodied in relationships such as NCL's with GE's, assymetries that have everything to do with conditions of post-coloniality, but also with the ways states chart their

[145] Ramesh Mashelkar, interview with the author, 20 July 2001.

strategic involvement in global commercial politics, strategies that have profound impacts on the manouverabilities of public institutions such as NCL. Therefore, Sivaram says:

> See, today, GE comes here, walks in and works with me. I cannot come and work with just anyone.... It's a question of assymetric axis. It's basically all about the competitiveness of nations. Today we are not bothering in this country, but US surely bothers about it. Europe bothers about it, Japan bothers about it.[146]

The challenge, therefore, becomes for Sivaram explicitly one of moving beyond a dependence on contract work for revenue generation towards a culture of indigenous innovation (it is precisely this move, I argue in Chapter 7, that is not paid adequate attention to by many other Indian state and private actors, located in India and in Silicon Valley, who believe that "globalization" is simply about increasing foreign direct investment in India, as an end in itself, rather than as a means to effect certain types of technoscientific advances and social developments). It is in this context that arrangements such as CBT's with the Indian pharmaceutical company Nicholas Piramal India Limited (NPIL) to seed the genomics start-up Genomed become interesting and relevant. Sivaram distinguishes contract research from entrepreneurial science thus (and this is a distinction that I return to and analyze more closely in Chapter 7):

> Contract research is to solve somebody else's problem. So you get paid for it. It's a service. It is like a consulting service. Contract research is nothing but a kind of consulting service, except that it is somewhat higher valued.... But when you do contract research the ownership rests with the contractor, the ownership does not rest with you, so you really have no stake in that development. You get current income, but you don't get future income.... I will be dealing in both. I can't be only surviving on future promises, I need to have current resources at the same time. But to depend only on current resources

[146] S. Sivaram, interview with the author, June 13 2001.

is also not fair. We need to have some eggs in the basket for the future.... And I think the rate of entrepreneurship generation in science today is insignificantly low.[147]

And of course, contract research has its own set of challenges:

The difficult thing is to sustain the relationship. To get a contract is not difficult but to sustain the relationship is quite difficult. Even with the multi-national contracts. Yes, yes, sustaining is difficult. The leadership changes are very frequent. And there are philosophical differences between people as to what can be done and what should be done. And therefore as the leadership changes the philosophy changes.[148]

Sivaram, therefore, explicitly sees NCL as reaching a phase change, where the phase of contract research needs to give way to a phase of entrepreneurial research. He sees that not because of any ideological angst about doing work for Western multi-national corporations, but because of the structural reasons that pressure a shift away from contract work: reasons that have to do with the tensions inherent to a dependence on economic forces elsewhere, and strategic decisions made elsewhere, for continued revenue generation. The move beyond contract research, for Sivaram, is dictated by the very exigencies of the contract research relationship.

According to the Director-General of the CSIR, Ramesh Mashelkar, there are two aspects to the essence of CSIR: to "advance knowledge, and to use it for the good of the people". Further: "[H]ow do you relate to the good of the people? Through economic and social development. And how do you contribute to that economic development? By contributing to industrial research".[149]

In this account, I indicate how "the good of the people" might otherwise be conceived, and indeed how it is otherwise conceived, by a scientist at Hyderabad's Centre for Cellular and Molecular Biology (CCMB), in ways that still pin huge faith on the emancipatory potential of science, but see that potential being realized by ways other than through a simple faith in market mechanisms.

[147] *Ibid.*
[148] *Ibid.*
[149] Ramesh Mashelkar, interview with the author, 20 July 2001.

First of all, it must be emphasized that like CBT, and unlike NCL, CCMB is an academic sector specific lab of the CSIR. Therefore, its mandate is considerably different from that of the NCL mandate that forms the most immediate basis for Mashelkar's prescriptions, and yet it is a mandate that is given to it by the CSIR itself.

Satish Kumar is the archetypal classical Marxist scientist, part of a dying breed that makes some very old points that are vital to be reminded of in this very new moment.

Kumar holds on to the fact that India has been unique in applying science policy with very specific public objectives in mind, and those needs haven't vanished yet – indeed, far from it (see also Chapter 7 for this dissonance between basic human resource needs in India and the drive to do "global" science). These are objectives that are very different from the market-driven Mashelkar objectives, and indeed are perhaps not even entirely resonant with Nehruvian objectives (though they have been pursued in what might be called the "Nehruvian era" of Indian science policy). Kumar sees the confusion between the pressure to do science with social values and the pressures of the marketplace. He feels there is no need to play the game of the West, because India still needs to focus on food security and health.

If the first myth is the myth of the technoscientific marketplace as in itself and unaided the panacea to the country's developmental ills, then the second myth, according to Kumar, is that technology will solve all of India's problems, since, as he says, "technology is not politically neutral".[150] Clearly having read his Langdon Winner, Kumar feels India's priorities should be in solving problems like provision of drinking water, and improving investment in and quality of food crops, animals and healthcare. He sees in the current regime of biotechnology a continuation of colonization by remote control. This is because India still "buys their biochemicals, follows the agenda set by them, and our best scientists immediately publish in those journals that most Indian universities can't afford to buy".[151] He emphasizes the importance of publicly funded healthcare and agriculture systems. In the case of the latter, for instance, he feels Indian scientists

[150] Satish Kumar, interview with the author, 6 August 2001.
[151] *Ibid.* Meanwhile, Brahmachari sees East-West inequity in the fact that Indian researchers are *unable* to immediately publish in those journals that Indian universities can't afford.

could focus on generating drought resistant crops rather than creating pesticide resistant crops. Kumar feels there has been total confusion over what India should be doing with regard to genomics, which of course means that he is directly at odds in his thinking on the matter with Brahmachari, who believes that he knows exactly what India should be doing as far as genomics is concerned.

When I pointed out that the thrust of India's science policy has changed from one focusing on self-reliance to one focused on innovation, he wondered why innovation and self-reliance cannot both be attained simultaneously. He sees innovation as a tool to attain self-reliance, and doesn't see why one has to choose between the two. What he is against, therefore, is not innovation or development of "global" science *per se*, but an unreflexive mimesis that stems from a reverse Orientalism. He strongly feels that government agencies should not change their focus from the fact that they exist for the people.

Kumar's own work in tune with this is to create a genetic map of the buffalo. Even though this is in his own words an "unglamorous" project, he thinks it is important as a scientist to start with the thought, "what if I'm successful with what I'm doing?" It's only when one becomes successful that the real question of the worth of one's research starts getting addressed. Keeping that in mind, Kumar feels that research efforts in genomics should concentrate on mapping and sequencing pathogens (which the Institute of Microbial Technology in Chandigarh does), rather than playing around with population genetics (which is the buzzword for people like Brahmachari and the Director of CCMB, Lalji Singh). Indeed, this is particularly ironical, since Brahmachari started his own demand for India to enter the genomics fray in the late 1980s and early 1990s with the suggestion that the ideal project to initiate India's genome efforts would be to generate a map of *Mycobacterium tuberculosis* – intentions that have now been sacrificed by Brahmachari himself at the altar of human population genetics.

I then asked Kumar for actual mechanisms that he proposed to bridge the gap between scientific priorities and social needs. His answer was that scientists have always blamed the politicians, but that this was unfair, since politicians have actually left issues of science policy to scientists themselves, which means that it is scientists who should take the blame for a failure to come up with mechanisms to bridge this gap.

However, Kumar feels that it is the politicians who need to help provide solutions by setting target areas and research priorities.

The fundamentals, according to Kumar, aren't going to change, and those fundamentals are that over the next 50 years, you can't take people off the land (also see Chapter 7 for my analysis of the central role that land plays in technoscientific politics in especially Andhra Pradesh, the state of which Hyderabad is the capital). Even wealth creation, he argues, ultimately has to be addressed in terms of the people on the land. Scientists in the lure of the market however pretend that only one section of the population exists. Whatever your politics, says Kumar, you can't divorce your work from the fact of the existence of your people.

His own research, as mentioned above, involves firstly creating a genetic map of the buffalo, which apparently took three years to persuade the funding bodies to fund. This is unique work because conventional knowledge of animal population genetics has not found application in India. The second strand of his work involves documenting buffalo biodiversity at the DNA level, with the objective of actually knowing the existing genetic resources in order to prioritize conservation of diverse resources. His idea is to feed his results back through co-operatives to landless peasants who depend upon livestock for their livelihood.

One would think that this is the sort of research that would have been done in a lab of the Indian Council for Agricultural Research (ICAR), and apparently the reason why it hasn't is because of problems with ICAR. Kumar feels that the problem with ICAR is that it has basked for too long in the glory of the Green Revolution. The problem with the Green Revolution was that the animal sector was completely ignored. The ICAR, further, has been completely untouched by the biotech revolution. Therefore, the ICAR is not in a position of biotech leadership, particularly in the agricultural sector.

Doing buffalo genomics is in some ways easier than human genomics because of the different priorities in animal genomics compared to human. With animals, knowing the whole genome isn't essential: one only needs to target specific traits such as milk production.

Therefore, Kumar is attentive to the *mechanics* of how to get scientific advances down to places where they can help marginal people (I suspect this might partly be reflective of an earlier founding instituitional ethos for CCMB, whose first Director, Pushpa Bhargava, has been actively involved for many years with peoples' science movements). On the other hand, people such as the Chief Minister of Andhra Pradesh, Chandrababu Naidu, or the Silicon Valley Indian entrepreneurs who are trying to establish an "entrepreneurial culture" in India (see Chapter 7 for an elaboration of both), or Mashelkar himself, all believe that scientific advance will somehow "trickle down" on its own if the market is allowed free rein. Brahmachari, the Director of the CBT, slightly differs from these positions in believing that science should be in the hands of the state (while himself claiming to be "for" globalization), as resource for the public good. There are parallels, of course, in all of these latter positions to the glorious rhetoric of "bridging the digital divide", which animates much technoscientific policy in India today, and which has been deconstructed by people like Kenneth Keniston as something that is a much more complicated process than simply introducing technology.[152] Kumar clearly understands this.

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5.3: Ethical Plateaux as Political Terrains

One of the fundamental points I have been trying to make throughout this chapter is that ethics is not simply about universalizing postures of morality, but that doesn't mean that it is simply about situated and relativist moral positions either. Rather, ethics is from the get-go *strategic and tactical*, and it is in this tactical rather than relativist sense that I map out what Adriana Petryna calls "ethical variability" across situations in the US and India in this chapter. I argue that the question of ethical principles *per se* is far less interesting and relevant than the question of how scientists, businesspeople and policymakers *deploy* ethics, thereby remapping practices of knowledge production, corporate strategy or governance. The institutionalized

[152] See also Monahan 2001 for his notion of the "analog divide", as the sets of infrastructural, conceptual and socio-cultural inequities that persist in spite of the "bridging" of the digital divide in the Los Angeles

bioethical concern with challenging individual violations leaves unpoliticized the question of how populations (themselves often constructed categories, as I explore in Chapter 8) get brought into the sphere of corporate-governmental calculation *through* science.

This is, explicitly, the question of what biopower is, a question that is, equally explicitly, an ethical one as much as it is theoretical. And that is because, as the work of people who do explore this space of ethics-as-politics, such as Adriana Petryna and Joao Biehl, so powerfully shows, questions of the incorporation of populations through various forms of biotechnical governance quite literally determine in what forms life gets nourished and supported, and in what forms it is allowed to die.

The other related problem with institutionalized bioethical framings of ethical-political questions of biopower is that they tend to set up, both through their own framings and through the oppositional readings that they prompt, a series of binaries, between property and humanism, ownership and ethics, always taking recourse to one at the expense of the other, which, while sometimes strategically vital to do, completely misses the question of how these apparently binary sets of categories are often co-produced. Therefore, the titles of each of my chapters – discovery and revolution, biotech and pharma, speed and information, ownership and ethics, vision and hype, nation and salvation, risk and subjectivity, ideology and praxis, even theory and methodology – intentionally uses the conjunction "and" *not* as an oppositional tool to pit two binary categories up against each other, but rather as an articulatory tool, that constantly questions the ways categories that produce, live with and indeed exist in dialectic relationship to one another, are in fact made to exist in such complicated relationships that can*not* be easily reduced to simple oppositional categories.

To the extent that I use ethnography as a "method", then, it is as a constant and implicit critique of bioethics, as a *counter* to a philosophical mode of intervention that is essentially

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public school system.

Platonic, as in serving to judge who gets to adjudicate on ethical matters (it does) as it itself does the adjudicating. It therefore cannot but help construct the world in the image of its own foundational categories, a construction that can't but be at odds with the various situated perspectives that life-worlds actually do provide. It is throwing light on these multiple perspectives, as illustrations rather than as evidence *of* this or that, that ethnography serves as a powerful alternative and political voice to institutionalized bioethics. Bioethics tends to reduce itself to rationally elucidating the grounds of ethics, without adequately scrutinizing what ethics *itself* is, how it plays out, how it gets constructed as a category in different situations. What bioethics leaves out, for prescription, is description. What this leads to, as I have argued in the first part of this chapter, is the reinscription and reification of certain ethical concerns, as having its basis in certain normative systems and, related to that, in rational action (and, specifically, rational action that can opposed in easy binary formulations to *ir*rational action, and the subsequent universalizing exportation of this faith as a globalized package). As I have shown, this often fails poorly in situations on the ground where ethics gets read and deployed differently to such faithful and naïve beliefs in *a* universal rationality.

In terms specifically of understanding intellectual property, then, what I am trying to argue is that intellectual property cannot be understood simply in terms of inventiveness, but has to be understood in terms of *materiality*, and even those, such as Paul Rabinow (1997) and James Boyle (1997), who seek to decenter the notion of the solitary romantic inventor that underlies IP rationales do so by showing how the *process* of invention is decentered from that of a single inventor to a much more nebulous assemblage of human actors and non-human actants. I am, instead, seeking to decenter the very *notion* of invention as the definitive notion that underlies the playing out of IP agreements *on the ground*. In this sense, I am reading IP disputes much more in

the sense that Rosemary Coombe does as she traces what she calls the "cultural life" of intellectual properties (Coombe 1998).[153]

Coombe sees intellectual property not simply as a set of rights or as (reductionist) attribuitions of inventive genius, but as constitutive objects in commercial and popular life-worlds, as sources and sinks of social power, as mediators of such fundamental notions of identity as citizenship in contexts of national imagination that are always already, as shown earlier, overcoded by corporate specters, as both symptoms and diagnostic markers of colonial histories and presents. Perhaps most in consonance with my own sensibility is her call for what she calls an "ethics of contingency with respect to the use of commodified social texts" (5). What gets encoded in the law, she shows, is not just a set of significations that suggest a certain ideological conception of invention, but the *materiality of such signification.*

Sunil Maulik, the co-founder and CEO of the e-learning start-up GeneEd, whose emergence I described in Chapter 2, has a similar conception of intellectual property. I quote extensively from an interview with him to provide a sense of this conception:

> The economy of the United States, and particularly the economy of Silicon Valley, has transformed in the last 15 years from an analog economy to a digital economy. And what I've been doing for the last 15 years is...[realizing] that you can now create widgets out of ones and zeros, out of the bits and bytes of information, and these widgets have value, they have a tremendous value.... As the Oracles and Apples and Intels and Microsofts and all of these companies have proven, it is a huge business selling essentially information and the ways to store, package and manage and transform information. So

[153] I think Coombe's notion of a "cultural life" rather than a "social life" is of utmost importance, because, as I argue in later chapters, understanding the lives of commodities cannot simply be an attempt to understand the circuits they travel as they get produced, circulate and get consumed, which is the unfortunately limited (and limiting) trajectory that is increasingly getting charted by those who claim to follow the likes of Appadurai and Kopytoff in tracing the "social life of things" (see Appadurai 1986). Commodities, by definition, are mystical things, and it is impossible to divorce their social life from an analysis of the imaginaries that they create, sustain and traverse. Hence the salience of the notion of

essentially just moving ones and zeros around. So the business of moving ones and zeros around is a huge business in the United States.... I think that has informed me over the last 15 years, that you can build a business that's essentially based on repurposing existing ones and zeros. I sometimes joke that I wrote a great memo back in 1986 and I've been cutting and pasting it ever since, but I've never actually had an original idea since then. But the very fact that I can cut and paste that original memo, right, the fact that I can manipulate the ones and zeros that represented the original content in that memo, and I've continued to be able to do it moving forward, has value. And if you see what GeneEd does, all we are doing is repurposing other peoples' ones and zeros, but the way in which we do it adds value, and people are at least beginning to show that they are willing to place a fairly substantial premium on the value that we add. So I'd say building something out of nothing, in a very strict sense, that's true, because there's no factory here, there's no inventory, there's nothing tangible, but it's the intellectual property, and the way our intellectual property modifies existing intellectual property and then packages it and resells it, that has value.

KS: So you're really arguing for a slightly different definition of intellectual property. It's not something that's just an inventive act of genius but something that is as tangible as property, except that the property in question is information?

SM: Absolutely. Absolutely; and that is not a static thing. It's like a river which flows over time and spreads out tributaries, some of them end up drying out...yeah, absolutely.[154]

Maulik goes on to develop the theme of the *fluidity* of intellectual property:

I think the idea of intellectual property and intellectual property ownership, it's sort of become a moot point. I mean people joke in Silicon Valley that nobody is allowed to take any property. But it happens all the time. People walk off with the intellectual property of

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"cultural life". Coombe indeed is intimately concerned with the imaginaries associated with intellectual property.

[154] Sunil Maulik, interview with the author, 15 May 2001.

> the company they were working for and start a new company, sometimes with the company's permission, sometimes with the company's tacit permission, sometimes because the company didn't want to seal that intellectual property or they didn't think it had any business value. But for whatever reason, it happens *all* the time. And so this idea of intellectual property as this...like you say, this one moment of genius, this point of time, contained, I think is sort of bogus.[155]

Perhaps nothing illustrates this point as well as the DNA chip company Affymetrix, whom I have talked about in the Prologue and again at some length in Chapter 4. Affymetrix has extended patents protecting their chip technology, including patents that cover the underlying principle on which the chip is based, methods of manufacture, specific applications of the chip, and so on. DNA chips, however, are also very easy to engineer, especially ones that are more rudimentary than the Affymetrix chips, but that might yet suffice for simple experiments to look at differential gene expression. After involving itself in elaborate, multiple and not always successful litigation, Affymetrix has now "open-sourced" its chip, suggesting not only a less aggressive attitude towards the protection of its intellectual property, but also showing how, firstly, a situation where protecting intellectual property is untenable can be strategically reconfigured as a move that has attached to it significant symbolic capital (that accrues from the apparent "openness" that Affymetrix can project itself as embracing), and secondly, how this "openness" is not just an acknowledgment of the *untenability* of enforcing intellectual property on the chip, but also an acknowledgment of the *brand value* the chip has accrued. Therefore, now that the Affymetrix DNA chips have becomes established as the industry standard for high throughput differential gene expression analysis, it doesn't matter to the same extent that others without the same brand loyalty might in some way copy the chips.

The question then becomes how this fluidity of intellectual property translates into ethical-political complexities, especially in regimes of globalized information flow, where the

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[155] *Ibid.*

information in question has to do with life itself (itself an ideological conception), and where the information often does travel, as shown in Section 5.1, along with tangible material objects such as blood and tissue samples. John Frow, for instance, echoes an argument made by many in the Third World who oppose global intellectual property regimes such as they get encoded in agreements such as the General Agreements on Tariffs and Trade (GATT) and the World Trade Organization (WTO), that such regimes directly disadvantage Third World countries (Frow 1996). While I am broadly in agreement with such sentiments, I am also keen to tease out the constantly contradictory morphings that take place in politics on the ground that problematize such easy political positions, especially in countries like India that refuses to take its "Third World" status for granted.

Therefore, at one level, bioinformatics in India would to a considerable degree just not be possible without sequence information and other bioinformatic resources that get generated in the West being accessible in the public domain, since private databases are often too expensive to afford for most Indian research centers. However, as indicated in Section 5.1, a number of "disenfranchised" groups, such as patient advocacy groups in the West, and indeed even CBT in India (which is precisely one such institution that depends upon public domain bioinformatic resources to do much of its bioinformatic research) are involved in leveraging intellectual property arrangements in strategic ways for their own benefit – which might be, in the former case, to ensure that rare genetic disorders that would otherwise never get researched do get research attention; in the latter case, as a mechanism to ensure a certain return in revenue for what gets framed as the "Indian" public good. Indeed, it is hard to take an excessively comfortable position on intellectual property issues in biotech and drug development writ large when, to take one example (as I have mentioned before), major proponents of DNA sequence patents are patient advocacy groups such as PXE International, and major opponents are big multinational pharmaceutical companies.

One of the by now classic examples that get invoked to point to the "biopiracy" that takes place, with Western corporations patenting "Third World" natural resources, is indeed the case of the patenting of neem, which has been traditionally been used in India for its medicinal properties for centuries. Again, paradoxically, it is *not* India's CSIR that is crying foul over this issue of piracy, even though it was CSIR that had to fight the case in global intellectual property courts (a case that CSIR won, thereby enabling the neem patent to be overturned). The CSIR, however, points to the instance of the attempted piracy of neem *not* as the case in point of biopiracy and biocolonialism, but rather as the ultimate proof of the fairness of global multilateral trade arrangements such as WTO, that provide organizations like the CSIR with the mechanisms to overturn blatant attempts at piracy. This is not to argue that I either agree with CSIR's position or disagree with it, but to point out, once again, that "politically correct" positions that are in fact probably better informed by the inequities of global trade systems than CSIR's (which after all is operating on politically constrained terrain, much as it is an enthusiast for globalization itself), are almost invariably infinitely more complicated on the ground, with organizations that are supposed, from their structural positioning, to have a certain "Third World" consciousness often resolutely failing to do so – and further, not simply failing to do on account of ignorance or coercion, but rather as a consciously strategic decision. Therefore, even acknowledging an intellectual property system as being stratified is often not sufficient to enable one to understand its effects, unless one is attentive to its (often unpredictable) political manifestations.

Indeed, the CSIR's embrace of globalization as signified by WTO is not just at odds with its structural position as a governing body of "Third World" public research institutions, but is even at odds with pre-1990 political currents in India. I have suggested (and detail in greater detail in Chapter 7) that the 1990s have seen a profound shift in the economic ideology of the Indian state, away from the Nehruvian state socialist agenda and towards aggressive market-oriented policies of liberalization, changes that have very much been central to the direction

charted by India's technoscientific establishment as well. Of course, while 1991 did represent a watershed of sorts, being the time when India proclaimed through a series of visible measures its intentions to open its markets, India's global leanings were already in evidence in the 1980s, as both Indira Gandhi and her successor Rajiv initiated economic liberalization in more modest but very definite ways. And yet, Indira Gandhi addressed the World Health Assembly in 1982 with the following words: "The idea of a better-ordered world is one in which medical discoveries will be free of patents and there will be no profiteering from life and death" (cited in Braga 1990: 253). The extent to which CSIR's current views on global trade regimes, that include WTO provisions on biotechnology and drug development, with even Indira Gandhi's 20 years ago (let alone Nehru's 50 years ago), of course, suggest changes in ideological direction. But they also suggest the various co-productions of law and corporate ethos with prevailing political ideology, which of course is itself influenced by structural constraints (such as the huge balance of payments crisis in 1991, that was the immediate impetus for massive liberalization policies to be implemented; or the Uruguay Round of GATT and the pressure brought to bear by the West on the Indian government to be a signatory) and the agency of individual actors (such as Ramesh Mashelkar), who chart seemingly irrevocable courses.

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Michael Fischer, adapting an imaginary from Deleuze, proposes the terms "ethical plateaux" as a means of thinking about the intersections and interactions of different technologies and / ethical-political emergences in ways that are always already stratified (Fischer 2001). The grounds for ethics then are topologies or terrains, rather than the unarticulated (and implicitly, therefore, level) playing field that is assumed by much institutionalized bioethics.

One lens through which the tactical emergence of ethical-political terrains can be traced is that of clinical trials, which I have briefly talked about in Chapter 3 as being sets of techniques within which values, in all senses of the term, get incorporated. The logic, rationality and what

she calls "ethical variability" of clinical trials in the US are being studied by Adriana Petryna. I wish here to talk about clinical trials in an Indian context, by drawing upon some of my fieldwork at CBT and its associated start-up, Genomed.

As described in Chapter 2, Genomed is a start-up that has been seeded by CBT in partnership with the Indian pharmaceutical company Nicholas Piramal India Limited (NPIL). There are two physical lab spaces in which Genomed is housed, that are very different from one another. There is one Genomed on the premises of CBT in Delhi, and another in a private hospital owned by NPIL, Wellspring Hospital, in Bombay.

The two Genomeds quite literally represent different worlds and different forms of life, and indicate vividly how place matters in understanding technoscientific production in situated and complex ways. On the one hand, there is the evidently different environment in which the two Genomeds are located: one drawing directly upon all the academic researchers, facilities and work happening in CBT, the other not, for instance. But there is also a difference in the types of work being performed at the two CBTs. In addition to doing population genomic research on schizophrenia (which parallels similar projects being done on asthma and Type II diabetes in Delhi), Genomed Bombay also studies pharmacogenomic drug response in clinical trials.[156] In many ways, the hospital is primarily an experimental site rather than a therapeutic one. It is, indeed, a "Five-Star" hospital in appearance: glittering marble floors, comfortable sofas littered around the hallways, hospital beds with bright yellow bed-covers, all make Wellspring Hospital seem more like a hotel than a hospital, and very different from, say, the All Indian Institute of Medical Sciences, India's premier referral hospital in Delhi with which CBT Delhi has collaborative projects underway. What makes Wellspring even more unlike anything resembling "normal" Indian hospitals is the striking and almost complete absence of patients.

[156] These are projects that the Director of CBT, S.K. Brahmachari, has a significant hand in designing. Indeed, moving clinical trials to India is a central part of Brahmachari's agenda of taking Indian corporate technoscience "global".

As I mentioned above, this is because the major interventions that take place at Wellspring are clinical trials. The idea that a local pharmaceutical company would invest in building a state-of-the-art hospital almost solely as an experimental site in itself makes Wellspring an interesting institutional component of a pharmacogenomic assemblage. What makes it even more interesting, and pertinent in terms of my arguments for situating ethical understandings in political economic contexts, is the larger urban ecology that Wellspring is situated within.

Wellspring is located in Parel, in the heart of downtown Bombay, but also in the heart of the part of Bombay that houses the textile industry. Bombay's economy largely grew on the strength of a textile industry that rapidly disintegrated through the 1980s and 1990s, leaving visible from the windows of Wellspring the empty shells of once prosperous mills. Parel, therefore, is teeming with unemployed mill-workers, who have gone through periodic cycles of unionization over the last decade, but whose struggles to reoccupy and reopen the failing mills have probably, once and for all, ended in defeat. Hospitals like Wellspring now abut both the poverty of recent deindustrialization (a very different space of poverty to that of, for instance, Daravi, widely regarded as Asia's largest slum) and the new wealth that is displayed through other monstrously glamorous erections, such as a nearby shopping mall that sells a range of foreign brand-name consumables that can only be afforded by the rapidly ascendant middle class consumer population. Such shopping malls are clearly, at least partly, built in anticipation of the mills finally being torn down and replaced by high-rise apartment blocks, since Parel represents prime real estate in a city with the most expensive real estate prices in the world.

In other words, Wellspring's location in Parel is almost certainly not accidental, as there lies available to the researchers a huge unemployed local population which ends up being easily recruited into clinical trials, which do after all compensate their volunteers. The ethics of such trials can only be understood and evaluated if situated within the local ecologies of their conduct,

ecologies that problematize the very notion of a trial "volunteer" in ways that are *not* relativist, but rather situated and historically, materially produced. Just as Marx describes the forced proletarianization of the working class during the Industrial Revolution in Volume 1 of *Capital* (Marx 1976 [1867]: 873-942), one can see how forced deproletarianization as a consequence of the crippling contradictions of capitalism leading to the virtual death of an entire industry in Bombay, leads in Parel to the creation of a new population of subjects that are created as sites of experimental therapeutic intervention.[157] What is at stake here is not simply a judgment of the dubiousness or otherwise of clinical trials recruitment strategies on their own terms, but rather the question of how para-regulatory and para-ethical regimes of pharmaceutical governance happen. Specifically, what is at stake is an understanding of the relationship between national – global enterprises of clinical trials and local forms of indebtedness.[158] In this process, biosociality itself gets configured as a relationship between vendors and clients, just as globalization is.

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What, then, are ethics, and what are the grounds for ethics, and how does ethics manifest itself *as* politics, and indeed, politics as ethics, and what space with respect to and responsibility towards ethics does the theorist occupy or have if she is to avoid falling into the same discursive and political traps that institutionalized bioethics falls prey to? What sorts of vigilance get called for, and called into account? What, especially, is the consequence of being an "ethicist" (of sorts), and "ethical" (only sometimes the same thing) in a regime of speed, where the only way to intervene in a *timely* manner is by subordinating oneself to the very same constraints of

[157] My suspicion that what I describe is far from unique to Parel, even though Parel's political ecology might be unique, is suggested from conversations with Joao Biehl, who has for a number of years ethnographically studied an HIV testing center in the Northern Brazilian province of Bahia. This is a center set up by the Brazilian state, and is part of the widely hailed Brazilian state intervention in the diagnosis and treatment of AIDS, that has often been referred to as a model for other states to follow. On a recent visit back to the center, Biehl found that adjoining the center was a huge five-star hospital, set up by a major multi-national pharmaceutical company, that primarily served as an experimental site for clinical trials. In this case, it was the people getting tested for HIV who served as the potentially recruitable population for the trials in this hospital.

commodified time that one seeks to critique in the first place? I try to think about some of these issues – of strategy and responsibility, dare I say, of praxis. In the process, I will try and elaborate upon what I suggested earlier in this section, about the role ethnography can play as a counter to institutionalized bioethics *if* it is understood as illustrative rather than evidentiary, and *if* it is further understood that illustration is not "mere" embellishment, a superstructural "artistry" that adorns but cannot substitute for an objectively determined, view-from-nowehere, enterprise of *fact* production. Effectively, what I am arguing for is for the importance of using ethnography to generate situated perspectives, as Haraway would argue for, while always being attentive to the dangers of that situatedness sliding into a functionalist relativism, and thereby surrendering its power to be illustrative of specific situations *in larger contexts* – for one cannot be situated without larger structural conexts to situate oneself *within*.

Derrida tells us that "since we cannot wait for these operations to be analyzed, for these levels to be distinguished, for the discussion to be over and for satisfactory conditions to be found to act and make decisions, given that urgency and precipitation are part of the very essence of the decision, our duty here is to *discover* and to *invent*, each and every time, in singular situations, that is to say, without a given rule" (Derrida 2002a: 214). Ethics and politics, ethics as politics, are acts that require the utmost urgency, because a failure to act urgently, an *in*action, is always already an action. And as Derrida says, ethics and politics both demand actions, actions that are both responsible – a responsibility that can only come from deep reflexivity, about the action, its contexts, consequences and constraints – and urgent. How to be both quick and careful? And as an ethnographer, an even further question, explicit in my interactions with Rep-X outlined in the first section of this chapter: how to not compromise *oneself* (by failing to write about an ethically compromising situation, by *in*acting), and yet not compromise the *informant* that has allowed me

[158] The relationship of bodies as sites of medical intervention to local forms of indebtedness is beautifully illustrated in Lawrence Cohen's (1999) account of organ transplantation in South India.

access, an allowance made with the implicit (if perhaps naïve) assumption of generally positive publicity?

How much one should reveal about situations one is, by virtue of being an ethnographer (and if bioethicists too are not ethnographers, of a sort and to the extent of their participation in and observation of the bio-technologies they adjudicate upon, then what business do they have being there?), complicit in the ethnographic *encounter*, but also in the *moment* of the encounter? Access to corporate biotechnical worlds has everything to do with temporality: time-frames are measured, pondered and strategized to an extreme degree. A major tool to get access to sites for this study was to emphasize its own time-frame – that it is part of a doctoral dissertation, and therefore will not be finished until what most informants automatically assume is an endlessly deferred time; that it will certainly not be likely published in the immediate enough future for it to be extremely compromising of such insights as informants might want to reveal.

And yet, time is also deployed strategically by scientists and corporations to create inarticulation on the part of those that might call themselves ethicists. In 1999, for instance, I heard a talk by Ian Wilmut, cloner of the sheep Dolly, who expressed perplexity about the fear-mongering over the temporally distant and therefore completely hypothetical possibility of cloned human beings. Even if such eventualities were to occur, he implied, they are so far in the future as to be beyond the realm of current feasible imagination – and therefore, presumably, adjudication. And yet there are many, ranging from James Watson to Lee Silver, who argue that it is pointless to stop potentially eugenic (or at least determinist) enterprises of fact and technology production, because they are already here, and being obstructionist, even if successful, can but be a momentary reprieve. An important component of the materiality of speed in biotechnologies is that it effects a complete temporal collapse between that which is too distant to legitimately judge, and that which is too late to effectively judge. Too often, then, the space that gets left for bioethics to adjudicate from is the retrospective space of "unintended consequences". The

challenge for an ethnographic intervention from amidst the unstable strata of ethical plateaux, as Fischer too explicitly reminds us, is to come up with words, and actions, and words as actions, that can proactively help shape these terrains towards whatever "progressive" political goals – goals themselves, probably, on which there cannot be complete consensus – might be at stake.

Ethics, therefore, is completely tangled in the political – there is no way an "ethical" intervention, of any sort, be it ethnography or institutionalized bioethics – can fail to be a political act. One of the acts of purification and absolution bioethics often tries to effect for itself, which is completely related to its conception of providing "objective" (and therefore necessarily apolitical) adjudication, is precisely this claim to not be subject to politics – a claim that is even more audacious when made by that section of institutionalized bioethicists, such as, most (in)famously, at the University of Pennsylvania, who spend a significant part of their time studying "bioethical" problems for biotechnology companies.

CHAPTER 6: VISION AND HYPE

These seismic events come from the future, they are given from out of the unstable, chaotic, and dis-located ground of the times. A dis-jointed or dis-adjusted time without which there would be neither history, nor event, nor promise of justice.[159]

If you're a reasonably well adjusted, fairly happy individual, you would never start a company and you should never start a company. You have to be maladjusted in some pretty defined way to create a company.[160]

6.1: Future Perfect, Present Tense

In this chapter, I am going to try and work through an argument dealing with futures and visions as nodes in tactical articulation as well as defining features of an emergent industry at an emergent moment in capitalism.

To begin with, it must be acknowledged that a project that traces regimes of what might be called "post-genomic" drug development in the United States and India is fundamentally a project that traces emergence in the midst of what is clearly an inaugural moment that is being brought about as a consequence of life sciences constructing and articulating different forms of meaning and value in the realms of political economy and subjectivity. The notion of emergence is from the get-go a temporal notion: it relates that which is to that which will be. This is often a contingent and unpredictable relationship, but it is nonetheless a relationship of a present to its future. My argument here is that studying emergence of the sort that corporate life sciences

[159] Derrida (1994: 170).

presents to us involves necessarily inverting the temporal orders that go into understanding the relationship of presents to futures: it isn't just the present that determines the future, it is quite often the future that determines the present and thereby shapes certain types of tendential emergences.

As mentioned above, there are two fundamental systems of meaning and practice whose interrelationship is vital to understand in order to make sense of the emergences that I am trying to trace. One relates to subjectivities, of both corporate-scientific actors and of consumers -- Paul Rabinow's notion of biosociality is the key heuristic that presents itself for unpacking here. The second relates to speed and tactics, and involves mapping the terrain of strategic praxis within which emergent commodification and subjectivities are instantiated, negotiated and contested. Ethics, as I have argued in the previous chapter, becomes a crucial node in tactical articulation.

The shifting notions of promise and vision link subjectivity and sociality to speed and tactics. The former are two related terms that themselves relate to the dual subject that is the consumer who invests and / or the investor who consumes. Therefore, there is a subjective relationship between investor and consumer, and a theoretical relationship between vision and promise, that needs to be mapped.

Vision is central to the functioning of investors and entrepreneurs, but also of countries. Chapter 7 contains the story of an emergent genomics marketplace in India that is situated in a larger context of an emergent innovative culture there of market-savvy technoscience as an explicitly envisioned means of becoming a global player. Therefore, there are different ways in which vision functions or operates: it could be missionary, nationalist, scientific or entrepreneurial. Each of these could in turn function as a call to action, as a Utopian promise or as a cynical calculation. The question is how these different forms of envisioning are articulated.

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[160] Sunil Maulik, co-founder and CEO of GeneEd, interview with the author, May 15 2001.

What I am interested in, to start with, is the question of how companies create promissory visions of futures in order to enable their existence in the present. This rests not merely on a particular mode of calculation (though such a calculus is essential), but also depends upon material, discursive and semiotic practices and strategies.

The condition of possibility of the presence of corporate biotechnology is enabled by a spectrality, in as much as corporate biotechnology is inherently a speculative venture. Speculation, as Jacques Derrida points out, is always fascinated and bewitched by the specter.

Let me back away then from the specifics of biotechnology to talk for a minute about speculation writ large. Speculation has a dynamic and fundamental relationship to capital. To quote Derrida: "Speculation always speculates on some specter, it speculates in the mirror of what it produces, on the spectacle that it gives itself and that it gives itself to see. It believes in what it believes itself to see: in representations.... In this sense, speculation is always theoretical and theological" (Derrida 1994: 146).

There are two things that get referred to here, one of which is fundamental to my argument and the other of which I will briefly touch upon towards the end of this section. The first is that speculation is not simply a manifestation of a certain phase of what might be called "speculative" capitalism, that is distinct from industrial capitalism. In this version of often accepted common-sense, industrial capitalism busied itself with things -- commodities -- while speculative capitalism deals with the realm of the more intangible, the visions and futures that I talk of in this chapter, risks, probabilities, investments in decisions and events that may never happen. The understanding of capitalism that posits tangible industrial thingly capitalism in opposition to ephemeral virtual speculative capitalism however misses the fact that the centrality of speculation in "speculative" capital merely relates to "thingly" capitalism by the degree to which the *act* of speculation is made manifest. An integral component of temporality does indeed exist in what we call speculative capitalism -- and biotech is definitely speculative capitalism --

but this concept of temporality, of deferral, and therefore of all the attendant baggage of risk and promise, hides the fundamental element of speculation that underlies all capital, and has indeed, as Marx shows in the *Grundrisse*, been a part of capitalism since long before industrial capitalism, being part of the circulation of cycles of money and capital that Marx analyzes at the very beginning of his logic of contradictions in the forms of value.

The power of capital, says Marx, lies not in the tangible processes of use, exchange and generation of surplus, but rather in the intangibles that provide capitalism with its mysticism and secret, with its magic. It is these intangibles -- abstractions, if you like -- that simultaneously mystify things with utility as commodities while naturalizing those mystifications as anything but mystical. The central mode of abstraction that Marx alludes to, of course, is commodity fetishism (Marx 1976 [1867]): 163-177). The commodity, as Marx points out, is lively from the get-go, because the fetish is by definition lively. "Lively capital", a phrase that might be used to describe the objects of study in projects such as this that look at the corporatization of biotechnology and the biotechnicalization of the corporate world, is virtually an oxymoron. There is an importance of temporality, and an idealization of time, in the very creation of fetishization.

Use-value itself is an advance promise, which leads to the existence of an object as commodity even before it exists itself as use-value: the *rationality* of the use-value of a thing in capitalism predates its *existence* as use-value. Things like pharmacogenomics and personalized medicine (that I describe in greater detail in the Chapter 8), that are dismissed by skeptics as simply being "hype", are therefore things that are much more serious and tangible. While I talk below about these specific biocapitalist manifestations about speculation and visionary articulation, it is perhaps important to further emphasize how the *bio* in this section merely serves as an example to throw some light upon what are, in all probability, features that are more generally fundamental to capitalism writ large.

Anna Tsing, for instance, shows the operation of speculation in a realm of capitalism that does not even deal explicitly with technoscience in her analysis of the Bre-X corporation, whose prospecting for gold in Busang, Indonesia ended in spectacular failure (Tsing 2000). Tsing is less interested in the actual event of failure than she is in the way Bre-X as a company was *performed*: the very existence of the company was, as she says, "always a performance, a drama, a conjuring trick, an illusion, regardless of whether real gold or only dreams of gold ever existed at Busang" (118). The ultimate outcome as measured in binaries of success or failure, whether for gold mining companies or biotechnology companies, matters little to the *anatomy* of conjuration, and the inherent temporal logic that underlies that anatomy, and it is that anatomy that I wish to dissect in this argument.

What Tsing further alludes to, that I take up in the next chapter, is the significance of Bre-X as a *Canadian* company, and the way, therefore, the conjuration of the prospect of gold in Indonesia, ready to be mined by Bre-X, as lucre for its investors, is always already articulated with / as Canadian *national* dreams of global corporate expansion. Of course, ideas of national strength and prowess always underlie any venture of global resource expropriation and capital expansion when the company doing the expropriating and the expanding can in any tangible way be identified with its originary country, and this imbrication of nation and capital is as old as the early period of colonial expansion as represented by companies such as the East India Company. I read Tsing's analysis of the way the Canadian nation is imagined through exploits such as that of Bre-X as being slightly more complicated and complicating, however, than a simple diagnosis of colonial imaginaries would allow. Bre-X, as explicitly a *Canadian* company, is not just significant in Tsing's argument because of the age-old identifications that brings with other Western colonial powers prospecting for natural resources in the "Third World", but also because it marks the site of an unfulfilled desire, a recognition of the *in*ability to easily identify with, especially, the United States, as a country with the strength and global reach to generate value

through effortless transnational ventures that mark such latter countries out as being true global players. It is this national imaginary, marked by a certain ambivalent desire to be a global player, rather than by an automatic assumption of global might and transnational right, that manifests itself quite acutely in India, as I have hinted at various points in Chapters 3 and 5, and as I will develop in Chapter 7. It is the automatic conjuration of a certain, historically and temporally specific, national(ist) imaginary *as always already an outcome of a potential global corporate endeavor*, an imaginary further that is based in a longing for a future global strength rather than in the smugness of past imperial glory, that marks out aspiring global players such as Canada and India as distinct from the United States. Millennium Pharmaceuticals collecting DNA from Chinese populations and thereby speculating on massive returns for its investors simply does not conjure a similar national imaginary of the United States.

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So what is personalized medicine? In scientific - corporate terms, it is the creation of drugs tailored to individual genetic profiles. It is at this point in its existence largely (though not entirely) a discursive entity: it is hype. But it is also, if we read our Marx right, a thing-in-waiting, where the thing in question is medicine -- as both therapeutic object and set of material-semiotic practices. It is a use value that is waiting to happen, and that has already been inserted into processes of exchange and capitalization, with corporate valuations dependent on it. Yes, we can dismiss it as hype, but how different in its social life -- as exchange-value preceding use-value -- *is* personalized medicine to Marx's commodified table? If we can accept then that hype is not merely the dismissable act of unrealizable cynicism -- which is not to say that hype isn't often cynical -- then it becomes clear that hype is part of a political economy that is as old as the Industrial Revolution, even if the conditions that have made its explicit manifestation a central part of corporate strategy are relatively new.

The point I'm trying to make above therefore relates to the *affects* of personalized medicine that precede its existence, affects that have to do with creating capital flows, corporate identities and strategies. But there is a second affective dimension involved, and that relates to the building of *social* identities. How *does* biosociality manifest itself through personalized medicine (a question I continue to explore in greater detail in the Chapter 8)?

Of course, there are multiple communities of practice that personalized medicine, and indeed genomics and biotechnology writ large, impinge upon, and in this chapter I restrict myself primarily to talking about scientists, scientist-entrepreneurs, venture capitalists and policy makers. My argument here is that personalized medicine is not a form of life (as in sociality of action, as Michael Fischer outlines it) that is created *by* pre-existing disciplinary communities as much as it is a form of life that *creates* these new scientific communities that could be called "the genomics community". And once again, this argument emerges from following what Marx says about the social life of commodities.

Commodities do not simply confer properties of anticipated use subsequent to a process of exchange on objects that would otherwise have existed to anyway be used. They also play with social bonds, which exist both amongst people and amongst commodities themselves. These bonds on the one hand bind people to each other, people who are inter-related in various ways through processes of labor, exchange and capitalization (all of which are inherently temporal processes), and on the other hand bind commodities to each other. The question that Marx implicitly asks, but which actually gets articulated by Derrida, is: "How is what takes place *on the one hand* among men, in their apprehension of time, explain what takes place *on the other hand* among those specters that are commodities? How do those whom one calls 'men', living men, temporal and finite existences, become subjected, in their social relations, to these specters that are relations, *equally social* relations among commodities?" (Derrida 1994: 154).

Such a question is a fundamental question to ask if one is to understand the complicated set of social bonds that one sees throughout genomics: bonds that tie the corporate genome community together, bonds that create sports team like alliances amongst workers of particular companies, bonds that tie companies together with their customers (who are often other companies), bonds that tie together investors and entrepreneurs. And so onto a little ethnography.

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The stage that I now move to is at the Hilton resort in Miami. The time, 1999. The occasion, an industrial genome conference organised by The Institute of Genomic Research, the non-profit organization headed by J. Craig Venter of Celera Genomics fame. As described in Chapter 4, 1999 was a particularly interesting year for genomics, as the "genomics community" was on the verge of generating a working draft sequence of the human genome. It was also a year when the "genomics community" was particularly fractured between the public-funded Human Genome Project and a number of private sector genome companies (of which Venter's Celera was simply the most visible). The Miami conference was a site of gathering for the latter.

The company that really stole the show in Miami in 1999 was not Celera as much as it was its rival, Incyte Pharmaceuticals (now Incyte Genomics, and there's a tale in the change in name as well that I won't go into here). In the context of the 1999 Miami conference, Incyte CSO Randy Scott's keynote address was important as the turning point of the proceedings into an Incyte conference. The visibility had been there, the publicity had been there, but it had been built up for a purpose: Scott knew his business, and he executed it well.

A lot of his talk was biology, about the various projects underway at Incyte. What was important about the biology, that made this more than, or at least different from, a Latourian scientific presentation, was its *visionary* nature – Scott was selling a vision for the future. So that what was really interesting was a timed series of projections, through 2010, by which time, according to Scott, would be achieved a real understanding of biological pathways – and a

systematic, annotated, accessible informatics understanding of it, with Incyte as the major creator of that understanding.

The beauty of a futuristic vision, of course, is that it doesn't have to be true. Legally, for instance, many futuristic pronouncements are qualified with disclaimers disowning the responsibility of the visionary to actualize the vision.[161]

Let alone legally, visions don't even have to be true to sell – Scott's talk was addressing simultaneously another audience, as much as or more than the strictly scientific audience: the audience of investors, who were clearly going to form their business judgments through events like this talk. For investors, of course, the sinking of money into such visions is risky. With genomics even more so, because it doesn't yet have many tangible drug products to show. But by selling his vision for the future, Scott can be assured of having money to go into that future, irrespective of what might actually be produced. If, as Johannes Fabian (1983) argues in *Time and the Other*, the anthropological study of spatial peripheries has tended to situate the subjects of such studies either explicitly or implicitly in a temporal past, then the study of spatial "super-centers" like genome conferences sees the subjects situating themselves in a temporal future.

I make two arguments that relate the generation of commercial value from genomics to necessary temporal lags. Firstly, in order to generate value in the present to make a certain kind of future possible, a vision of that future has to be sold, even if it is a vision that will never be realized. But simultaneously, in order to extend the life of that value into that relatively distant future of therapeutic product development, either ownership or publicness must be sought for the

[161] Disclaimers such as this one that was put out by Incyte while announcing a collaboration with the Huntsman Cancer Institute to study the role of genes in the diagnosis, treatment and prevention of cancer, which says: "Except for the historical information contained herein, the matters set forth in this press release, are forward-looking statements within the meaning of the "safe harbor" provisions of the Private Securities Litigation Reform Act of 1995. These forward-looking statements are subject to risks and uncertainties that may cause actual results to differ materially. For a discussion of factors that may cause results to differ, see Incyte's SEC reports, including its Quarterly Report on Form 10-Q for the quarter ended June 30, 1999. Incyte disclaims any intent or obligation to update these forward-looking statements". See www.incyte.com/news/1999/huntsman.html.

information in the present, and in the former case further tied in to the possible product of the future by asking for patent rights on the downstream products that might emerge from the information. The promises of genomics are statements of that which is yet-to-come, as opposed to that which will be; it is by virtue of creating such spectral futures that the reality of the present is created.

There is a tension between the notions of vision and promise, and the promissory visions of genomics straddle an uncomfortable dialectic between the two. A vision is participatory, a promise contractual. In other words, a vision is an exhortation on the part of the visionary to the listeners to participate in the realization of that vision (visions for newly independent countries, visions for self-reliant economies, visions for a world without war and so on). A promise on the other hand is an undertaking on the part of the speaker to a listener to perform certain activities and / or produce certain results – it is the speaker's duty to realize her promise. The realization of both promises and visions, however, is posited in terms of the act / outcome itself. Genomics however is peculiarly located. Its "ultimate" realization, personalized medicine, is purely in the realm of feasible imagination; the promise of genomics is not the creation of an improved version of an existing product, but of a revolutionary form of medicine, a revolution that extends not just to *medicines* (as products) but to the entire *practice* of medicine.[162] It is quite possible, therefore, for the realization of promissory visions *as effects in general* to function completely independently of their realization *as effects for the speaker* (in this case, the genome company).

The product of a genome company is the creation of (some form of) information that is in turn a condition of possibility for the creation of a drug. The conditions of its *own* possibility (and thereby the actual conditions of possibility of the drug) can only be created by the *performative* creation of the conditions of possibility of the drug i.e. through a vision. This is however a vision

[162] Which will even lead to a Foucauldian epistemic break in the way patients are categorized as medical subjects, in terms of variability rather than normality and pathology. See Chapter 8 for an elaboration of this argument.

whose realization is not communal, but is, in the first instance at least, the responsibility of the company. Further, while not contractual in a legal sense, this is a vision that functions as a direct plea to the investor to make possible its (possible) realization by investing capital in the company. This is why the promissory vision of the future creates the conditions of possibility for the existence of the company in the present. While this does not guarantee the realization of the vision in the future, it is a necessary condition for such a realization.

A guarantee is a vexed word as well. While the implicit guarantee of the promissory vision of the genome company is towards the investor investing capital in it ("we will realize your investment by enabling the creation of this product"), the performative of the vision is directed to a number of listeners and functions differently for each of them. The primary audience in the conference whom Randy Scott was addressing, for instance, was of scientists, who are interested in his visions from the perspective of enablement of their own research. The pharmaceutical companies, which are downstream to the genomics company, are particularly interested parties, since they are the actual realizers of the drug. For the general public, this is a vision in a much less immediately interested manner; for policymakers this interest manifests differently. The performative of the future, therefore, functions to create very different futures for the different concerned actors, irrespective of the actual future product that may (not) be produced.

There is also a slight but tangible difference that depends on whether the company making the investor pitch is a public or a private company. In the latter case (for instance, in the case of GeneEd, the e-learning start-up that was one of my ethnographic field-sites), the investors in question are often venture capitalists or other private investors; in the former case, it is Wall Street, and the public stock market, that is listening. The explicitly speculative nature of recent, especially technoscientific, capitalism, is indeed a function of the acknowledgement by Wall Street of the nature of the performative operation of the promissory statement: those public companies that are still years away from making a tangible product (usually biotech companies),

but that are driving their stock prices by virtue of promise alone (something that was particularly marked with genomics companies in 1999-2000) are referred to on Wall Street as story stocks.

But there was something else that was going on in Scott's talk, and that had to do with the symbolic capital of genomic information as information that is a precursor to therapy. There was this wonderful moment at the end of the Miami conference (in a party organized by Incyte) when Scott raised a toast, to "the genomic community. Because they aren't in genomics for themselves, they are in it for Life". Mirroring, indeed, Incyte's own logo, which is Genomics for Life™.

It is very evident that the production of value in genomics is to a large extent a discursive act, whether it be through advertising, the selling of futures or the rhetorical creation of *a* genomic community committed to Health. Even if it is indeed a single genomic community has as internal to its logic the existence of multiple competing actors all of whom try to propagate their particular brand and product at the expense of their competitors'.

What is evident is that active work gets performed, work that is variously discursive and performative, in the process of which the genomic community is created as a homogenous entity, but one that is simultaneously an *ethical* entity, an entity represented (and encompassed) by the Incyte logo, Genomics for Life™. It isn't just the subject within the genomics profession who gets in-formed at this moment; equally in-formed is the subject (as in discipline / endeavor / venture) *of* genomics and the corporate subject such as Incyte, as ethical subjects that are in the business of saving lives. Scott, in his many flashes of brilliant performance, establishes that the real goal that is at issue is saving lives; that genomics is the vehicle through which lives can be saved; and that the genomics community, led by the vanguard scientists at Incyte, merely exist for the purpose of fulfilling that vision. Genomics, in this performative, is not vocation, but calling. Scott's employees are not scientists but missionaries.

Further, the missionary zeal, at least in Scott's case, is not tied into some abstract utopian desire for Health, but is embedded and embodied by real stories of suffering. So that Scott

finished his talk with the perfect poignant story that speaks to the motto and vision of Genomics for Life™: a story of Scott's friend, recently diagnosed with cancer, who 10 years into the future could have been saved by genomics.

And at this perfectly poignant, perfectly appropriate moment, after a talk that was perfectly orchestrated, Randy Scott, Chairman and Chief Scientific Officer of Incyte Pharmaceuticals, broke down and cried.

Once again, making sense of this sort of performativity involves both suspending one's sense of cynicism and being wary of buying completely into the performance, of retaining, without being disrespectful, one's ability to be cynical. I do not want to be dismissive of Scott's pain here, but do want to emphasize the importance that Barry Werth places, in his story of Joshua Boger, on "strenuously rehearsed spontaneity" (98), a spontaneity that is central, in Werth's rendering, to the performativity of promissory story-telling by biotech entrepreneurs, even if it is a spontaneity that was perhaps, in this case, painfully unnecessary for Scott to rehearse.

"Ethics" in corporations, therefore, depends on social and rhetorical apparati, but also on individual figures and self-images. The ethical corporation is both a legal entity and a cultural ideal, and frequently an important idea for the participants in the corporation as much as the public at large. So to understand the idea of "ethical" corporations it is too simplistic to assume that "ethics" is only a badge of cultural legitimacy that the corporation manipulates: it also functions at the level of core beliefs and relationships for the participants in the corporation. We have to remember that "ethics" is always a way of naming or designating types of social and material relationships by the actors themselves, and to think that this is always done cynically is to blind ourselves to a lot of important ways that social power functions.

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I have talked so far of the promise(s) of genomics, as being the condition of enablement of a certain type of present. What however actually happens in the present, and how does the promise by its very nature create contradictions that make the present untenable simultaneously to making the present possible? There is a more directly historical way of posing the questions that I have already been trying to ask in this chapter: how does one explain stock prices in the hundreds of dollars for companies less than a decade old with no tangible therapeutic product even on the horizon in the dot com heydays of 1999-2000, and how does one explain the equally dramatic slump that sees those same stock prices operating sometimes in single digits today? The simple answer, of course, it to take recourse to that ultimate Agency, the market, and attribute the fall in biotech stocks to the general slump in the market. There is, I argue, a more complicated set of answers. The answer to the former question is what I have been trying to get at so far in the chapter, and is related to the political economy that hype works within and creates. Before moving on to the latter question, a little more history is needed to actually explain why it is that I feel that hand-waving "market" non-explanations are insufficient to understand the dynamics of the biotech industry between 1998 and 2001.

The simple fact is that the biotech industry has been experiencing cycles of boom and bust pretty much since its inception in the mid-to-late 70s, and these cycles of boom and bust have been morphologically highly akin to the dot com boom - reality check bust of the last three years. This similarity has much to do with the fact that biotech has played to highly inflated stocks in the past with no sign of a tangible product to show pretty much from the get-go, in the context of a larger economy that was much more conservative and that was much less willing to go along with the Silicon Valley mode of (apparent) high risk investment that has marked the dot com economy. The apparently irrational response to promise has in fact been the single factor that has enabled the existence and growth of an industry that would otherwise just not have been able to survive the extremely long periods of time and high amounts of investment required to bring

drugs to market. The realization that promise rather than pipelines could create enduring value started dawning as early as October 14, 1980, the day Genentech went public.

Genentech was not the first biotech company (Cetus Corporation was formed before it, so it was the second), but it was the first to go public. Founded in 1976, it spent its early years focusing on interferon research, as interferons were considered to be major candidates as anti-cancer drugs. The popular and business press at the time all regarded interferon research as one of the great hopes for cancer therapy.

The Genentech IPO was closed with 1 million shares at $35 each, an amount that exceeded all expectations, and an incredible amount for a company whose first product (insulin) didn't appear on the horizon until 1984. In the next 6 years after the Genentech IPO, another 19 biotech companies went public, and together raised $542.3 million through their IPOs (Cetus, which was the second biotech company to go public, alone raised $107 million). Clearly, therefore, promissory visions have been much more than just a feature of the biotech industry: they have enabled it to exist.

There is, however, a gap that is opened up at the very heart of this promise, and that is the gap between infinite promise and what has to be necessarily measured as inadequate in relation to the promise. So while the promise creates the conditions of possibility for the present, it also, necessarily, creates the conditions for its own unfulfilment, and the consequences of that. This gap mentioned above is the place of spectrality -- and of marketing / PR. In other words, really successful long term marketing / PR is not the articulation of vision, but the closure of the gap between what is envisioned and what is (inadequately) achieved. The economic bust in biotech (and its periodic cycles) have to be thus understood. There is a difference between a promise and a teleological design, and this difference is the gap opened up between promise and its realization. This is the gap where *events* occur, and where *politics* -- speed and tactics -- take over. If promissory visions have made the biotech industry possible, then they have also placed

the risk that attends all drug development -- in this case, the risk of not acting through on one's promise -- at the heart of the calculus of biotech. Werner Hamacher, in a brilliant reading of Derrida's reading of Marx (Hamacher 1999), points to this distinction between structures of messianic promissory articulation (and I will explore this messianism in greater detail later in the chapter) and teleological design. Reading the articulation of the former *as* the latter is a misreading, because telos has an *end*, whereas messianism is *without horizon* (see especially Hamacher 1999: 201 for an elaboration of this distinction). Even personalized medicine, that I have referred to, consciously in quotes, as an envisioned "end" of genomics, is in fact not an end at all but a strategic promissory horizon, just as the sequencing of the human genome was until the working draft sequence was generated in June 2000.

What I have described so far is what Hamacher refers to as "spectreality", which is a gesture towards the impossibility of separating the "real" from the "conjured", when the "real" *is* both conjured, and the "conjuration" is the condition of unfulfillment of the "real".

Let me return at this point to Anna Tsing's (2000) analysis of Bre-X and my analysis of vision in, especially, biotechnology, to see if it is possible to tease out subtle differences in which to begin to look for specific dynamics of biocapital. Tsing sees enterprises such as that of Bre-X as the confluence of three sets of scale-making projects: "the globe-making aspirations of finance capital, the nation-making coercions of franchise cronyism, and the region-making claims of frontier culture" (141). Indeed, "revolutions" in biotechnology, such as genomics, are precisely such scale-making projects, and include further the knowledge-making aspirations of technoscience, which is a significant scale-making project with profound consequences for what gets accepted as "fact". However, when biotechnologies such as, but not limited to, genomics, are situated in the context of a larger drug development marketplace that is, if enthusiastic, then certainly so with a certain amount of inertia and skepticism about modes of therapeutic development that are relatively untested and that compete with traditional (and traditionally

extremely successful) organic chemical synthetic methods, then one comes up against what I have already argued is the fundamental market terrain of drug development, which is the relatively vulnerable position that biotechnology companies are in with respect to big pharmaceutical companies. Therefore, while *on the one hand*, the conjuration of new revolutionary biotechnologies such as genomics is all about scale-making, *on the other hand*, it is, for the concerned actors, often so when what is at stake, otherwise, is their own survival. The structural contradictions inherent to the biocapitalist marketplace ensure that *the only way to exist, as a biotechnology company, is to conjure scale-making revolutionary futures*. There is no alternative, for a biotechnology company (as opposed to a big pharmaceutical company), to what Tsing calls "spectacular accumulation" (which she defines [141] as that which "occurs when investors speculate on a product that may or may not exist").

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Let me then ask three sets of questions that I have alluded to in this chapter so far.

The first has to do with a statement by Derrida that speculation is always theoretical *and* theological. It is perhaps not insignificant to the story of Randy Scott that he is an evangelical Christian. But I am not indicating this with a wish to attribute motives -- I am *not* saying that Scott is a good genome entrepreneur because he is a good Christian. Rather, I am arguing for a natural co-habitation of discourses, the visionary discourses of corporate bioscience being from the get-go morphologically akin to messianic discourses (for the operation of discourse in messianic movements, see Susan Harding's [2000] work on born-again Christians). Scott's ability to co-habit the two worlds of science and religion clearly allow him to use the discourse particularly well. Biotechnology, therefore, occupies a messianic space, of technology and of Life linked through capital, which becomes, naturally, the object mediating fetishization (and I will explore this space in greater detail in the next chapter).

Indeed, this messianic space is a structural part of the biotech industry, and has to do with much more than Scott's Christianity or lack thereof. This is evidenced in Barry Werth's description of Joshua Boger, founder of Vertex Pharmaceuticals and Jewish, in his history of that company *The Billion Dollar Molecule.* Below is an extract from Werth's account of Boger's pitch to investors, and how that pitch is always already positioned from the get-go as a religious and salvationary project:

> Boger knew that stories have to be accessible and that what investors want most from them is affirmation, so he molded Vertex's slide show not as a disquisition on science or business strategy, but as a quest. The grail – the object of the quest – was structure-based design and its transcendent prize of safer, smarter, more profitable drugs. The impetus, as always in such stories, was a combination of righteousness and greed. (Werth 1994: 96).

Nonetheless, the salvationary-cum-profitable structure of this performative discourse was undergirded and overdetermined by Boger's own background and attributes, just as Scott's Christianity is not determining, but definitely significant, for the types of stories he tells and the ways in which he conjures up futures as scripted by Incyte. As Werth proceeds:

> That was the text. There were also subtexts that Boger didn't mention, the most intriguing being about himself. Boger never referred in his slides to his relationship with Merck [where he had formerly been an employee before starting up Vertex], but he was seldom introduced anywhere without it being mentioned. To listeners with a knowledge of the drug industry, his defection was the most tantalizing part of Vertex's story, introducing, as it did, a whiff of patricidal intent, of vengeance. Here was Boger, a scion of America's Most Admired Corporation, the most productive drug company in history, Wall Street's gold standard, rejecting all that it had to offer because he thought he could do better. It didn't take a rereading of Genesis: Boger's saga of defiant departure was as old as Adam. (96-97).

The second question has to do with risk. Personalized medicine, more explicitly than other type of biotechnology, sees the intertwining of two notions of risk, one put forward by Francois Ewald (who sees risk as capital) and the other put forward by Robert Castel (who looks at patient subjectivities as they get molded by risk profiling). Individualized therapy is inherently about individual risk profiles of future illness and therapeutic intervention. Therefore the biotech / pharma company's risk of huge capital investment towards a product that might not be realized is directly in play with the ultimate patient-consumer's risk of future probable illness. The rationale of personalized medicine – indeed, of biocapital -- is fundamentally an outcome of this intertwining (I explore this in greater detail in the Chapter 8). Indeed, risk is, as Pat O'Malley argues, a way of governing through the future (O'Malley 2000).

The third has to do with credibility. I have argued elsewhere how in genomics the "classical" scientific binaries of truth and falsity are *articulated* with those of efficiency and inefficiency, justice and injustice – articulations of non-economic forms of socio-moral values that the sociology of science in its earlier Mertonian guise regarded as separate. But it could indeed be argued that in the rhetoric of biocapital, truth and falsity themselves have no meaning -- even if science is about truth and falsity, corporate PR is rather about credibility and incredibility. A triangulation could therefore be made for the contemporary biotechnology corporation, in which speed still mediates the linkage of efficiency and inefficiency to virtue or its lack, but it is credibility rather than truth that is the "ultimate" aim to start with. At some fundamental level, it doesn't *matter* whether the promissory visions of genomics are true or not, as long as they are credible.

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The relationship between credibility and truth, and the place this relationship occupies in biocapitalist visionary practices, is important to explore further. Visionary technoscientific practice is the act of fabricating the truth, which does *not* equate to fabricating a lie. In order to

understand this point further, it is worthwhile to focus on one of the classic discursive apparati of contemporary capitalism, the forward-looking statement.

A forward-looking statement is defined as:

A. a statement containing a projection of revenues, income (including income loss), earnings (including earnings loss) per share, capital expenditures, dividends, capital structure, or other financial items;

B. a statement of the plans and objectives of management for future operations, including plans or objectives relating to the products or services of the issuer;

C. a statement of future economic performance, including any such statement contained in a discussion and analysis of financial condition by the management or in the results of operations included pursuant to the rules and regulations of the Commission;

D. any statement of the assumptions underlying or relating to any statement described in subparagraph (A), (B), or (C);

E. any report issued by an outside reviewer retained by an issuer, to the extent that the report assesses a forward-looking statement made by the issuer; or

F. a statement containing a projection or estimate of such other items as may be specified by rule or regulation of the Commission.[163]

Under Section 27A of the US Securities Act of 1933, there is a provision of a "safe harbor" for forward-looking statements, which means that the issuers of such statements (usually corporate investor relations departments) are not liable in case of the failure to fulfill any promises or predictions made within the statement. It is immediately evident from the Act however that a failure to fulfill a promise or prediction does not constitute a lie, to the extent that a lie, indicating intent, might be indicative of fraudulent behavior. Indeed, the safe harbor

provision is not available to issuers who have committed certain felonies or misdemeanors such as false reports, bribery, perjury, burglary, forgery, counterfeiting, fraudulent concealment, embezzlement, fraudulent conversion, or misappropriation of funds or securities:[164] all of which might be said to be acts of lying. What sort of not-truth (as opposed to untruth), then, is a forward-looking statement? For that, I will turn to an example of such a statement, that I quoted in an earlier footnote, which was put out by Incyte while announcing a collaboration with the Huntsman Cancer Institute to study the role of genes in the diagnosis, treatment and prevention of cancer. This says: "Except for the historical information contained herein, the matters set forth in this press release, are forward-looking statements within the meaning of the 'safe harbor' provisions of the Private Securities Litigation Reform Act of 1995. These forward-looking statements are subject to risks and uncertainties that may cause actual results to differ materially. For a discussion of factors that may cause results to differ, see Incyte's SEC reports, including its Quarterly Report on Form 10-Q for the quarter ended June 30, 1999. Incyte disclaims any intent or obligation to update these forward-looking statements".[165]

The truth ingrained within the forward-looking statement is the implicit statement on the part of the issuer that "I will not have lied, and that is the truth". In other words, regardless of the outcome of Incyte's collaboration with the Huntsman Cancer Institute, Incyte would not have *defrauded* its readers with its promises – even if some of those readers might have invested in Incyte as a consequence of expectations raised by those very promises. And yet, making a promise that one does not fulfill would, in a general cultural conception, constitute a lie. What the forward-looking statement formalizes is the fact that, as Derrida points out, it is impossible to locate an unfulfilled promise *as* a lie even as it is always perceived – even perhaps accepted – as a non-truth. In that sense, a forward-looking statement quite nicely fits in with Derrida's

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[163] As per Section 27A of the US Securities Act of 1933, available online at http://www.sec.gov/divisions/corpfin/33act/sect27a.htm

[164] As per Section 15B of the US Securities Exchange Act of 1934, available online at http://www.sec.gov/divisions/corpfin/34act/sect15.htm#b

formalization of the popular cultural conception of the lie. He says, "for structural reasons...it will always be impossible to prove, in the strict sense, that someone has lied even if one can prove that he or she did not tell the truth" (Derrida 2001 [1995]: 68).

The tension of venture science, then, is the tension between the "lie" of corporate PR and the "truth" of science; where corporate PR "will not have been a lie", and science is *authoritative* as truth when its statement attains facticity. This tension becomes even more acute when facticity is accorded *inherent* truth (inherent both as in essential to the statement, but also, when the facticity concerned has to do with knowledge about "life itself", then inherent as in essential to the self that gets constituted by the "true" fact). This is of particular importance in understanding the constitution of subjectivity by genomics (as always already venture science), that I explore in Chapter 8.

What then is the truth of venture science, as opposed to the truth of Mertonian science? It is that *the truth lies somewhere*, "lying" here meaning both existing and being the thing that is not the truth: the truth of venture science, from the get-go, is under erasure, it is ~~truth~~. But this ~~truth~~, which is *not a lie*, is also *not an error*.[166] If a lie could be said to be an intentional falsehood, then an error might be said to be an unintentional mistake, a failure to calculate adequately the uncertain circumstances that might lead a promissory statement to "not pan out". A forward-looking venture-scientific statement cannot be a failure to calculate correctly, because the futures it promises are precisely *incalculable* (and therefore it becomes even more important to calculate them). Neither is this ~~truth~~ an error in the Canguilhemian sense, as pathological (in the sense of being in opposition to the norm. (See Canguilhem 1989 [1966]), in this case as deviant from the Mertonian norm: because, in venture science, the Mertonian norms are not *violated*, they simply are *not*.[167]

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[165] Available online at www.incyte.com/news/1999/huntsman.html.
[166] Derrida talks about the lie as distinct from error in "History of the Lie". See Derrida 2001 (1995).
[167] See Merton (1942) for his exposition of the normative structure of science.

What constitutes a venture-scientific statement is itself a question, since it is not the formalized scientific statement that goes on to constitute "fact": indeed, it could be argued that scientific facts do remain the same, regardless of where they are produced. I am not arguing that corporations produce different scientific facts from academic labs; I am arguing that the sorts of scientific ventures that get undertaken in the first place change, that the agenda of scientific practice changes as it becomes venture science, and this changed agenda has everything to do with the sorts of *non*-scientific ~~truth~~-claims that constitute corporate public relations and investor relations. Therefore, corporations, like academic labs, can produce erroneous scientific "facts" (those that get falsified subsequently and at that point stop operating as facts), independent of the context of the production of ~~truth~~-claims through which they operate.

There is a question of temporality that resides in the relationship of a lie, or of a ~~truth~~, to error. In the case of the ~~truth~~, the statement precedes, and indeed often performs or conjures, the event (or fails to do so); in the case of the error, the event (such as, for instance, the result of a genetic test) leads to a statement that then assumes facticity. While in this chapter I am predominantly concerned with the former, in Chapter 8 I concern myself with the latter. As I have been arguing until this point, venture science is constituted by the dialectic between the ~~truth~~ – truth that is always under erasure, and that pertains primarily to formally non-scientific articulations that create the conditions of possibility for science to occur (such as the existence of the company, and capital, in the first place) – and fact, which *may* be erroneous (in this case, erroneous refers to incorrectness, as opposed to abnormal deviance – so that a genetic test that *shows* error: abnormal deviance: need not be erroneous, though it might be [the false positive]) on occasion, but doesn't have to be. Regardless of the particular error that may or may not occur, however, fact operates on the fact that it is, authoritatively, true.

In other words, in venture science, the operation of ~~truth~~ provides the grounds for the production and operation of facts. *This former operation* – which is basically the act of selling

promissory futures in order to create the present that enables one to go into those futures – *does not need to take place in Mertonian science.* This is the distinctiveness of venture science, and the politics – utopian, dystopian, productive, regressive, liberatory, repressive – that may or may not stem from venture science, and that I engage with at different moments in this thesis, are a consequence of this distinctiveness. The facts produced may be erroneous (as in incorrect), and they may correctly point to error (as in deviance); they may, indeed, erroneously point to error (the false positive). But it is the operation of ~~truth~~, not the operation of facts, that conjures the biocapitalist political terrain within which facts operate.

Why, then, is ~~truth~~-saying important beyond performativity? I turn here once again to some ethnography to begin an answer to this question.

As mentioned in Chapter 2, the co-founder of GeneEd and its Chief Scientific Officer (CSO), Salil Patel, shows an almost naively Mertonian adherence to and belief in the truth of science, a belief that sits in some tension with his role as manager of a start-up company that has to improvise and be flexible with its discourses, albeit without ever explicitly lying. This tension, however, is not as acute as the tension Patel felt in his earlier company, in which he was an employee who managed some of that company's gene therapy projects. One of the reasons Patel decided to take the risk of leaving a secure corporate job to found a start-up was indeed because of the disillusionment he felt with his former company's mode of functioning. He recounted the causes of this disillusionment to me twice, on different occasions, and each of those renderings was slightly, and interestingly, different from the other.

The first time Patel told me about his disillusionment, he mentioned how he was asked to manage one of the company's flagship gene therapy projects with a meager staff and few resources. After a number of attempts, it was clear to Patel that the project was floundering, and he suggested to the company that they drop it. The company listened to his recommendation, but shortly therafter put out a press release detailing their rapid advancements towards gene therapy,

using as examples the types of seriously troubled projects such as Patel's that they were actually deciding not to pursue further. Expectedly, the company's stock prices soared as a consequence of their promising statements. Patel, however, felt, at least in this rendering, that the company was lying, and he was deeply troubled by this. Indeed, that he couldn't quite escape this mode of "lying" (in Patel's sense; ~~truth~~ as I have been arguing for it) at GeneEd, in spite of his own best intentions to be "honest" (thereby also suggesting how this form of ~~truth~~-telling is a structural part of contemporary high-tech capitalism), was made quite clear on at least a couple of instances: once, when Patel admitted that he knew that at least one of the custom e-learning courses GeneEd was building for one of their clients (a course that as chief content editor in the company he had a significant hand in designing) had "lies" in it; and again, on the occasion of a six-monthly reception that GeneEd threw for its investors, where they made a pitch about their current situation and promised an exciting future, and where again Patel felt squeamish about the fact that such pitches weren't entirely "truthful". In fact, Patel felt uncomfortable about aspects of the pitch that couldn't possibly be truthful, such as sales forecasts, which are precisely that: forecasts, based on reasonable intuition, necessarily subjective and subject to all sorts of contingencies that could lead to outcomes radically different from those forecast. In other words, even calculating what is essentially incalculable had, for Patel, the manifestations of a "lie", with the same moral connotations that lying intentionally in a scientific paper would have.

And yet, the second time he told me about his disillusionment with his former company, he easily slipped into a more pragmatic, and typical, mode, saying that he had no problems with untrue press releases, as long as companies don't publish false data in scientific papers. In this rendering, Patel was acknowledging that even intentional and deliberate untruths (since a press release of the nature Patel was referring to referred to past events rather than to future incalculable events) in certain discursive spaces that accepted those untruths within certain limits

as a part of the rules of the game could not be equated with a lie, which is what scientific fraud would constitute.

This is precisely the conflict between Patel the "scientist" and Patel the "business-person", subjectivities that increasingly get conflated as venture science gets naturalized, but that are not at all unique to Patel. Indeed, Barry Werth recounts in great detail precisely such conflicts amongst many of the early management of Vertex Pharmaceuticals in *The Billion Dollar Molecule*. Therefore, on the one hand, it is important to tease out the different categories of the performative discourse of the truth, which is what Derrida does in "History of the Lie" (Derrida 2001 [1995]). On the other hand, it is important to simultaneously stay attentive to the institutional groundings from which such discourses emanate and within which they operate, especially when, as in the case of venture science, the germ of conflicts of interest are inherent in them from the get-go. The notion of conflict of interest, a normative notion that draws attention to the possibility of non-truth emanating as a consequence of the institutional space from which statements might emanate, is indeed one that has for many years, as a good Mertonian watchdog, been a wedge that has allowed a certain mode of truth accountability to operate in technocorporate discourse. It is one of the norms that are at stake as venture science gets naturalized.[168]

I am, therefore, specifying the importance of staying attentive to conflicts of interest as an *ethical* notion, not in the terms of ethics as moral discourse, but in terms of specific contradictions within the social relations of production that produce these discourses. In this sense, I am echoing the position that Marx adopts in *The German Ideology* (Marx 1963 [1845]), where he argues that

[168] Indeed, as I argued while talking about estimates for clinical trials costs in Chapter 3, the failure to take DiMasi et al. to task for the obvious conflict of interest in generating figures regarding the cost of drug development solely figures provided by the industry, which has an interest in over-reporting these costs, has significant consequences for the naturalization of the "fact" that bringing a new drug to market costs between $500-800 million.

ethical political positions – positions that regard philosophy as praxis – must emanate not from the realm of ideology, but from the material relations of production that shape political terrains.

The next question to ask is: what, if anything, is specific to biocapitalism in my analysis of promise thus far? I think this is where a distinction between technology and science becomes important, a distinction that has famously, and for generally good reasons, been imploded by Bruno Latour in his coining of the phrase technoscience. The fact however is that *science*, at least in a Mertonian conception that now, because of its normative content as it pertains to specific relations of production, suddenly seems important to hold onto even as its existence seems an impossibility, is explicitly about the production of facts. What is specific then is that biotech / drug development depends, in its very structure, upon some notion of (presently unpredictable) *discovery* in the future. Drug development is an enterprise, industrialized and corporatized, that necessarily depends upon activities of fact production, and depends upon activities of *fact* production: for successful drug development ventures to happen, effective discovery is critical (see Chapter 3 for a discussion of the clear distinction between drug discovery and drug development phases in bringing a therapeutic molecule to market). The phase during which the discovery process is industrialized and made into a technology (and again, I use technology here not in the rigid positivist sense that STS authors such as Latour or Haraway would reject, but as something that is qualitatively distinct from the fact producing enterprise of drug discovery) is the clinical trial. Clinical trials operate in a realm of industrial calculation that is quite distinct from the much more intuitive and unpredictable, yet more factual, phase of discovery.

In terms then of working towards a typology of truth-like statements in drug discovery and development, one could talk about promise, that operates both in the interactions of companies with investors and in the public relations apparatus of companies; about fact, that operates during discovery; and about *evidence*, which is what clinical trials produce, and which necessarily has associated with it notions of regulation and expert mediation (in the case of US-

based clinical trials, by regulators at the Food and Drug Administration [FDA]). Each of these constitute a different type of ~~truth~~ producing enterprise that collectively constitute biocapitalist corporate envisioning. Further, the enterprises that produce fact, evidence and PR are completely intertwined. One could quote Nietzsche as being remarkably prescient when he says "It might even be possible that *what* constitutes the value of those good and honored things [could we here think of Mertonian science as one such good and honored thing?] resides precisely in their being artfully related, knotted and crocheted to these wicked, apparently antithetical things [the "lie" of PR, in this case?], perhaps even in their being essentially identical with them" (Nietzsche 1973 [1886]: 16). This is why dismissing hype as "simply cynical", a mode of dismissal that is fundamentally what I am writing against in this chapter, is not a fruitful way of understanding the mechanisms of its operation: attributions of cynicism serve to erect a simple binary between the truth and the lie (hype always being somehow associated, not just typologically but normatively with the latter), a binary that just does not serve to understand the ways in which the truth and the lie are co-constituted, as different types of ~~truth~~.

There is another reason why dismissing hype, or corporate PR, or corporate PR as hype, as simply being cynical, effects erasures in understanding the terrains from which statements, actions, ethics, effects and affects get produced. And that is that while the ~~truth~~ of PR *might* be cynically manipulated from the get-go (one cannot say that hype is *not* cynical when one says that hype is not *just* about cynicism), it *might* equally be a sign of innocence, a faith in other systems of ethical evaluation that don't simply operate in terms of the truthfulness of statements. As Nietzsche says, "There is an innocence in lying which is the sign of good faith in a cause" (Nietzsche 1973 [1886]: 88).

Therefore, one could understand Patel's ~~truths~~ / "lies" as CSO of GeneEd in terms not of cynicism but of an innocent adherence to ethical frameworks that sometimes operate antithetically to frameworks that simply legitimate and normativize truth. In the case of the

company for which Patel produced a course knowing that it had what he called "lies" (what might perhaps more accurately termed factual inaccuracies?) in it, what Patel was actually doing was providing a service: his mandate to his customer was to design a custom course to the customer's specifications, and he felt obliged, even to the point of countenancing "lies" in the content that he created, of *not* ruling in the content. In this case, he was reflecting GeneEd's role as a *custom* content provider, where the focus is on providing *customized* (and customer-focused) solutions rather than on the scientific *content*, which becomes much more central in the in-house catalog courses that GeneEd develops, that are more strictly "educational", "factual" and "scientific". The fact that these catalog courses are not the source of sustainable business value for GeneEd in the way that custom courses are, of course, is a fact worth noting. This is at the heart of the tension, introduced in Chapter 2 when I first wrote about GeneEd, of its contradictory roles as an "education" versus an "advertising" company – it has found that it is hard for it be purely in the business of education and still be a company.

Further, in the case of the investor pitch, riddled with sales forecasts that troubled Patel as not being truthful (even though they couldn't possibly be), the fact that he still was part of the team that constructed and articulated the pitch – that he completely inhabits and is productive from within the structures of contradiction that he feels so ambivalent about – is not just a reflection of pragmatism, but also a reflection of his commitment to the GeneEd cause, of his willingness to be a "team player", even at the expense of some moral squeamishness. I am not saying here that it is more important to be loyal to one's company than to tell the truth; what I do want to mention, however, is that what is at stake is not just competing normativities or moralities, but completing moralities that are completely conditioned by the situation within which they are evaluated. Therefore, the investors to which Patel was pitching the ~~truth~~ were *fundamentally, at that moment, evaluating the cohesion of GeneEd's management team* (I learnt this from subsequent conversations with the investors, so this isn't merely conjecture), which

means Patel's willingness to make a pitch that he might be squeamish about is *precisely* what would reassure his investors that their money was being soundly invested. A more "honest" willingness on Patel's part to admit to doubt and uncertainty, on the other hand, would have troubled the investors that their investments were not just errors of their judgement, but a misplaced faith in the management team in whom they had reposed their trust to work for a common cause. Telling the "truth" (and what, indeed, could the truth have been, except an admission of a fact known to everybody, that sales cannot be forecast in any completely objective manner?), in such a situation, would not just have been poor pragmatics on Patel's part, *it would have been an abdication of the investors' trust in him as an entrepreneur and manager they have invested in.*

When the "lie" comes from a larger company with enough of a division of labor to have its own ~~truth~~-producing divisions (such as public relations or investor relations), of course, cynicism becomes a more explicit part of the calculation. Such departments, as in Patel's old company, are after all in the business not just of projections, and certainly not of designing customer solutions, but also of writing up past and present events, into documents such as press releases or annual reports. Therefore along with a typology of the ~~truth~~ful statement needs always to be a typology of the institutional groundings from which such statements emanate.

The company that perhaps most epitomizes a venture science approach to its business, and therefore epitomizes the constant game of future perfect / present tense that I discuss in this chapter is Millennium Pharmaceuticals, which indeed calls itself the "Biopharmaceutical Company of the Future". An example of their promissory envisioning can be seen in the pitches they make for one of their major subsidiaries, Millennium Predictive Medicine (MPMx). Millennium's predictive medicine strategy consists of pharmacogenomics and what it calls Diagnomics™ (which is basically genomic-based diagnostic testing), about both of which I will elaborate upon in Chapter 8. MPMx's major initial therapeutic focus is in oncology, and their oncology promises fit perfectly into the promissory rhetoric of venture science. Reading Millennium

web sites, press releases and annual reports, one could be excused for thinking that they are *the* revolutionary force in predictive medicine, that no one really does what they do to such an ambitious extent, and that they are at the very least the upstream market leaders in oncology. Whether these are "true" or not (or even whether the "truth" of such statements that are always-already forward-looking as they are boasts about current or past achievements is relevant) is, as I have argued above, not the point. Indeed, it is certainly true that Millennium is amongst the most ambitious of the biotech companies that have at one point or another used (or continue to use) genomics as the center-piece of their R & D and business efforts. And yet, three of the major upstream advances in the field of cancer therapeutics -- all of which, at some level, are based in genomics -- have come from companies that have not classified themselves as explicitly as "genome" companies (I refer here to herceptin [Genentech], gleevec [Novartis] and the tailoring of tamoxifen because of the discovery of the BRCA genes by Myriad). Millennium, in its ability to sell itself as a market leader in spite of not having such spectacular diagnostic or therapeutic products on the market, epitomizes how promise alone, if made strategically, can be driver of (at least provisional) success.

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6.2: Entrepreneurial and Investor Envisioning

In the first part of this chapter, I have talked about the broader structural terrain of envisioning within which biocapital operates. In the process, I have drawn upon stories of Randy Scott and Joshua Boger, both founders of start-up biotechnology companies that have now become relatively established biotech players. As companies grow, of course, the identity of the company starts asserting itself independently of the identity of its founder, identities that are often collapsed during the earliest stages of the start-up. In this section, I hone in on the particular start-up dynamics in which the founder-entrepreneur, and often the venture capitalist, play key roles, in order to articulate the types of envisioning that operate in this key sub-terrain of the biocapitalist enterprise.

I will start doing so by focusing on the story of a start-up company that is neither a genomics company, nor a venture capital funded one, GeneEd. I had outlined a brief history of the emergence of GeneEd in Chapter 2, and talked about them in greater detail in context of changing labor practices and relationships in Chapter 4. Without therefore going into those stories in great detail again, I will move towards a deeper analysis of starting up a company, and a role that vision plays in such a venture. GeneEd, in spite of itself not being a genomics / biotech company, is absolutely central to the stories of biocapitalism that I tell, because their customers are both upstream biotech and downstream pharmaceutical companies, and this differentiated customer base that is based on the market terrain of drug development is definitely significant to the story of GeneEd as a company.

The CEO of GeneEd, Sunil Maulik, has many things to say about vision, and one of the first is that being visionary is being inter-disciplinary in a profound sense, of not just allowing different disciplines and perspectives to cohabit in some bland acknowledgment of mutual tolerance, but in the sense of actually putting what might be considered incompatible regimes of knowledge, and their practitioners, into the same enterprise, where the very success of that enterprise depends on these various forms of knowledge articulating in productive, and often unpredictable, new ways.[169] Secondly, for Maulik being visionary involves *not* recharting paths that have already been tread. He says: "As a person, the type of company I would want to start

[169] Needless to say, I feel there are profound lessons here for purported inter-disciplines like STS, which often ends up, in academic spaces such as STS Departments, being a carefully negotiated multi-discipline, with great care taken *not* to brainstorm across disciplinary preserves so that each component discipline's "sanctity" can be "respected", and a certain amount of peaceful co-existence maintained. The productivity of corporate spaces such as start-ups, and new technoscientific endeavors, such as bioinformatics, comes precisely from the willingness to take the risk of encroaching upon another's disciplinary turf, and thereby creating the conditions of possibility for new forms of knowledge, strategy and co-habitation to emerge. The parallels of multi-disciplinarity to the now highly problematized notion and practice of multi-culturalism, that allows, in the name of political correctness, an *unreflexive* co-existence of different cultural and religious beliefs and practices and their institutionalization, without adequately posing the "thick" questions of the historical genesis and political embeddedness of these "cultural forms", and further reifying the individual "cultural" components of a multi-cultural assemblage into homogenous entities, need to be further paid attention to. Perhaps corporate technoscience can provide some salutary lessons for progressive praxis after all.

wouldn't have been a nuts-and-bolts company, it wouldn't have been a 'they are making clones, let's make clones. They're sequencing the genome, let's sequence the genome'. It was a company that was going to do what nobody had done before".[170]

On the one hand, this points to a contrast with, for instance, many big pharmaceutical companies that increasingly are in the business of generating "me-too" drugs (either new versions of drugs that are already on the market, or drugs for indications that are already treatable by existing drugs), that precisely do *not* operate the same visionary terrain as smaller more supple companies do, and avoid doing so at least partly, as I have argued in Chapter 3, because of their size, and a consequent division of labor that leads to a certain constitutive management inertia. On the other hand, this points to a certain recognition of what Deleuze might call a line of flight, that is not just reflective of start-ups compared to big corporations, but also of scientists who choose their research projects for specific reasons. This question of vision, as articulated *as* a certain kind of risk taking in search of a new frontier or horizon, which is actually, in an ironic sense, a form of risk *minimization* by finding a niche that isn't already encroached upon by much more powerful competitors, is equally central to the calculus of S.K. Brahmachari, the head of India's flagship public genome center, the Centre for Biochemical Technology (CBT), that I have discussed at some length in Chapter 5. Indeed, this particular form of almost forced envisioning, as a way of dealing with a distinctly marginal and vulnerable position in a hugely stratified political terrain, has to do with, in Maulik's case, negotiating a space of sustainable operation for a start-up that avoids having to compete with well entrenched and more powerful existing corporations, and in Brahmachari's case, of negotiation of a global power terrain where it is extremely hard for an Indian basic research laboratory to do cutting-edge science without thereby coming into direct competition with more networked, resource-rich, Western labs. Brahmachari, therefore, echoes Maulik's sentiments above, but in a way that is more reflective of the

[170] Sunil Maulik, interview with the author, 15 May 2001.

constraints of power inequities that drive certain visionary articulations, that force a kind of strategic creativity that perhaps isn't necessary for those who do not occupy positions of such strategic vulnerability. So on the *one* hand, like Maulik, Brahmachari articulates his desire to study areas that aren't heavily researched already in terms of a certain inherent drive to be on the frontiers of knowledge production rather than simply be mimetic of others' efforts: "So my early learning was, think of research problems in this way – don't go to the library, read others' work, and start thinking what can I do? Think, what can be done? What resources you have? Then go and check in the library whether already somebody has done it or not. You follow? Scientists will rush to the libraries on Thursdays. So we said new ideas used to come Thursday evenings. Which means all new ideas must generate after reading somebody else's article".[171]

On the *other* hand, there is a strategic rationale that stems from a position of marginality that underlies this desire to do visionary, cutting-edge science that no one has done before. In Brahmachari's case, this uncharted work has been to study the functional significance of repetitive DNA sequences, and other unusual DNA structures, with the former at least being written off, with little evidence, by even respected Western scientists as being part of "junk" DNA because they don't occur in regions that code for proteins. Brahmachari: "I was already looking for opportunities where a niche can be created.... Now, Francis Crick and all those had published papers saying [DNA] repeat [sequence] has no function, that no American funds will be available for repetitive sequence. So no publication. If I can do, I publish. So I have a niche cut out to work on repeats. And this was a wonderful niche till 2000 genome showed repeat is more important. Repeats are useful as markers, and functional understanding of repeats becomes very challenging".[172] Of course, the contradiction of this type of frontier visionary practice is that, while on the one hand, it provides an uncharted and therefore less competitive niche, on the other it makes such enterprises extremely risky. Further, the "success", in some way, of a visionary

[171] S.K. Brahmachari, interview with the author, 19 January 2002.

hunch such as this virtually ensures that stronger competitors will eventually come to share the vision, which means that the niche gets lost. Effectively, selecting an uncharted market niche or an uncharted scientific route, when successful, affords to the visionary what, in venture capital parlance, gets referred to as "first mover advantage". But the sign of a successful creation of a visionary niche is that it will remain a niche no longer. While Brahmachari can feel justified when the working draft sequence of the human genome starts showing the functional importance of repeat sequences that he has argued for for so long, it also signifies, in some sense, the end of his competitive advantage in that area of research.

Therefore, having the vision to do something that hasn't been attempted before is not sufficient to ensure a successful enterprise. Maulik goes on to argue for *evangelism* as a third component of vision (and I talk about this at greater length in Chapter 7):

> Because a company is visionary...it does not make a business a success. In fact some people are going to argue that it almost ensures business failure because it is hoisting something new into a business climate. So not only do you have to convince people to buy your product, you have to convince people that the product is worth buying in the first place. So in a sense you're attempting to answer a question that nobody has thought of asking you. So first you have to convince them that there is a question worthy of answering, and then you have to convince them that you're worthy of answering it using your particular product or service. And in that sense, what GeneEd is doing, e-learning, is I think a bit of evangelism and missionary selling. First you have to convince them that they have the problem and then you have to convince them that you are the only company who can solve their problem. That leads to the other side of vision which is that visionary companies have a certain cult-like image attached to them, and there's a certain degree of brainwashing attached to the idea of vision, and it is that you create the market by basically...by not just the force of one person's personality but by the force of a group

[172] Ibid.

> personality which you try to foster and create and build, and then you find the champions of the industry and people who can mouth the same words. So after a while it becomes a self-sustaining entity and then you've got this culture, this sort of drum beating of people, "this is the next way", "this is the next way", "this is the next way".[173]

Vision, in this third conception of Maulik's, is ideology, in a manner very similar to that in which Marx's conceives of religion as ideology in *The German Ideology*. But fourthly, Maulik compares it to a set of *guiding principles*, "a set of principles that are far-fetched but not too far-fetched that people can't believe in them if they stretched their minds sufficiently".[174] Vision, then, serves simultaneously as imagination and as prescription, as an ambitious statement that says, "we're going to draw a line in the sand, we're going to do something nobody has ever done before, it's going to be a mission, it would be crossing the Sahara with one bag of water",[175] but that implicitly indicates to those who have a stake in the realization of the vision *how* it might be that this improbable goal will be reached. It is in this sense that vision, in the way Maulik articulates it, is different from hype.

Integral to such an understanding of vision, of course, is vanguard leadership that is charismatic in the Weberian sense, and that is, further, embedded in life stories. It is in this context that the stories of Randy Scott and Joshua Boger that I recounted in the previous section are absolutely vital to generating thick understandings of the functioning of vision.

The question of the *distinction* of vision from hype is one that I have problematized in the previous section, by referring to hype as a type of promissory visionary articulation that allows the conjuration of certain types of futures in order to create the conditions of possibility of presents that allow those futures to materialize. And yet, in Silicon Valley, in 2001 and 2002, the distinction between hype and vision is acutely made manifest by entrepreneurs like Maulik,

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[173] Sunil Maulik, interview with the author, 15 May 2001.
[174] *Ibid.*
[175] *Ibid.*

where the former refers to that unsubtantiated, dematerialized and somehow *false* conjuration that was epitomized by the dot com era – an "era" that is now, already, spoken of in firm historical terms as an "aberration" by the same people who, no doubt, were extolling its invincible capacity for continued growth, revolution, creating paradigm shifts and so on just a couple of years previously.[176]

There is no question, however, that this is a distinction that is of some importance to GeneEd, which resisted calling itself GeneEd.com, a resistance which probably protected against its obsolescence with the receding dot com wave. At least a part of the reason why GeneEd wasn't caught in the dot com frenzy was that it really was conceived of in a pre-dot com era, having been incorporated in 1997. It effectively therefore incubated through the dot com years, lacking, as I outlined in Chapter 2, sufficient "activation energy" to transform into a real company, but also somewhat befuddled by the dot com goings on around it. As Maulik says:

> Part of the reason GeneEd had such a long incubation period was that none of us was really comfortable to really take that leap. The other part of it was [19]98-99 were two years when this extraordinary ferment was going on all around us, this internet boom, dot com hysteria, and it did have an effect on us in the sense that we were no longer sure if having this hard, well thought out, well defined business plan that called for so much market penetration and so much revenues and so much time with so many products with so many people made sense anymore. A lot of supposedly very smart people were telling us it made no sense. They said why are you setting this up, create a large database instead...you know, things like that, like do not worry about revenues, use advertising

[176] The question of whether the dot com era was indeed something that can so easily be dismissed away as an "aberration" is, of course, an important one to ask. For indeed, such a dismissal stems from a deeply ahistoric supposition that the dot com era marks, for the first time, a manifestation of capitalism in such an explicitly "excessive" mode. And yet, one in fact sees the same forms of excess, albeit concentrated in different institutions (primarily Wall Street and investment banks rather than in Silicon Valley and high-tech venture-capital funded industry), in the 1980s. Michael Lewis's accounts of both, in *Liar's Poker* and *The New, New Thing* respectively, in spite of a certain unreflexive enthusiasm for Silicon Valley over Wall Street, provide a wonderful perspective from which to comparatively situate key institutional sites of excess in these two historical moments (see Lewis 1989, 2000).

> and this...all kinds of things. And all that went against all that I had learnt in the prior 15 years, so it was a very strange time to be considering starting a company. If you were a Harvard MBA who was 24 years old who didn't have those previous 15 years of working experience, you might go, this is a great time to be starting a company, but having learnt the careful business models of how to build.... I'd worked for companies all my life, for a variety of small companies, and here, there were plans on the back of a napkin and now you get a company the moment you see it, it was actually disconcerting.[177]

In this portrayal then, GeneEd is almost like a caterpillar in a time-warped coccoon, insulated by its own pedagogical background against the "realities" that were now propounded as fundamental to start-up corporate dynamics. It was a period where Maulik felt GeneEd's vision was being incubated, suggesting that vision isn't just a one-time articulation, but rather an entire discursive and material apparatus that needs nurturing, and that needs to be articulated with strategies and tactics in many ways. Indeed, Maulik's explicit assertion that vision is not vision until it's articulated "in the way that people see that, oh yes, I can see how this is going",[178] is an understanding of entrepreneurship as explicitly hegemonic in the way that Stuart Hall understands hegemony (see for instance Grossberg 1996). Maulik's idea of a visionary is someone who is involved in cutting, pasting and synthesis; as I mentioned in Chapter 5, he thinks that tropes of romantic genius inventors, that underlie intellectual property rationales but also the gloriously sycophantic narratives of genomics as linear progress brought about by vanguard knights in shining armor as propounded by authors such as Kevin Davies (2001), are somewhat bogus.

An important part of the entrepreneurial process is the relationship of the start-up to venture capital funding. GeneEd was able to get companies such as Incyte and Alza on board as early investors, instead of venture capitalists, though not for want of effort at attracting the latter. In fact, as mentioned in Chapter 2, Maulik actually had promises for VC funding, on the basis of

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[177] Sunil Maulik, interview with the author, 15 May 2001.
[178] *Ibid.*

which he had made eight initial job offers in late 1999. He had even thrown a party for his new employees on December 22, 1999, a day before his promised benefactors called him up and decided that they had decided not to invest after all. Maulik, therefore, had been let down badly by venture capitalists, but it was a let down that he felt ultimately made the company possible, made it come out of its incubation period and gave it the activation energy necessary to become a real company. It was an activation energy borne of a desperate situation, of eight promised jobs, four maxed out credit cards, a child to provide for as a single parent, and a mother whose medical expenses Maulik was bearing, that, paradoxically, fuelled in him the desire *not* to go back to the relative security of the job he had given up at Pangea. It was the failure of venture capitalists to invest in Maulik after indicating initial interest that hardened his belief that his was a vision that he was determined would come to fruition.

The first company to invest in GeneEd was the major Silicon Valley genome company, Incyte, whose founder Randy Scott has himself figured prominently in this chapter. Typically, like almost any investment in high-tech capitalism, this was made possible not by the superiority of GeneEd's business plan as much as it was by Maulik's personal contacts at Incyte. It was, however, a fraught investment on both sides, given Incyte's own history of ups and downs with Pangea, which was always a company that might have been Incyte's competitor (see Chapter 4 for the story of Pangea's glorious slide into oblivion as DoubleTwist). Maulik feels that what eventually carried the day at Incyte was the personal credibility he had there, even though he had worked for a competitor. Trust and credibility are subjective judgement calls that are absolutely central to the dynamics of start-up worlds.

Getting Incyte as an investor however was always potentially a double-edged sword, because there was the danger of GeneEd being seen as a company seeded by Incyte, which Maulik knew could have huge consequences for the trust and credibility GeneEd might or might

not have amongst potential customers, many of whom would have to be Incyte's competitors if GeneEd was to succeed as a company. Maulik expresses his ambivalence thus:

> A part of me didn't want to take the investment because I was concerned that if we were seen to be in Incyte's pocket, nobody will accept our products. And the other part of me wanted to take the investment from Incyte because I didn't get an investment from Pangea and I probably just wanted to thumb my nose at Pangea, say to them that your biggest competitors are investing in me, why aren't you, and there was definitely some of that. And I think, again, the rationalization for the investment – and it is a rationalization – is that we will take the investments from a large variety of companies, and not be beholden to any one of them. Now that's easy to say and much harder to do. I mean the fact is that there is always a little bit of string that they can pull with us.[179]

In fact, however, GeneEd managed to sign up Celera Genomics, Incyte's biggest competitor, as one of their first customers, and it was Incyte, not their customer, who was put into a position of having to show trust. Maulik's account of the moment when Incyte learnt of GeneEd's sale to Celera:

> The day we were going to close our investment with Incyte...this was the day the Celera Genomics website went live [with GeneEd courses on it], which we had conveniently forgotten to tell Incyte about. So it's five o'clock on a Friday afternoon, it was a classic afternoon. Marion [Marra, VP of corporate development at Incyte], and Randy Scott and the two of us [Maulik and Barry Giordano, GeneEd's VP Sales at the time]. They said there were two things we needed to discuss, there were some issues with this contract we needed to get clearance on. And the second thing is – what the hell is going on with your being on Celera's website? What we said was, take off your Incyte cap for a moment, put on your investor cap. You should be glad we're getting Celera Genomics as a customer, just as we intend every other genomics company to be our customer. And as an investor, that only enhances our value, and gives you return on your investment. We're doing

> business with companies of the stature of Celera Genomics, and just from a monetary standpoint, every dollar that Celera Genomics pays us is indirectly going back to you. So I think they do look at that rationally.[180]

Trust and credibility, of course, has everything to do with understanding the work done by truths, lies and ~~truths~~, as discussed in Section 6.1. These are subjective judgements, of course, that also have everything to do with the networks and connections that actors in an entrepreneur / investment deal bring to the table, as I will argue for further when I talk a little later in this section about some of the rationalities that go into venture capital investment.[181] Trust is also inversely related to secrecy. As I mentioned in Chapter 2, I found companies in Silicon Valley much more open and willing to talk to me than East Coast companies, and this is an openness that marks Maulik's interactions with everyone he meets. It is an openness that is very much at odds with a defensive corporate pedagogy that deems any conversation that could imply a potential flow of "company" information to "outside" ears as potentially devastating for the company in question. Indeed, such defensive secrecy is less manifest in Silicon Valley not just because of a more "laid-back" or "open" corporate culture, but because such secrecy is simply untenable. Maulik himself feels that what he calls the innovation barrier is so low that such defensiveness in high-tech worlds just does not confer the sort of significant advantage that some people think it does. Of course, the fact that openness or secrecy is not simply structural, but also, for want of a better word, "cultural", is still very evident by the tight-lipped attitude of companies like Millennium Pharmaceuticals, as I suggested in Chapter 2.

Openness and secrecy, of course, are also a function of a company's size, and GeneEd's relatively open culture will undoubtedly be at least somewhat at stake as it grows into a larger,

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[179] *Ibid.*
[180] *Ibid.*
[181] It would be interesting to rigorously compare the networks of trust and credibility, and the social exclusions that they effect, in venture science worlds to the operations of such "values" in early modern science, which Shapin (1994) has written about. Indeed, Shapin's current project does look at the role of trust and credibility in interactions between entrepreneurs and venture capitalists.

venture capital funded entity, a "full-grown" corporation, as I describe in greater detail a little later. This was very evident to me in my interactions with the bioinformatics start-up Neomorphic, whom I introduced in Chapter 4, and who have since been acquired by Affymetrix. Neomorphic was initially a company I was hoping to do participant observation at, and when I first met them, at The Institute of Genomic Research (TIGR) genome conference in Miami in 1999, they were an extremely young, laid-back group of people who were very willing to talk and have me in their midst. Of course, once they were acquired by Affymetrix, they didn't have the agency to grant or deny me any access; but their move towards "seriousness" was evidenced even in the days leading up to the acquisition. By the time the TIGR conference in 2000 came about, they were already deep in conversation with Affymetrix about the merger (a fact, of course, that neither I nor many of their employees knew about at the time), and in order to indicate their seriousness, had hired a senior, rather dour executive vice-president, David Pritchard, who lent their young jovial image appropriate gravitas. That Pritchard's outlook was significantly at odds with the Neomorphic team's much more open outlook of a year previously was clearly in evidence to me, as, even as members of the Neomorphic management team spent time with me during the conference, at least one of them advised me quite explicitly to not show myself interacting with them in Pritchard's presence, as he would frown upon such "outsider" interactions whose context he didn't know.

Even Incyte, whose management and employees were much more open to talking to me and showing me around than those of, for instance, Millennium, had a retinue of 60 lawyers to negotiate once they had grown into a "full-fledged" corporation, making long-term access there virtually impossible.

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GeneEd's failure to attract venture capital funding has had certain positive consequences for the company. Firstly, it has forced a certain fiscal discipline on the company that many richly

funded start-ups in the dot com era simply did not have, to their eventual detriment. Secondly, it has allowed Maulik to stay in control of the company's vision and execution in a way that would have been hard to maintain had the founders' ownership been significantly diluted by venture capitalists at the start.

These are, however, fraught positives, and there have been a number of times when it has seemed almost certain that GeneEd would run out of funds, and out of business. It is impossible to get out of a bootstrapping mode through sales alone, and a certain significant amount of capital as cushion is probably essential for most companies. In addition, one of GeneEd's initial investors had invested in them through a bridge loan, which meant that the "investment" was made on the condition that a further significant financing event (such as venture capital funding) would occur within a stipulated period of time, which was by September 2002.[182] If that financing event were to not take place by then, then the "investment" would be treated as a loan, which would mean that GeneEd would have to pay back as loan a significant sum of money: significant enough to bankrupt them. In other words, if the drive for big pharmaceutical clients (that I mention in Chapter 4) was constrained by the need for stable revenue, then the drive for venture capital funding was dictated by the terms and conditions of previous investment agreements.

Perversely, but not surprisingly, venture capitalists refused to invest in GeneEd when they really needed funds, before they got their big pharmaceutical clients. Now that they have the big pharma clients that ensure a certain amount of stability in revenue flows, the VCs are much more enthusiastic about investing. This points to a certain venture capitalist logic, contrary to intuitive perception, that suggests an enterprise of risk *minimization* rather than risk taking. Indeed, Pat O'Malley (2000), reading the work of the 1920s economist Frank Knight, makes the distinction between risk and uncertainty, the latter being the statistically non-calculable "risk" that is the source of entrepreneurial creativity. One could, indeed, see the interaction of entrepreneurs and VCs as being one in which entrepreneurs are involved with uncertainty, while

VCs calculate risks. While calculating risk is most certainly taking a gamble, it is in order that risk can be minimized.

Nonetheless, even though VC money is less of an urgent need for GeneEd in 2002 than it was in 2001, the terms of GeneEd's early bridge loan, combined with a risk minimization logic that operates in the entrepreneurial world as well (which states, emphatically, that you *never* turn down investment when you get it, because you never know when or if you'll get some later), ensure that GeneEd is aggressively pursuing VC funding.

The person whose job it is to explore that funding is Maulik, both because that is part of his job description as CEO, and because as founder, GeneEd is a product of his vision more than anyone else's. Ironically, the person whose job is most on the line if he succeeds in his job of getting funding is Maulik's. And for a number of reasons.

The first is an almost pedagogical insistence by venture capitalists that founders shouldn't be CEOs, a line that is constantly reiterated in, for instance, business school classes on how to start new companies, in spite of many successful examples of founder-CEOs. The reason for this, largely, is that venture capitalists like to have, on the one hand, a "professional" CEO: founders are often the visionaries who get companies going, but, as argued in Chapter 4, one of the transitions a start-up has to make as it grows into a "real" company is precisely a shedding of its mercuriality that made it a successful start-up in the first place. While Maulik's creative unpredictability could be an asset in a start-up with a small management team, it could make for an increasingly volatile situation in a larger management team, spread across two coasts, with a number of managers more senior and experienced at managing than Maulik himself. The transition that VCs like to see is one from an idea-driven company to a procedure-driven company, the latter often being precisely what successful entrepreneurs run away from in order to start their own companies in the first place. On the other hand, VCs also like to have a dispensable CEO, someone who can be blamed and scapegoated if things go wrong, and thereby

[182] I am writing these words in June 2002.

replaced. From the point of view of the structure, capitalist – worker, the CEO is very much also a "worker" once the company gets venture capital investment. At that point, the CEO is effectively an executor of a whole range of wills to increase return on investment (RoI). While the company is still private, VCs look ideally for a 60-70% return on their investment in the company, so that they in turn can generate 20-30% RoI for the investment funds that have invested money in the VC fund and still make a profit. Once the company (ideally) goes public (this constitutes for the VCs one of their ideal "exit strategies), the CEO has a fiduciary responsibility to her stockholders, which makes her answerable to Wall Street.

I am not, here, trying to portray CEOs as weak victims of a greedy capitalist system, especially since the incentive structures for CEOs are often grotesquely attractive. What I am trying to indicate is a certain constrained field of action that CEOs have to operate within once they become answerable to other investors, private or public, in a way that they don't have to be accountable if they are a non-VC funded start-up like GeneEd has been. It is often difficult to be both visionary and constrained tactician / manager, and VCs therefore often like those roles to be filled by two different people. Often getting rid of a flailing CEO, if she is also the founder, is, for the VC, throwing out the baby with the bathwater: they are reluctant to put the prime visionary of the company in such a constrained position.

Indeed, Maulik himself reflects on this position of venture capitalists, and their potential relationship to GeneEd, as follows (and these are characterizations that are relevant to my further discussion of VCs later in the section):

> There is a clear "formula" to VC success, based around a "tried-and-true" management team, usually of the VCs' own choosing, and one that has succeeded before. There is also a clear formula for the profile of company that they will fund, typically one base around a well-developed U"niversity project, preferably from a researcher that is well known [*sic*] and with a proven track-record of success. In this way, all the "risk" and early

> groundbreaking hard work is done in an academic environment under (usually) government funding and the VCs are simply funding the commercialization.
>
> Neither of these models apply to GeneEd. In some way, we may be "unfundable" from a VC perspective, simply because we don't fit these pigeon-holes. I believe GeneEd could be a very profitable company generating nice returns for its investors, but I think this is irrelevant from a VC perspective (!). If the deal does not fit the profile, they simply pass on the deal (they have hundreds more to review, after all).
>
> What does this mean for GeneEd's culture? Obviously it is very different from Pangea / Doubletwist, which was the most VC-influenced company I have experienced. But better? More successful? All I can say is that we are having lots of fun, a talented and motivated workforce, and compelling and exciting products. Doubletwist may go out of business too,[183] so there are no guarantees. Millennium is interesting, their CEO, Mark Levin, comes from Mayfield Fund, but they clearly are a deal-making machine....[M]y contact raves about Levin as a CEO she would follow to the ends of the earth.
>
> So what is my point? A big part of the corporate culture (for better or worse) is dependent on the founders / CEO. If they are in sync, the culture is strong, if there is conflict, this will be reflected in the organizational values.[184]

In the case of GeneEd, Maulik's position is further made vulnerable because of the changing client base towards big pharma, and the consequent change in what becomes GeneEd's critical operational locale, to the East Coast. Here, all the attributes that made Maulik so attractive to his initial angel investors and his initial management and employee team, that make him so much a *part* of the Silicon Valley entrepreneurial stereotype of *not* fitting a corporate American stereotype, become potential liabilities. East Coast business, goes the normative belief, is run by serious, grey-haired, tight-lipped, white men in pin-striped suits, not by a young Indian immigrant who makes it a point to start up a conversation with anyone whom he sets next to on an airplane (he actually once managed to talk someone next to him on a flight into a small investment in

[183] As mentioned earlier, Doubletwist has since gone out of business.

GeneEd before the plane landed), and whose invariably bare-chested presence at parties was what gave one of his early angel investors in Silicon Valley the confidence that his money was being soundly wagered.

Everyone at GeneEd, at some level Maulik included, does believe that in the long run, GeneEd will have to be run by that industry caricature, the "grey-haired pharma manager", someone who has worked for years in a big pharmaceutical company, who is keen in his later years do something more "risky" and "exciting", and who therefore brings his staid management style to a younger company, and thereby gives the latter legitimacy and an apparent seriousness of purpose when it presents itself to its big pharmaceutical customers. Indeed, Maulik himself claims that it isn't his long-term ambition to run a nuts-and-bolts company, that what he really wants to do is to take GeneEd to a point where he feels that whoever runs it will have to run it on the terms set by Maulik's initial vision. What Maulik aspires to is not management power as much as a legacy, at which point he claims that he wants to retire on his stock options, sit on a beach and write a novel.

Nonetheless, it is clear that it is not clear to anyone, least of all Maulik, *when* that point will come when Maulik will willingly hand off to experienced management, and indeed a crucial determinant of how painful GeneEd's growth will be is going to be whether that point of handing off that Maulik desires is concurrent with what his investors desire. As of June 2002, Maulik's potential investors (and the managers of two companies that GeneEd, at this point, is potentially planning to merge with), do want Maulik to continue running the company, a point in which, in spite of his carefully stated indifference to being a long-term CEO, Maulik clearly finds huge amounts of affirmation. It is a continued affirmation that is very much at stake as GeneEd undertakes its next period of growth, which is likely to be even more dramatic and painful than the transition from biotech to big pharma clients in 2001-2002 has been for it (see Chapter 4 for an account of this period of growth). The apparent irrationality of the entrepreneur, as (in this

[184] Sunil Maulik, correspondence with the author, 20 November 2001.

case) he starts up a company in the first place, and then, once started and somewhat stable, proceeds to search for venture capital funding that will almost certainly dilute him out of the position of control he holds over the company, is itself grounded by a fetish – the very condition of possibility of the interaction of an entrepreneur with a venture capitalist is fetishistic and libidinal.

If all goes according to plan, GeneEd will, over the next year, become a venture-capital funded entity, merged with two other companies, with a presence in six cities spread across three countries, and an at least four-to-five-fold increase in number of employees. Such dramatic growth, which again is almost pre-ordained by initial investment demands and is not much of a choice for anyone in the company (though it is something that the management is aggressively pushing for, and are hardly reluctant about), puts everyone's job on the line, makes everyone's labor potentially redundant – from the increasingly unhappy graphic designers, through the middle management (who will be competing for their positions with sometimes more experienced middle managers in a more streamlined management structure, where everyone will need to have a clear rationale for their continued existence), all the way up to Maulik himself.

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I want to move on now to talk a little bit about venture capitalism, which is after all quite defining of, and to a large extent also defined by, high-technology industries. As shown above, venture capitalism is always a double-edged sword, but it is often not a choice that can be evaluated with considerable freedom by the entrepreneur, who invariably needs to take whatever funding she can get, when she can get it. VC funds also often specialize in particular types of companies to invest in, and in particular stages of a company's development (seed – when the company is just starting up; early stage; later stage; or mezzanine – a financing round just before an initial public offering [IPO]). The interactions between entrepreneurs and venture capitalists are all about introductions, networking, and an elaborate period of what gets called "courtship",

though it's a constantly uneven courtship, with the entrepreneur invariably in an extremely constrained position (unless it's a very well known serial entrepreneur whom many VCs are interested in investing in, or in the dot com heydey, when VCs were tripping over their shoelaces to invest in just about anything).

The important thing to re-emphasize, as I've mentioned before, is that venture capitalists (or indeed, investors of any sort) pay much more attention to *people* than to the business plan itself. Arthur Rock, an experienced VC, sees the plan as strategic and the execution of the plan as tactical, and believes from his experience that there are many people who have good strategies but far fewer who have the people to execute on those strategies successfully (Rock 1987). While Rock enumerates these qualities, quite predictably, as intensity, self-belief, honesty and so on, effectively these are qualities that invariably crystallize around known contacts, and are much harder for VCs to see in anybody who presents a plan to them without such personal networks that they can situate them in.

I would like to talk further about entrepreneurship and venture capitalism by telling the story of a person who has traversed both worlds. Noubar Afeyan is a Candian-Iranian, who founded his first company, Perspective Biosystems, in 1987. The company had an IPO in 1992, at which point it had 45 employees, and less than $1 million in product sales. It was a company that made instruments and reagents for genomics and proteomics applications. The first business plan for the company was written in October 1987, it was incorporated in November 1987, it received angel investment in May 1988, got its round of VC investment in March 1989, and its second round of VC investment in December 1989. Its first product sales occurred in 1990, and it had a third VC round in 1991 before its 1992 IPO.

The challenges, as Afeyan recounts them, are quite typical of the challenges budding entrepreneurs are taught to face in business school, and effectively encompass the entire range of activities the entrepreneur undertakes. Raising the seed round and hiring the early team are

predictably difficult, and it is often important for the entrepreneur to go after well known VCs in order to establish credibility. Deciding on the CEO is also a difficulty, as mentioned above in my account of GeneEd on the verge of its financing. Then, a herd of VCs has to be managed on the board of directors. The first products have to be made, the first sales closed, and customers have to be happy with the products and services on offer. The IPO is itself a challenge, after which comes negotiating the life of a public company, managing the company's growth as dictated by Wall Street, dealing with issues such as patent litigation and forging strategic alliances. Perseptive eventually grew to become an 800 person company in six countries, with $100 million in sales. The company was finally bought by Perkin-Elmer (PE) at around the time the latter was seeding Celera.

Celera started up on $350 million capital, seeded by PE (see chapter 4 for an account of PE). 300 people were hired during the first year. At that point, according to Afeyan, Celera's business model was not clear, but it didn't matter, because the only thing which was deemed important was that people would buy many more sequencing machines (made primarily, as mentioned earlier, by another PE acquisition, Applied Biosystems) after the "genomics revolution" was well underway than before. (Of course, this absence of clarity on Celera's long-term business model is proving to be a hindrance for the company now, as being a database provider has clearly not manifested itself as a source of long-term value for the company. The biggest problem with this in hindsight, according to Afeyan, was that by not knowing the business model, Celera didn't know the right type of people to hire for the long-term). Celera's market capitalization rose dramatically from $3.5 million to $11 billion by February 2000 (it is currently about $1.5 billion).

Celera's case is much less typical than that of a more "conventional" company like Perseptive, since the former was seeded at a particular conjunctural moment to fulfil a particular strategic objective, and had as central to its strategy the personality of Craig Venter, who was

hired to head it, and whose ego had to be constantly contended with. There were the inevitable culture clashes between PE, a rather staid conservative parent company, and an aggressive start-up that was running to Venter's ambitions as much as it was to PE's long-term strategy (once again, see Chapter 4 for the role of PE and Celera in the "race" to sequence the human genome). Celera had to become very big very fast, and in the process had to eschew building consensus with academic researchers and other potential customers. It was very rapidly thrust into public company status, showing how early success for start-ups can be a curse. Since the relative failure of its informatics business, Celera has been facing pressure to turn into a drug discovery company, which is hardly an easy transition.

Afeyan presently runs a group of companies called the Newcogen group, which comprises of Newcogen, and a VC fund called Applied Genomic Technology Capital (AGTC) Funds. Newcogen is a start-up incubator, that not only seeds companies but also provides hands-on mentoring.

Afeyan is also on the faculty of MIT's Sloan School of Management, and teaches a yearly course, highly popular, called "New Enterprises", which is full of wannabe high-tech entrepreneurs trying to "learn" how to start companies. As I argue in Chapter 7, this is a mode of pedagogy that is important to be attentive to, because it often gets imported and imitated in places like India as actors there decide they want to create an "entrepreneurial culture". A very rough overview of the pedagogical lessons provided in spaces like entrepreneurship classes in business school can be provided by Afeyan's own messages.

Afeyan starts his classes with a fundamental contradiction: that on the one hand, starting up a company is "start-upology" and not "start-uponomy" (meaning that there is no exact science to starting up a company that can be taught); and yet, on the other hand, that one can be given "lessons" on starting up a company that are in fact faithfully replicated in business school pedagogy and writings. Therefore, there is a set of codified reasons that get taught, on why start-

ups fail, what the important attributes of entrepreneurship are, what the elements of a business idea should be, what sources of capital can be explored and so on.

Jeffry Timmons, in his entrepreneurial "textbook" *New Venture Creation: Entrepreneurship for the 21st Century*, also, like Maulik, decenters the notion of the idea as being the driving force for entrepreneurship, but, unlike Maulik, does so at the altar of the market (Timmons 1999). Timmons, therefore, distinguishes between ideas and opportunities, where opportunities are measured by market demand, market structure and size. Ultimately, says Timmons, the entrepreneurial process is opportunity driven.

And here lies the problems with such modes of pedagogy. On the one hand, decentering the notion of the idea as the sole motive force for a venture is precisely being attentive to structural factors that go beyond entrepreneurial "genius" to make a start-up possible. On the other hand, such decenterings don't work particularly well when they are posited in terms of binaries, and when agency is handed over entirely to "the market". Because of course, such "lessons" constantly come up against the exception to these lessons, "exceptions" that in fact form the rule. As mentioned earlier, for instance, Maulik believes that a truly visionary start-up, one that isn't simply a "nuts-and-bolts" company, is *precisely* one for which there isn't already an existing market demand, but which is able to create such a demand – and it does so, of course, not simply on the strength of its idea, but on the strength of a whole range of articulatory hegemonic manouevers that, if successful, are in a position to reshape market terrains, though of course not in completely unconstrained ways.

Another standard start-up lesson regards the importance of a "sustainable competitive advantage", which usually involves intellectual property protection. While GeneEd is building a patent portfolio for itself, its competitive advantage lies primarily with the brand value that it has managed to generate for itself through providing consistent quality service, rather than through intellectual property protection.

From the point of view of the evaluator of a financial opportunity, such as a VC, then, we are taught that the attractive aspects of a company are those that suggest it can create or add significant value to a customer or end user; that it can solve a significant problem or meet a significant need for which a premium will be paid; that it looks financially attractive (a criterion, presumably, that cannot be independent of the previous two attributes); and that there is a fit with the founder, the team and the timing. The business plan, therefore, needs to indicate the breakthrough idea that a particular group claims to have; an assessment of the market; an execution plan (that includes plans for product development, and for sales and marketing); a description of the team; and an indication of the competitive advantage.

And yet, as I mentioned earlier, and as Rock suggests, many of the more "objective" attributes such as the financials are ultimately evaluated at the altar of the final point, as to whether the VC ultimately feels he can do business with the specific set of individuals founding and running the company.

William Sahlman, a professor of Business Administration at Harvard Business School, for instance, indicates that there are 15 personal questions that a business plan should answer. These are enumerated by him as follows:

- Who are the founders?
- What have they accomplished in the past?
- What directly relevant experience do they have for the opportunity they are pursuing?
- What skills do they have?
- Whom do they know and who knows them?
- What is their reputation?
- How realistic are they?

- Can they adapt as circumstances warrant?
- Who else needs to be on the team? Are the founders prepared to recruit high-quality people?
- How will the team respond to adversity?
- Can they make the inevitable hard choices that have to be made?
- What are their motivations?
- How committed are they to this venture?
- How can I gain objective information about each member of the team including how they will work together?
- What are the possible consequences if one or more of the team members leaves?[185]

On the one hand, of course, there are "objective" and meritocratic criteria that Sahlman is evaluating, such as experience, skill, likely response in adversity and so on. And yet, he too acknowledges quite explicitly that networks and reputations count, and indeed VCs are much more comfortable investing in someone who has a proven track record of starting successful companies to someone who might have a terrific idea but be a newcomer or an "outsider".

Investment is all about these tacit evaluations and relationships, and about personal comfort levels; which means, of course, that it is exponentially harder for "outsiders", whether they be women, racial minorities, or from small mid-west towns rather than from Silicon Valley, Boston or New York, to be a part of the venture financed entrepreneurial world. Indeed, this mode of closed networking, that ultimately serves to perpetuate forms of racial-ethnic and gendered discrimination, is what has led a group of Indian entrepreneurs to form The IndUS entrepreneurs (TiE) in 1994, in order to provide a similar networking forum for South Asian entrepreneurs. I discuss TiE in detail in Chapter 7.

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[185] Sahlman 1999: 142-143.

CHAPTER 7: NATION AND SALVATION

7.1: The Born-Again Ethic and the Spirit of Biocapitalism?

Capitalism is not just a formation that is conditioned by religion, but is essentially a religious phenomenon. This is why I used Geertz on religion in my introduction to the dissertation. But science too is a religious phenomenon, in terms of the belief structures within which it operates, and in terms of its structural messianism. The question for biocapitalism is one of the mechanisms of articulation of the various religious manifestations of life sciences with capitalism.

In this part of the chapter, I wish to explore at greater length the theological and messianic embeddedness of biocapitalist discourse and practice. In order to do so, I must begin by indicating how the conception of drug development as a *miraculous* enterprise pervades its stories; and how stories of the miracles of pharmaceutical development constantly crop up at each "revolutionary" moment in the industry's history. These stories, as I suggested in section 6.1, are not abstract and disembodied structural figures, but have to do with real lives that new miracle cures (that of course, in the linear progressive historical renderings of science, are always subsequently deemed as having been always inadequate) have saved. Consider, then, the following three stories, the first two recounted by Barry Werth in *The Billion Dollar Molecule*, and the third by Cynthia Robbins-Roth (2000) in *From Alchemy to IPO*.

The miraculous story of the use of penicillin in the World War II effort had as its key moment its administration in 1942 to Anne Miller, who was dying of streptococcal fever and not responding to sulpha drugs. But, says Werth (1994: 123-124): "At 3.30 Saturday afternoon, when she received her first shot of Merck's penicillin, her fever was 105 and she had 'well over' fifty bacteria per cubic centimeter of blood. By 4 the following morning, her temperature was normal. By Monday, her blood was sterile. She was still alive in 1990 and living in Connecticut".

Later in that decade, it was cortisone that was the miracle drug. Says Werth (1994: 129): "In September 1948, Merck shipped six of its ten grams of cortisone to the Mayo Clinic for the treatment of a twenty-nine-year-old woman so crippled with rheumatoid arthritis that she couldn't roll over in bed. The woman had already received massive doses of penicillin, streptomycin, gold salts, and sera with no improvement. Three days after her first injection, she was able to raise her hands above her head. Four days later, she went shopping, declaring, 'I have never felt better in my life'".

Robbins-Roth starts *From Alchemy to IPO* with the story of Betsy Patterson, diagnosed with non-Hodgkin's lymphoma (NHL), who was suffering as much, if not more, from her chemotherapy regimen as from the disease itself. Consequences of the chemotherapy, which did succeed in pushing her cancer into remission, included a premature menopause, diabetes, severe folic acid deficiency leading to anemia and peripheral nerve damage. Eighteen months later, another spot showed up on a chest scan, threatening yet another battle with chemotherapy. It was at this point that she decided she wanted to try Rituxan, a new monoclonal antibody treatment for NHL that had been developed by IDEC Pharmaceuticals. As a consequence of the Rituxan treatment, according to Robbins-Roth (2000: 6-7):

> The nodes in her neck were completely gone, and those in her back and groin were disappearing and were no longer painful. CT scans in June prior to her second dose continued to show a substantial reduction in her tumors.
>
> This great response was not accompanied by toxicity. And there were few side effects....
>
> Biotechnology has completely changed to way we discover and develop new drugs and has allowed us to help patients with previously untreatable diseases. Stories like Betsy's are one reason so many people have invested their time, money and careers in biotech.

As mentioned before, the purpose of these renderings is neither to pour scorn on nor express cynicism towards these stories, but rather to point to their constant miraculous structure, a

structure, further, that is founded on the inadequacy of previous therapies (even though they too were once miracles). It is a structure of linear progress that is embedded and embodied in specific salvationary stories, heroic rescues of individual extremely sick patients (that all the "rescued" patients in these stories are women is a further feature worth noting).[186] It is a structure of the type "If you relent and submit to penicillin / cortisone / Rituxan (each at the time of these stories relatively experimental therapies), then you will be saved". It is *not* the trope of public health in which therapy intervenes to prevent the spread of plagues or epidemics: even though penicillin, in particular, was used precisely in the always potentially plague ridden situation of World War II, its origin story still remains that of the solitary dying woman rescued by the miracle cure. In other words, the symbolic capital for the drug development industry *doesn't* come from the story of ridding Africa of AIDS. Further, these stories that I recount do not simply describe cures, but resurrections; what is at stake in these stories is not just survival, or getting better, but about living life to the full, again.

If drugs as instruments of salvation echo one structure of biocapitalism as reflected in the three origin stories I outline above, then markets as instruments of moral purpose are equally articulated as part of the missionary enterprise since the 19th century. Around the time that Marx was writing about the theological nature of the commodity, for instance, David Livingstone was undertaking his expeditions in Africa with the firm belief that commerce and Christianity went hand in hand. The mid-19th century, indeed, marked the co-production of a metropolitan imaginary of Africa as a site for both evangelization and raw materials to feed the productive demands of the Industrial Revolution. The triad of media, religion and markets, which Arvind Rajagopal (2001) explores in his book *Politics After Television* in relation to the rise of Hindu nationalism in India, is explicitly reproduced today in Africa as well, with the Christian

[186] For longer accounts of the pharmaceutical industry that equally subscribe to this idea of the history of drug development as being one of linear progress, see Mahoney 1959, Mann 1999.

Coalition's media magnate Pat Robertson evangelising and mining in Western Africa (see Roth 2002).

Let me then refer back to Randy Scott's speech that I described in Chapter 6 in the context of each of the stories of miracle recounted above. Like these stories, Scott's pitch for Incyte, couched as a pitch for genomics, where genomics meshes into Genomics for Life™, is originary, revolutionary and paternalistic, all attributes that go hand-in-hand with a performative of futurity.

The paternalism that inhabits these miraculous tales is not simply a part of their rhetorical structure. Sometimes, as I realized during the course of my fieldwork, that rhetorical structure can get embodied in specific corporate ventures that are explicitly, sometimes painfully, salvationary. The story of Patrick and Sharon Terry, PXE International and Genomic Health, in which one of the co-stars is Randy Scott, is indicative of this. The story of PXE International is a story of many things: of biosocial communities, of intellectual property, and of the effect of the internet. Here, I tell it as a story of the salvationary promise of biocapital.

Patrick Terry used to be in the construction business, and got involved in biomedicine when he and his wife discovered that their two children had pseudoxanthoma elasticum (PXE), a rare genetic pigmentation disorder that usually leads to blindness by the mid-20s. Terry, therefore, got into science not through the normal routes of formal training, but as a lay person who was forced to take an interest in it. He calls his a "perspective informed by experience". The Terrys found out as much as they could about PXE, networked with other parents of PXE-afflicted children in both the US and Europe, and started a patient advocacy group, PXE International. In addition, Pat Terry is one of the co-founders, along with Randy Scott, of a biotech company called Genomic Health, whose vision, according to Scott, is "to build a new arm to the healthcare system. New genomic technologies will enable the world to characterize every patient's disease and health status as a complete genomic package. Every disease has a molecular

basis and some level of genetic-encoded response. Individuals respond to therapy based on the molecular alterations of their disease and their own genetic code. Genomic Health's mission is to one day provide physicians and patients with an individualized molecular analysis that enables the treatment team to utilize relevant treatment guides for all diseases. Our ultimate goal is to make personalized medicine a reality and to dramatically improve patient care."[187] One of the things the Terrys have done, as mentioned in the previous chapter, is negotiate agreements with companies like Genomic Health that PXE International members donate DNA samples to for research, whereby the patient advocacy group shares in the intellectual property that the company generates.

Terry starts his talks by laying out all the things that he is – parent, PXE International administrator, Genomic Health co-founder, researcher. It is a style that completely mirrors Scott's, who often starts his own presentations with a similar outline of his multifaceted set of involvements, responsibilities and motivations. As a part of his work, Terry is both a typical and a unique example of a venture scientist. He is involved heavily in policy activities, through an alliance of genetic disease patient advocacy groups called the Genetic Alliance. Through PXE International, he is involved in a worldwide effort to initiate, conduct and fund PXE research. Much of that is through the establishment of research collaborations, such as mentioned above, which involves the need to negotiate intricate contracts, alliances and understandings. The organization has now succeeded in setting up 59 support offices worldwide, and, as of November 2001, had 1200 samples, 160 tissue samples and cell lines and extensive epidemiological data in their registry.

All of this stems from Terry the parent. PXE International is a paternalistic venture, not in an abstract discursive sense, but in terms of its actual genesis. In addition, Terry claims that his alliance with Scott has everything to do with their shared beliefs, in terms of their libertarian bend

[187] Stated on Genomic Health's webpage, at http://www.genomichealth.com/message.htm.

towards the free market and conversant religious beliefs (Scott, as mentioned earlier, is an evangelical Christian, like Terry). Scott is, according to Terry, "a regular guy, a super guy, a nice guy, a family guy". It forms the basis of a trust that Terry does not necessarily feel towards other businesspeople, and there are those whom he feels have betrayed PXE's cause after indicating interest.

Like good evangelists, then, Terry and Scott merge their belief in Christianity merges with their belief in the market. Terry strongly believes in the market not just as the route to therapeutic *production*, but as the route to therapeutic *knowledge* and *dispensation*. What Genomic Health is about, as much as or more than a wet-lab research based company, is empowering consumers by providing them with "actionable therapeutic information".[188] The goal is nothing less than to foster what Terry calls a "consumer genomic revolution". Terry thinks in terms of "consumers" and "targeted therapeutic interventions" rather than "patients" and "cures": he doesn't like the normativity embedded in the latter word. What he also doesn't like is the role of the physician as expert gatekeeper, which he feels hinders the patient-consumers' ideally indivualized quest for self-knowledge. He thinks, therefore, of medicine in salvationary terms, but also thinks that the market has to intervene for medicine to change in ways that can enable it to attain its promise of salvation. Further, PXE International doesn't just operate as an institutional structure that acts as a formal negotiating party: it acts quite literally as a networked biosocial community, with all the peer pressures attendant on small intimate communities. Terry, for instance, says that the community uses peer pressure to "push good habits", such as getting members to stop smoking. PXE International is much more, clearly, than an advocacy group: it is a religious movement. Terry's biography is an exploration of the disjunctured relationship between commodification and subjectivity, as the grieving father becomes an entrepreneur, who

[188] www.genomichealth.com

is also a political figure and a religious figure, forcing us, therefore, also to ask what concepts of family are embedded in these entrepreneurial / religious / political / capitalist lifeworlds.

It isn't just entrepreneurs like Scott and Terry who bring their Christian beliefs to bear on their conduct of life science as salvationary enterprise. Francis Collins, the head of the public Human Genome Project (HGP) is also a Born-Again Christian, who has worked in a missionary hospital in Nigeria. He says that his passion for tracing disease genes is like "appreciating something that up until then, no human had known, but God knew it.... In a way, perhaps, those moments of discovery also become moments of worship" (quoted in Davies 2001: 72).

For actors like Scott, Terry and Collins, then, biotech has that element of calling that Weber points out was introduced by the Reformation (Weber 2001 [1930]). But this is a calling that is not coupled to asceticism, but rather, as evidenced from scenes such as that of the Incyte-sponsored party that I described in Chapter 4, to a Bataillian *expenditure*, to worldly pleasure. Even if such excess is not practised by Born-Again figures like Scott and Collins themselves, it is a part of a certain ritual structure of corporate biotech. And yet, it is a ritual structure of excess that is hardly irreligious, if one if to understand religion, in the sense that Geertz (1973) articulates it, as a source of authority that derives its authority from the enactment of ritual.

An example of this, not dissimilar to the Incyte party story I recounted in Chapter 4, and which like that story ties in to question of corporate loyalty that stems from a certain structure of *belief*, is a story of Genentech. For after all, the question that has to be asked, especially of corporate biotech actors, is not simply about their adherence to their profession (which, in Robbins-Roth's understanding, is a consequence of the virtue attendant on the profession, but is also, clearly, a consequence of pedagogical trajectories and career opportunities), but of their loyalty to specific companies within the profession, and the willingness, necessarily, to couple that loyalty to a certain level of antagonism towards such companies' direct competitors. This of course is especially marked in the American situation, and reflects an allegiance similar to that of

allegiance to sports teams, but it is an allegiance that involves not just a certain degree of time, and emotional or monetary expenditure, but a devotion of labor to the corporate cause. Further, there are certain companies that are able to build what I quoted Maulik in the previous chapter as calling "cult-like" images around themselves, a consequence both of their visionary status and of the way in which that visionary status is articulated in hegemonic ways to foster loyalty.

The following story of Genentech was told to me by a former employee, whom I shall keep anonymous. I do not transcribe it verbatim, but rather recount the gist.

Genentech had just won a patent infringement case, and in order to celebrate they called all of their 2000 employees into a makeshift tent constructed on the premises in order to make the announcement. As soon as the announcement was made, according to my informant, the entire tent broke out into a standing ovation (which my informant couldn't understand, since as she said most of them had pretty crummy jobs), after which the company threw a party, with lots of food, music, drink and rose petals being strewn from the makeshift stage. After an adequate amount of revelry, the employees were all called out of the tent to witness a fireworks display put on by the company. Since Genentech is in South San Fransisco, just north of San Fransisco International Airport, it became an urban myth in the company that Genentech was able to stop flights into and out of the airport for 15 minutes while it put on its own fireworks display. My informant herself would not have been surprised if that had been the case; what she was more impressed by was the ostentatious display, of extravagance on the part of the company, and invincibility on the part of its employees, who of course completely bought into the company's extravagance as a matter of course. In the process, of course, a corporate aura and a sense of belonging to a larger cause, that wasn't simply the cause of eradicating disease, but was also the cause, in itself, of committing oneself to Genentech, was reinscribed. The calling, in biocapitalism, thereby both comes from the symbolic capital accruing from being in the business of "life itself", and from being part of a specific, embodied, corporate ethos that itself gets constructed through ritual excess, thereby

leading to a therapeutic salvationary discourse that gets completely entwined with faith both in the market writ large and in specific market entities.

Indeed, as I mentioned in my story of Incyte's party at the end of the 1999 Institute of Genomic Research (TIGR) conference in Miami, a performance marked by excess is a ritual mode of inscription of a corporate presence in the lives of its workforce. It was the labor angle, the question of loyalty to the employer, which was the frame through which I most immediately told my story of that party in Chapter 4. There was, however, a larger question of branding at stake. Indeed, the backdrop to the Incyte party at TIGR 1999 was a party thrown by Celera at the same venue in 1998, which was on Miami beach, and signified the 1998 conference (which occurred in the aftermath of Craig Venter's announcement that he would sequence the human genome before the public researchers) *as* a Celera conference. Indeed, it was Celera's first act of public display since its formation earlier in 1998, and it was the TIGR party, as much as Venter's announcement regarding the genome sequence in May 1998, that in some material, embodied sense, catapulted Celera into a certain sort of public vision as the company that was racing to sequence the human genome.

That the 1999 party had managed to turn that year's proceedings into an Incyte conference was clearly not lost on TIGR, which after all is an organization which had close links to Celera at the time (as mentioned in Chapter 4, Venter was heading TIGR at the time that Perkin-Elmer approached him to run Celera; TIGR was still being headed in 1998-99 by Venter's wife and fellow genomicist Claire Fraser). Sure enough, at the TIGR conference in 2000, Incyte was conspicious by its absence from the organizational scene of such revelry. This was because, as I learnt from an annoyed Incyte employee, TIGR had not allowed them to stage any of the major conference parties, and had not allowed them to advertise as easily as they had done the previous year. For much of the 2000 conference, Incyte was reduced to advertising its presence through giant blimps flying overhead.

Celera, meanwhile, needed not just to register its presence, but to do so in a manner more audacious and spectacular than Incyte had the previous year; and preventing Incyte's spectacular publicity from having an easy outlet, through the organizational agency of TIGR, was clearly only half the battle won. Therefore, Celera, who organized the 2000 TIGR party, did so at the Villa Vizcaya, an Italian renaissance style villa and gardens, filled with art and antiques, which was built as a winter estate of the industrialist James Deering in 1916. Included as part of the evening's festivities were a live band, and plenty of food and alcohol.

If on the one hand, then, reducing the "religious" aspects of capitalism to a dour Weberian asceticism completely fails to take into account the actual and excessive forms through which capitalism operates, then on the other hand, it is too simple to reduce this excess to an "irrationality", that is all too easily done, especially today (2001-2), especially in places like Silicon Valley, where such exuberance is disdainfully marked off as an "aberration" of the dot com boom, as somehow only spectacle, from which we have returned to the "reality" of rational accumulation. And yet, such forms of excess are always undergirded by forms of rational calculation, just as rational accumulation in capitalism is always undergirded by excess – excess and rational accumulation are dialectically intertwined components of capitalism. Therefore, the head of sales of a bioinformatics company, with me at the 2000 TIGR party, was completely unimpressed with its extravagance, to the extent that he saw it as a perfectly sound and fiscally conservative sales and marketing decision. After all, he told me, it's much cheaper to advertise one's presence in dramatic fashion to many potential investors and customers at one place, especially if it's a place they have happy memories of and at which they are not explicitly being sold something, than it is to make individual sales calls across the world to each one of them.

The other question to ask in the context of excess, at the risk of an apparent and temporary digression, is its relationship to scandal. The 1980s, for instance, also saw capitalism in

its explicit excessive ebullience,[189] an excess that spilt over not uncommonly into scandalous manifestations. The biggest scandal in American corporate history related to the collapse of the savings and loan industries in the 1980s, and happened precisely through such excess consumption (for an account of this scandal, see J. Adams 1990). The deregulation of this once staid and conservative industry saw its eventual collapse, through spectacular burn-out and a possible loss of up to a trillion dollars. Men who were caught in its midst included such moral crusaders as Charles Keating.

Parties, incidentally, are not incidental to this story. Stephen Pizzo, Mary Fricket and Paul Muolo (1989), in their expose of the scandal *Inside Job*, tell the story of Sunbelt Savings' Edwin McBirney, who, in an infamous party thrown for his friends and customers with company money, had four showgirls strip, have lesbian sex with one another and proceed to perform fellatio of some of the guests, four months before he left Sunbelt and the company went out of business.

How such modes of explicit consumption are different from the excess seen, for instance, in Miami, is a serious question, especially in the context of the re-emergence of scandal as central to the dynamics of contemporary corporate America (Enron, Worldcom, Tyco and the like). After all, excess consumption is a central part of sites of speech such as industrial biotech conferences, and in addition to the "major" conference party such as those sponsored by Incyte and Celera are other "smaller" parties that occur every evening in what is, primarily, an industrial trade show. Perkin-Elmer, for instance, had organized a casino for conference participants at the 1999 TIGR conference, and these are sites not just of corporate excess, consumption, but also quite explicitly libidinal sites. I am reminded, for instance, of one inebriated Perkin-Elmer employee I met at the casino-party, who, in the midst of a series of advances to the various women at the party, found

[189] This is a fact that most people in Silicon Valley seem inattentive to in their ahistoric periodization of the dot com boom as the foundational act of capitalist excess, and also, perhaps therefore, an aberration that can be dismissed thus as we return to the "realities" of the capitalist enterprise.

the time to confide to me that his company's real aim was to take over the world. Instead of dismissing such statements as sozzled gibberish, I would like to point, again, to the sense of invincibility that such modes of ritual performativity foster amongst its participants, an invincibility that translates into the making sacred of the source of such power, the corporation.

Of course, scandals such as the 1980s savings and loan scandal, or the recent Enron and subsequent scandals, are always framed in terms of delinquent morality, and therefore as aberration. Such a framing, thereby, allows the everyday business of excess to continue, unscathed and unstopped. The dialectic relationship of the sacred is not to its binary opposite the profane, but to its dialectic counterpart, the scandalous. Sacred power can only arise from the constantly deferred but always present risk of scandalous misappropriation – the very excess that lends sacred power to the corporation / enterprise at sites and moments of surplus consumption carried within it the risk of the recognition of that excess *as* somehow aberrant, abhorent, immoral, scandalous. By deferring such recognition, of course, the corporation / enterprise in question doesn't just gain an aura of power and invincibility, but also gains ethical legitimacy, as *not* therefore immoral or scandalous – simply powerful, the cult that demands to be bought into. Performativity both provides material force, that gets consecrated in the body of the corporation (which itself is simultaneously material and dematerial), but especially in its name, *brand*. Hence the relevance of Derrida's questions, regarding what is in the name, what is it we do when we act in the name of (religion, for instance, but here also, of science, of nation, of capitalism, of specific corporations) (see Derrida 1995, 2002b). And further, says Derrida, the very possibility of such faith that we can act in the name of (religion, or, I add, science, nation, capitalism, corporation) has (today at least, and in the ways that faith gets media-ted through performativity and ritual, for which also see Rajagopal 2001), as its condition of possibility, the technical. And hence:

> [T]he technical is the possibility of faith, indeed its very chance. A chance that entails the greatest risk, even the menace of **radical evil**. Otherwise, that of which it is the chance

> would not be faith but rather program or proof, predictability or providence, pure knowledge and pure know-how, which is to say annulment of the future. Instead of opposing them, as is almost always done, they ought to be thought together, as *one and the same possibility*: the machine-like and faith, and the same holds for the machinal and all the values entailed in the sacrosanct (*heilig*, holy, safe and sound, unscathed, intact, immune, free, vital, fecund, fertile, strong, and above all, as we will soon see, "swollen") – more precisely in the sacrosanctity of the **phallic** effect.[190]

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Therefore, on the one hand, there are messianic actors, such as Scott, Terry and Collins, as well as the corporate messiahs such as Incyte and Genentech, who are forging one set of visionary biocapitalist agendas. As mentioned at the beginning of this chapter, however, the commodity itself is theological: it is imbued with mystical and religious force. When that commodity is a therapeutic, it becomes salvationary. The source of the magic of the drug does not simply exist from its use-value as object that makes sick people better, but arises from the modes of abstraction that allow drugs to be commodities. Further, the *promise* of medicine, as mediated by the drug, does not need to be articulated: it is a promise that is *inherent* in the mundane objects, that are, as Marx would acknowledge, full of "metaphysical subtleties and theological niceties" (Marx 1976 [1867]: 163). This is why understanding the social life of drugs as simply being a call to map their sites of production, circulation and consumption is wholly inadequate. Drugs, as commodities, have as integral to their social life their imaginary life, an imaginary life that is definitional of their social life.

Therefore, the fetishism of the *drug* arises, as Marx outlines for the fetishism of any commodity (Marx 1976 [1867]: 163-177), by alienation. I will argue in Chapter 8, however, that the fetishism of *scientific fact* operates instead by *interpellation* i.e. by the intense association of such facticity (which is often information about individual genetic profiles) with individual

[190] Derrida 2002b: 83 (emphases in original).

subjectivities. It is this dialectic between alienating and interpellative fetishisms that needs to be made sense of if one is to understand emergent regimes of post-genomic personalized medicine, where diagnostics – scientific *facts* about future probable illness – become an integral material-semiotic part of the structure and practice of medicine.

In further addition to messianic actors and theological commodities is what Derrida calls a *structural messianism* – "a messianism without religion, even a messianic without messianism, an idea of justice" (Derrida 1994: 59), which is the emancipatory promise of science. Derrida talks of this structural messianism in relation to Marxism, but then Marxism itself was explicitly regarded by its practitioners as scientific, and much of emancipatory potential of Marxism did indeed stem for Marx from its scientificity. This is a structural messianism that is as much a part of the foundational Nehruvian ideology for post-independence India, enshrined in his famous description of science and technology as the "temples of modern India" (Nehru 1958), as it is a part of Randy Scott's rhetoric. The questions for comparison, then, are questions of how such structural technoscientific messianism articulates with / as other structures of promissory imagination, such as nation or corporation.

The challenge then becomes to generate an understanding of the messianic embeddedness of biocapitalism that is attentive both to religion as an anthropological phenomenon (Geertz), and to religion as one causative influence (Weber), in other words a co-productionist and conjunctural attentiveness.[191] I take inspiration here from Weber's demonstration in *The Protestant Ethic* that the connection between the Protestant ethic and the spirit of capitalism occurred historically, and at a place in the social structure that tends to hive off other forms.

[191] Further, according to Walter Benjamin, there are three aspects to the religious structure of capitalism: capitalism is cultic (things have meaning only in relation to the cult); there is a permanence of the cult (naturalization on the one hand, but also an *ahistoricity*, which is precisely inscribed in the structure of the salvationary narratives I recounted at the start of this chapter, on the other – the magic of capitalism is that it manages to transcend temporality, even as it is completely determined in all its manifestations by temporal logics); and the cult makes guilt pervasive (Benjamin 1996 [1922]). He refers to the relationship

Weber does however set up a particular, contextually situated dichotomy between asceticism and mysticism in *Economy and Society* (Weber 1978 [1968]: 541-556). It is the subsequent *collapse* of this dichotomy which is important to trace – if mysticism is, in Weber's terms, "world-fleeing" (might we say thus in the case of science in its Mertonian guise – abstract, knowledge, truth?), and asceticism is "world-serving" (the symbolic capital of drug development, as being in the business of saving lives), then the collapse of the mystical and ascetic aspects of Mertonian science and Weberian capitalism respectively collapse most evidently in venture science, just as, as I argue in Chapter 8, genomics and personalized medicine as corporate endeavors see the collapse of pre-capitalist and commodity fetishisms.

Religion, then, cannot be reduced either to a Weberian binary of asceticism / mysticism, or to a Geertzian generation of authority *in ritual* (though, as I've argued above, the latter understanding is a vital one to take account of in explaining the source of religious authority). Indeed, one is a diagnosis of religious phenomena, the other an attempt to trace its mechanisms of operation, making them different explanatory operations that cannot be compared against one another for their relative erudition, or explanatory capabilities.

I turn next to two categories of *performative* force that Derrida enunciates in his analysis of religion to investigate the ways in which religious categories manifest and are important to make sense of. I speak here of *belief* and *sacredness* (see Derrida 2002b). Belief has to do with *truth* and therefore understanding (even in the absence of understanding – one has to *believe* in the understandings provided by truth even if one does not understand them, or understand how they are provided for by truth). Sacredness has to do with mysticism. Facticity has to do with truth; the commodity is a mystical entity. When facts and commodities implode in / as venture science, what results is the implosion of these two structures of being of religion.

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between Christianity and capitalism in parasitic terms: he sees capitalism as a parasite of Christanity until the history of Christianity becomes essentially that of its parasite.

In order, then, to look at the sacred dimensions of venture science, especially as they pertain to *bios*, I read Weber antagonistically again, this time in relation to Bataille (1988 [1967]). For Bataille, the source of the sacred is reflected by the manner in which resources are consumed extravagantly and unproductively, again in sharp contrast to Weber's ascetic Protestant. As Jean-Joseph Goux puts it in his reading of Bataille: "Whereas the profane is the domain of utilitarian consumption, the sacred is the domain of experience opened by the unproductive consumption of the surplus" (Goux 1990: 207-208). It is such sacralization that forms the grounds for social power.

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7.2 Envisioning India Inc.

In this section, I think about nationalism's relationship to globalization and to capital, as informed by Indian entrepreneurial and venture capitalist communities (many of whom operate / network out of and into Silicon Valley), and by Indian public actors and institutions, such as the Council for Scientific and Industrial Research (CSIR) and the Centre for Biochemical Technology (CBT), that I described in Chapter 5. In the process, I want to highlight how the Indian nation, in the context of these actors, becomes one way (religion and capitalism being at least two other, mutually implicated ways that I have discussed in this dissertation) of, in Benedict Anderson's terms, "linking fraternity, power and time meaningfully together" (Anderson 1991 [1983]: 36). I further argue that in the context of biotechnological globalization, the Gramscian distinction of strategy and tactics, in this case, can be further temporalized into vision, strategy and tactics. Even if a range of actors whose views are broadly in consonance might have similar underlying visions (that of India "going global", or developing an "entrepreneurial culture", both of which, I argue, are sometimes, and sometimes not, the same thing), their own strategic and tactical conceptions, combined with the institutional constraints and formative pedagogies that provide them with their situated perspectives, serve to differentiate

their modes of action, leading to a range of ways in which India in fact "goes global", or "becomes entrepreneurial".

I begin by talking about two major non-resident Indian (NRI) organizations with powerful presence in the United States, one of which has something to do with biotechnology, the other apparently nothing at all. The former is The IndUS Entrepreneurs (TiE), and the latter the Vishwa Hindu Parishad (World Hindu Forum, or VHP).

TiE's mission is the "advancement and nurturing of entrepreneurship".[192] Established in 1994 in Silicon Valley, it now has a presence in North America, Europe and India. The story of TiE, and of its related and younger offspring focusing on life science entrepreneurship, the Entrepreneurial Pharmaceutical Partners of the Indian Continent (EPPIC), is, at one level, one of a venture capital approach to governance, and I explore this evident story later in the section. A thicker analysis of organizations such as TiE or EPPIC, of course, would have to confront them as a part of the Indian diasporic assemblage, as part of Silicon Valley as a particular locale, and as part of a certain sort of social movement that, like any governmentality, cannot bring about formal political economic change without being driven, itself, by conceptions of broader social change. The VHP, on the other hand, is a much older organization, founded in 1964, its purpose being the global dissemination of Hindu values and the strengthening of Hindu networks around the world. Not surprisingly, the VHP has risen to public prominence and grown in stature during the 1990s, along with the rise of Hindu nationalism as a mainstream political force in India, but also with the rise of NRI communities themselves becoming powerful and vocal political actors in Indian affairs in their own right.

TiE's conception of change is very much based in its vanguard elite, men like Kanwal Rekhi and Kailash Joshi who have made it big as Indians in American entrepreneurial worlds, and

[192] According to their website, www.tie.org.

who therefore act both as role models and as networking nodes for other aspiring sub-continental entrepreneurs. TiE's objectives are threefold, to: "

- Foster entrepreneurship and nurture entrepreneurs
- Provide a networking platform for its members
- Help members integrate with the mainstream community."[193]

At one level, these objectives, of nurturing what is simultaneously a community, a cause and a way of life, eerily echoes the focus and activities of organizations like the VHP. Further, both TiE and the VHP go beyond simply spreading ideology to actively participate in making possible capital flows between the US and India, in circuits closely tied to India's ruling corporate-political elites. The VHP in America, for instance, has been singularly involved in channeling funds back to the Hindu nationalist movement in India, which is an assemblage of socio-political actors of which the ruling Bharatiya Janata Party (BJP) is an integral part. TiE, meanwhile, aims not just to foster an Indian entrepreneurial community in the US, but also to transpose back to India the sorts of cultures and mechanisms of innovation that typify high-tech entrepreurial capitalism in places like Silicon Valley. There are also uncanny similarities in the way the two groups function organizationally, through seminars, lecture tours, mentoring / counseling and operating projects back in India.

There is, however, a crucial difference between the value systems of the two organizations. At the risk of an apparent digression, it is necessary to explore this difference a little in order to lay the ground for further analysis of the way India gets envisioned by entrepreneurial communities such as TiE, and how such envisionings tie in, or don't, to the way science and technology get envisioned as a component of the nation, and the way nationalism gets imbricated as a componenent of technoscience, on the ground, by various actors in India. This

[193] www.tie.org/library/about.asp

difference has to do with the fundamentally *exclusionary* ideology of organizations like the VHP, which, as an ironical consequence, have, as Arvind Rajagopal (2001) shows, to be able to innovate for themselves democratically accessible modes of grassroots functioning. TiE, on the other hand, is ideologically inclusionary, and as part of its mission explicitly claims respect for religious, ethnic and political diversity. Indeed, while most TiE management and members are from India, there is a play on words in the name of the organization itself: IndUS represents not just the confluence of India and the United States, but also the river that flows through Pakistan, has tributaries in India, is considered the cradle of sub-continental pre-historic civilization and is the basis for a water treaty between the two countries that is almost sacred in its symbolization of the links between them even in times of great diplomatic stress. TiE indeed believes that its success "stems from its single-minded focus on the mission of advancing entrepreneurship and on its unrelenting value that successful entrepreneurship eschews all culture, religious, and political boundaries".[194]

Leaving aside for the moment both the impossibility of an entrepreneurship without culture and the contradiction of an organization that is explicitly formed on the basis of ethnic / geographical identification as "eschewing" such boundaries (and presumably therefore the identities that are formed precisely by such boundaries), I tell the story of Kanwal Rekhi, a founder and former president of TiE, and arguably the best known Indian venture capitalist in the world. Rekhi's biography is the classic one of the poor outsider who made good in the American melting pot. Of Sikh parents, and born in Rawalpindi (current-day Pakistan), Rekhi moved to the US in 1967 as an engineer, got laid off thrice in the early 70s, and finally moved to San Jose where he realized the Silicon Valley entrepreneurial dream. He co-founded an extremely successful computer company called Excelan, which merged with Novell in 1989, and then moved on to become a highly successful venture capitalist and angel investor. Rekhi was one of

[194] www.tie.org

the generation of early (1980s) NRI entrepreneurs who learnt from experience that, while there were an increasing number of Indian software professionals (usually highly educated and highly qualified) coming to the Valley, there were very few who were actually in management positions or starting their own companies. A major reason for that, of course, was the Catch-22 situation that all entrepreneurs find themselves in when first trying to start a company with venture capital money without significant entrepreneurial / VC contacts: Rekhi himself, for instance, was constantly turned away by VCs while trying to start Excelan because he didn't have the "right management team". Rekhi read that, probably accurately, as meaning to say that his problem was that there was no white person on his team. This was the situation that he hoped to rectify, not by fighting against the closed networks that served to, ultimately, perpetuate a form of racial-ethnic discrimination, but by becoming "as white as the whites", by forming his own sets of networks and mentoring relationships that would foster a community for the next generation of aspiring Indian entrepreneurs that he himself did not have the luxury of tapping into.

Rekhi's ambitions, however, are far from merely local, and far from merely being about enabling Indian professionals to be successful in the US. He dreams, indeed, of changing India, of turning it into an innovative and entrepreneurial society. These are visions that are based firmly in an idea of meritocracy and vanguard intellect. Himself a product of the Indian Institute of Technology (IIT), the prestigious set of institutions that are the training grounds for most of Silicon Valley's Indian software professionals, he believes completely in the IIT self-belief that this group is the best of the best. In other words, an organization like TiE, which is deeply inflected by the views of Rekhi and those like him, is, in spite of its religious and cultural inclusiveness, precisely *not* the sort of grassroots organic movement that the VHP is: these are entrepreneurs who truly believe that change can come from the top, that they represent the top, and that they can, therefore, change India on their own steam. In terms of strategies and tactics, therefore, TiE and VHP believe in completely inverted Gramscian fields of hegemonic action.

In addition to this strategic-tactical binary, of exclusive-grassroots versus inclusive-vanguard, are related binaries in conceptions of community and family. The VHP, like any fundamentalist religious movement, is deeply family-centric in its focus. The entrepreneurial ideal type, however, is that of the Lone Ranger, and indeed the risks of starting a company are so great that it is deemed exponentially harder to do so when the entrepreneur has other people to provide for. Most male Indian professionals who come to places like Silicon Valley from institutions like IIT, indeed, do come as bachelors, and invariably "make good" before they return to India to get married. The mantra of entrepreneurialism that TiE espouses, and indeed seeks to establish as a way of life in India, is intensely centered around a vision of a community that is formed by a more American vision of *networked individuals*, not, as in the VHP's case, a community of strong patriarchal families.

TiE transposes back to India, then, ways of starting companies that are normal in the US, and the financial and institutional backing to follow those ways. Rekhi, for instance, has set up a start-up incubator at IIT Bombay, a model of corporate incubation in university settings, where the university provides entrepreneurs with subsidized space and some funding to see them through their earliest stages of company formation, that is quite typical of models followed at a number of US universities. As Rekhi says:

> The people who are at IIT Bombay, the professors and the students, they wouldn't have thought of being start-ups, so we brought this notion in.... You know, just...bringing this tradition of entrepreneurship – like they have at Stanford, like they have at MIT – to Indian universities. The Indians...followed the British model, by and large [for universities]. There is the notion of being very pure [and] non-commercial in your studies. In the US there's a big notion of how do you use your knowledge very quickly to create wealth, create jobs? So we're bringing this concept to India now.[195]

[195] In an interview to cnn.com, available at www.cnn.com/SPECIALS/2000/virtualvillages/story/india/interviews/rekhi.html

Such a conception as Rekhi's doesn't see ideology as something that is spread or diffused, but sees it literally as a *thing*, plant-like perhaps, that can packaged, physically transported and deposited on new soil, where it will take root, spread and grow. Notions are "brought in", like a laptop, and one can almost imagine Rekhi declaring his notions at customs as he flies into Bombay.

Related to this faith in vanguard individualism as the engine for economic growth is, not surprisingly, a disdain and contempt for the state:

> India took a wrong, a left turn, about 50 years ago and became socialist. It was a tragic mistake India made, and it's paying for that one.... One of the the messages that I deliver when I travel there is [that] entrepreneurs are the only hope. They are the wealth creators, job creators of the society. They are the locomotives which will pull the whole train along, which is a new concept for India because the...the mindset under Nehru, Gandhi was central ownership of industry.[196]

Indeed, at a meeting of EPPIC that I was attending, one member talked of a recent visit to Bangalore where a high level state official asked him how the state government could be of help in setting up entrepreneurial ventures, and he responded that the best way the government could help would be by staying as far away from them as possible.

On the one hand, therefore, is an entrepreneurial community that professes a philosophy that could be read as being stridently Thatcherite. On the other hand, it does so without having to take into account the fundamental contradiction of Thatcherism, which is that it needed the state to dismantle the state. Rekhi and the Silicon Valley NRI entrepreneurs think they can do it from without (a belief, as I explain later, that is unable to escape the dependency that even these agents have on the state).

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[196] *Ibid.*

What drives these entrepreneurs then is of envisioning India Inc., and placing that mode of nationalist envisioning both alongside other types of corporate / investor envisioning that I have talked about so far, and also in the context of other nationalist imaginaries operating in India today. For Rekhi, spreading the free market is no less a calling that it is for Randy Scott or Patrick Terry, or indeed was for David Livingstone. However, this is a calling, explicitly, of nation rather than religion, but a "national" calling that reflects what I had in the previous section, quoting Derrida, called a "structural messianism". Rekhi talks about himself and his comrades thus:

> We see ourselves as missionaries now. The Indian independence movement in the '20s was led by the Indians who came back from England. They came to India [where there was] no thought of lawful society, liberal society, and they applied those concepts, and that was the basis of our freedom movement, in the '20s and '30s.
>
> Essentially what we're doing [now] is the economic freedom movement for India.[197]

Therefore, capital flows back to India from US-based NRI organizations focus, depending on the organization, on entrepreneurship (TiE), religion (VHP) and disaster relief (both). Indeed, a major mechanism by which Hindu nationalist organizations have gained grassroots legitimacy in India has been through provision of relief at sites of those disasters that they haven't engineered themselves. The massive earthquake in Gujarat in early 2001 meanwhile saw an outpouring of relief efforts on the part of entrepreneurial organizations such as TiE, who further encouraged American companies to donate money for relief and reconstruction (interestingly, the VHP has claimed credit for first drawing attention to the need for massive relief funds in Gujarat after the earthquake, which they claim was responsible for creating the impetus for organizations like TiE to get involved in the first place).

The question of the motivation for NRI groups to get involved in channeling capital back to India isn't just one of ideology or philanthropy, and further cannot be explained simply by the

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[197] *Ibid.*

"guilt" of NRIs who feel they "owe" something to their home country, as many Indians in conversation often postulate. Rekhi, for instance, is quite contemptuous of explicitly "philanthropic" entrepreneurs. For instance, a group of entrepreneurs pitched their business idea to him, in which a part of their business plan promised to set aside 5% of their profits for the development of science and technology in India – something that, one would imagine, would be in consonance with Rekhi's own ambitions. Rekhi was openly disdainful of the idea, and chided them that they were supposed to be starting a business, not a charity. Easy psychoanalytic attributions of feelings of guilt as being the motive force for channeling capital back to the country are likewise little more than conjecture, and fail to take into account the larger structural forces that create such feelings of obligation to one's home country. My own sense of duty to somehow reinvest material or intellectual capital in India stems not from charity, guilt or a nebulous and ill-defined "patriotism" (for it is, after all, that patriotism that one needs to explain rather than use as explanation) as much as it does from the realization that I received, from the Indian state, a virtually free college education that enabled me to move on to the most prestigious centers of learning in the world (my total college fees for a three-year undergraduate degree, *inclusive* of tuition, accommodation and utilities such as electricity, amounted to about 720 rupees, which, at the exchange rate of the time, would be roughly $25).[198] Rekhi himself acknowledges the quality of education that IIT graduates receive, an education that is almost to the same extent subsidized by the Indian state (which makes Rekhi's contempt for the state even more ironical). These are obligations, stemming not merely from the psyche or from ideology, that are, I argue, the *obligations of citizenship*.

The category NRI was officially coined by the Indian government in 1973 through the Foreign Exchange Regulations Act, thereby recognizing Indians abroad, through formal systems

[198] The United Nations Development Program (UNDP) 2001 *Human Development Report* estimates that an annual resource loss for India from software professionals who migrate to the US is $2 billion, if one calculates the amount of state investment that is put into most of their (virtually free) higher education.

of state classification, as a distinct group with a clear incentive structure set up for them to reinvest capital back in India. Indeed, I argue that citizenship for NRIs is defined almost solely in terms of their ability to repatriate capital. This is partly because the Indian government doesn't allow dual citizenship. The 1973 Act, however, also recognizes a category called "person of Indian origin", which is anyone who has at any time held an Indian passport, or is the female spouse of such a person (male spouses of women of Indian origin are not considered to be of Indian origin), and provides similar investment incentives for these people as it does for NRIs who are Indian passport holders (Ramachandran 1992; see also Rajagopal 2001: 241-242). Further, the formal citizenship for even those NRIs who possess Indian passports is somewhat nominal, as they are, rather perversely, unable to vote in Indian elections unless they are physically present in India at the time of elections, or government officials stationed in a foreign embassy. Therefore, citizenship for NRIs gets defined solely in terms of their ability to repatriate capital, and the Indian state has a quite conscious agency in shaping such a definition. Conversely, the repatriation of capital, for NRIs, becomes the defining act of citizenship (whether they are formally still NRIs, or have abdicated Indian citizenship to become merely "persons of Indian origin"). Capital, quite literally, becomes the social bond that links Indians abroad to their homeland, but it only works as such a bond because there are other, less structural, ties already in place.

Of course, what is repatriated by members of organizations such as TiE is not simply capital but also *expertise*, in an odd quasi-inversion of that oft-repeated malady of Indian technoscience, "brain drain". There is, therefore, a confluence of repatriated capital, labor and imaginaries. Labor, because there is an increased incidence of Indians who have gone abroad for graduate or post-doctoral study or work returning to India to further their careers; imaginaries, because the "expertise" that is repatriated is not simply formal technical expertise (which, after all, is garnered in abundance and in quality by these professionals at institutions like the IIT

before they leave India), but cultural ideals, such as of entrepreneurship, ideals that get reflected in mimetic institutional structures, but also in larger urban landscapes. Hyderabad, which, along with Bangalore, has been the favored city for the repatriation of capital and expertise to set up high-technology industries in India (initially mainly information technology, but now increasingly biotechnology as well), has a designated 600 acre area of land that is called "Genome Valley", explicitly conjuring an image, and thereby, it is hoped, eventually a reality, of an entrepreneurial technoscientific haven on the lines of Silicon Valley.

As my account of CBT in the Chapter 5 shows, though, it isn't just NRIs who have technoscientific imaginaries about India. Such imagining is very much at the heart of the public Indian scientific establishment as well, especially in cutting edge high-tech fields such as genomics. The question then is how NRI (and reciprocal "local" Indian) technoscientific imaginaries are at odds, or not, with NRI (and reciprocal "local" Indian) cultural –religious imaginaries, such as those of the VHP and the ruling BJP, and how "nationalism" differentially inflects these different sets of actors. Perhaps the emblematic representative of the VHP-BJP type of cultural Hindu nationalism as it articulates between its US-based and Indian-based versions (see Rajagopal 2001 for a comparison of these "versions") is their President, Ashok Singhal. Similarly, the emblematic representative of a technoscientific nationalism as it articulates between Silicon Valley and emergent Indian high-tech industries is the Chief Minister of the state of Andhra Pradesh, and the man who "created" Genome Valley, Nara Chandrababu Naidu.

It is important at this point to emphasize that the Silicon Valley high-tech entrepreneur is not the only type of expatriate Indian to the United States, and is certainly not the original one. Karen Leonard (1997), for instance, talks about Punjabi (mainly Sikh) immigrants to California in the early part of the 20th century, who were mainly involved in agricultural labor. These Sikh communities, many of whom have moved to California as whole families, are still a significant migrant community in the state, and their affective bonds with the homeland have both

historically and in the present remained quite strong. It was these expatriates in the 1920s who founded the Gadar Party, a revolutionary party for India's liberation from the British that sent its members back to India to get involved in armed struggle for freedom.

Today, in addition to the high-tech software and biotech professionals who are the most powerful and visible part of the Silicon Valley Indian diaspora, there are still a large number of Sikhs, signified by the fact that a road in Fremont is named Gurudwara Lane. Many of these Sikhs are taxi drivers, and their fierce sense of nationalism was reflected in a conversation I had with one of them as he drove me to a friend's house near Berkeley. As I spoke to him initially in Hindi, his heart immediately warmed to me. I learnt that he had just moved from Amritsar three years previously, and was pining for home. He asked me whether I planned to settle down in the US, and I replied that while I would probably end up doing so, my heart was still in India. At this, he turned around, smiled broadly, and said, "*Han bhai. Is behanchod desh mein reh rehke khoon bhi safed ho jaata hai.*" ("Yes, brother. Staying in this sisterf***ing country too long turns even one's blood white."). He refused to charge me for my ride, even though ferrying another Indian around must hardly have been a novelty for him. And yet, as he said, "*Apne mulk ke aadmi se kaise paise le sakte hain?*" ("How can I take money from someone who is from my country?").

I am trying to emphasize through this digression firstly that nationalism is of many different varieties – an obvious fact in itself, perhaps, but one that gets all too easily overlooked when a particular brand of nationalism becomes the dominant discursive form through which one is expected and allowed to express alliegance for the nation (and nationalism does, quite literally, get branded and circulated as commodity, certainly in India, and through technologies like the media, as Rajagopal [2001] shows). Secondly, these varieties don't simply polarize into an anti-imperialist, secular, "Congress" nationalism and a culturally aggressive, Hindu, "BJP" nationalism. In places like Silicon Valley, and for expatriates, in particular, nationalism is often necessarily defined as an inchoate affective "love" for one's country and countrymen, but it is

also defined in relation to the American Other. The modes of articulation of this relationship are starkly different in the case of my cab driver on the one hand, and TiE on the other. Both recognize themselves as racially marked, even in the absence of an explicit self-admitted racial violence that is so much a feature of everyday life for South Asian expatriates in, for instance, Britain. While the cab driver distances himself from the "white-blooded" American (under which category he might include the Indian who doesn't speak to him in Hindi), TiE, as part of its institutional mandate, seeks to identify with the Americans, play their game, be "whiter than the whites". This is clearly stated in the organization's objectives, one of which, as mentioned above, is to "help members integrate into the mainstream community". The way TiE seeks to deal with minority status is by becoming such a model minority that they stop being recognized as minorities anymore.

Not surprisingly, Rekhi has been an activist lobbying for the relaxation of US immigration restrictions on Indian high-tech professionals. He has become actively involved with the Immigrant Support Network (ISN) to help foreign high-tech workers lobby to change immigration laws. But again, the way Rekhi involves himself is by projecting American interests, and himself as an American, rather than by projecting issues such as racial disparity or discrimination. For instance, he said: "My generation came here and became strong Americans. We were productive citizens, creating wealth and jobs for society, everybody was a winner. This whole new thing worries me because it ties people down, disenfranchises them economically...and I am worried that this will not produce a strong American economy or help entrepreneurship. So my point is to raise awareness that this situation is not very healthy for society, and if the US needs engineers, it must step up and offer them a fairer deal" (quoted in Din 2001a).

And of course, the cost of easing restrictions on high-tech model immigrants has to be a tightening of restrictions on those who are not professionals. In the interview cited above, Rekhi continues:

> When immigrants were first allowed in the '60s, they were engineers and highly skilled people. Then there was family reunification, and parents and brothers and sisters were allowed in. All of a sudden, primary immigration of professionals became secondary immigration of taxi-drivers.... That secondary immigration was of very poor quality, and that caused a backlash. For one engineer, you'd get ten others. It's time to go back to the original setup, where you allow professionals and only their spouses and children, not one's brothers, sisters, parents...The US cannot take everyone in the world. I brought my brother and sisters here, don't get me wrong, but none of them turned out...if you let things continue, you get an endless loop of poor quality immigration".[199]

These remarks are well in keeping with the meritocratic, highly individualized visions of India Inc. that TiE repatriates to India as its "entrepreneurial culture".

Joseph Dumit (1998) talks about the formation of identities by scientific fact through his notion of "objective self-fashioning", a notion that I engage with in Chapter 8 as I talk about genomic fetishism. Identity in technoscientific capitalism however is shaped not just by the knowledge provided by technoscience, but by the hybrid de- and re-localizations that often accompany globalized knowledge production enterprises. TiE entrepreneurs, therefore, engage in a *subjective* self-fashioning, which is a mimetic American self-fashioning that doesn't just

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[199] Expectedly, Rekhi's comments, made in April 2001, created quite a controversy, with heated debate ensuing on online Indian newsgroups and discussion groups. In May, Rekhi issued the following clarification on his remarks: "The raging debate about my views regarding secondary immigration were taken out of context. I hold no views about who should be or who shouldn't be allowed in. I am too much of a free marketer to worry about the quality of one profession over the other. I did make a distinction between primary and secondary immigrants in that primary immigrants come on their own merit and compete like hell to survive on their own. Secondary immigrants often were sponsored brothers and sisters who were not qualified like primary immigrants and needed a lot of help to adjust here. Incidentally, I am somewhat of an expert here [*sic*], having sponsored five brothers and their spouses over a 15 year period. I am not against family re-unification at all. Is an endless loop of sponsored brothers and sisters family re-unification?" (Quoted in Din 2001b).

confine itself to "non-resident" locales, but gets repatriated in the form of such imagined constructions as Hyderabad's Genome Valley. Further, it is a form of self-fashioning in the image of the American Other that already exists, before the act of repatriation, in the Indian middle-class consumer population, fed as it is on America in every form through satellite television and the flooding of its markets with foreign consumer goods. At the level of the state, this technoscientific subjective self-fashioning is epitomized by Chandrababu Naidu, the Chief Minister of Andhra Pradesh.

This last point is particularly ironic, because Naidu himself, when he became Chief Minister, inherited the mantle of a leader, N.T. Rama Rao (popularly called NTR), who most explicitly self-fashioned his politics in terms of Telugu *locality, as* itself a form of nationality.[200] This is indicated in the name of the political party that NTR founded in 1982, Telugu Desam (literally meaning Telugu Nation), which Naidu now heads.

While objective self-fashioning is, at one level, a highly individuized and individualizing form of identity formation, it is also a form of identity formation that often occurs, or subsequently manifests itself, as collective social movements, such as patient advocacy groups. Therefore, it is a mode of collective individualized identity formation that, on the one hand, often propagates beyond the individual through media such as the internet. It is also, on the other hand, often the preserve of those who have recourse to the "culture of no culture" – scientific fact shapes identity not just because it is deemed supremely authoritative, but also because it is deemed to be somehow *a*cultural. Sharon Traweek, indeed, refers to the culture of high energy physicists as being a "culture of no culture", which she describes as "an extreme culture of objectivity...which longs passionately for a world without loose ends, without temperament, gender, nationalism, or other sources of disorder – for a world outside human space and time" (Traweek 1988: 162). By allowing the authority of science to mold one as consumer (rather than

[200] Telugu is the state language of Andhra Pradesh, and the people of Andhra Pradesh are called Telugus.

scientist), objectively self-fashioned subjects take on an identity that is perceived to be supremely objective.

There is, however, a very different sense in which the notion of a "culture of no culture" has been used, by Ruth Frankenburg (1993) in her analysis of racial-cultural self-identifications of white women, done after interviewing a number of women in Northern California. The space of no culture here is the privilege of unmarkedness that accrues to a dominant culture that does not have to define its identity in relationship to an Other, but can assume itself as normative. If the "culture of no culture" represents *objectivity* when the identity-forming agent is science, then it represents *normativity* when the identity-forming agent is race.

The question for an analysis of *bio*capital, which is always already an analysis of forms of biosociality, then becomes the following: given that there is no shortage of American companies targetting the consumptive capabilities of the middle class in India, one would imagine that the problematic, of understanding emergent forms of biosociality in comparative context, should *not* be the question of how biosocial communities such as PXE International and Genomic Health (discussed in the previous section) emerge as articulate(d) entities in the US. Rather, it should be the question why such biosocial arrangements that depend on a consumptive market of precisely the sorts of networked individuals envisaged by organizations such as TiE *have not* emerged in India in spite of their mimetic efforts. In other words, why is it that the importation / repatriation of corporate technoscientific cultures of *production* to India have *not* led (as yet, at least) to the same kinds of biosocial emergences as these productions do in the US? Why is it that the subjective self-fashioning of *both* the productive entrepreurial community (and its allied state actors) *and* the consumptive middle class, *as* explicitly "Americanized", have *not* led to a salvationary objective self-fashioning in the image of corresponding American identity-formations through processes of production and circulation of facts, technologies and commodities? It is in asking the question of a *failure* of homogenous emergence in spite of the

explicit attempt by many actors to reproduce such homogeneity that one comes up against the importance not just of nebulous attributions of cultural difference, but also of the different salience of precisely those cultural and ideological categories, such as nation and salvation, that completely imbricate, and thereby differentiate, "cultures of no culture" as "acultures" that can *only* be understood and made sense of through cultural analysis.

In other words, entrepreneurial "cultures" do not simply emerge from capital, infrastructure and ideology, though all three are undeniably essential. Rather, they emerge from complex institutional, material and semiotic assemblages, that in the US, for instance, involved the coming together, at a certain conjunctural moment, of legislative changes (such as the 1980 Bayh-Dole Act), legal precedents (such as *Diamond v. Chakrabarty*, that allowed patents on genetically engineered micro-organisms; June 1980); technological advancements (recombinant DNA technology); changing business terrains (the emergence of venture capital as a serious force in enabling technoscientific research) and business events that either anticipate or respond aggressively to these changing events (for instance, the hugely successful Genentech IPO in October 1980). Therefore, the question of the failures of mimesis that I pose can be answered in terms of the fact that while one can replicate components of an assemblage, it is not so easy to replicate their strateified dynamics or their structural conjunctures. To assume that India in 2002 will replicate the US in 1980 is ultimately buying into an allochronistic discourse that is deeply ahistorical, because the material relations of production, the institutional relations and the larger socio-economic contexts are simply not comparable.

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Let me move away from the specifics of the NRI entrepreneurial community, then, to make some more generalized remarks about the conception of India Inc., before swinging back to talk is greater detail about Chandrababu Naidu.

I use, as the basis of this critique, a special (June 2001) issue of that bastion of British Conservative capitalism, *The Economist*, titled "Unlocking India's growth". This issue, filled with inescapably stereotypic capitalist rhetorical maneuvers, manages constantly, on the one hand, to use historical evidence to denounce the multiple failures of the Indian state, while on the other hand simultaneously denying the historical failures of economic liberalization in India over the last decade, failures that it claims indicate *insufficient* liberalization.[201] Similarly, incidences of market corruption are pointed to as individual aberrations that can be set right by more privatization, while incidences of state corruption are revealed as a systemic, structural feature of the state apparatus.

And so, therefore, *The Economist* survey proceeds on a *tour de force* of systematic contradiction, selective argument and logical inconsistency (Unger 2001). For instance, it points to Maharashtra and Gujarat as the "successful" states upon which an Indian economic vision ought to model itself, without at all mentioning that the undeniably impressive growth rate of these two states has come with the price tag of massive closures of textile mills, leading to huge unemployment, and violent communal tension, such as was witnessed in Bombay for weeks in 1993, and in many parts of Gujarat for months (still ongoing) in 2002. Further, mapping Indian states by growth or liberalization alone fails to take into account the fact that the conditions of possibility for such growth already existed in high growth states independent of privatization policies. The agricultural economies of Gujarat and Maharashtra, for instance, depend upon cotton, a cash crop that has always been a significant revenue-earner. Andhra Pradesh, Naidu's home state, and Karnataka, the state of which Bangalore is the capital, meanwhile had net state domestic products per person in 1998-99 that were significantly lower than even a relatively "backward" state like Haryana, in spite of being the most aggressive economic liberalizers,

[201] This is identical to the moves that Francis Fukuyama makes in his "end of history" thesis that Derrida (1994) deconstructs.

because these are highly drought prone states that are not as agriculturally productive as Maharashtra, Gujarat or Punjab (figures from Unger 2001).[202]

Wherever Unger sees "glory" for the Indian economy, it is invariably in a sector that provides services for the West. And yet, ironically, by *The Economist's* own logic (and certainly by the logic of those it would most appreciate, such as members of TiE), the challenge for India ought to be to develop an *innovative* technoscientific culture. How precisely one can make the transition from back-end contract work for big Western corporations to innovative research that can garner its own intellectual property is a question that is never even addressed by Unger's survey, even though, as I outlined in Chapter 5, this is the key question that is vexing state enthusiasts of the market in India such as the Council for Scientific and Industrial Research (CSIR). Unger's conclusions, that becoming a "global" player are most gloriously achieved by doing the sorts of work that need to be outsourced as cheap labor away from the West is well in keeping with the survey's overall tone of crass paternalism and allochronism, indicated in sentences such as the following: "The 1990s were Woodstock, a time of liberation and youthful experimentation but not much discipline for Indian industry. Only now are the pressures of adulthood being felt. Growing up is proving to be painful" (Unger 2001: 17). Such brazenly Orientalist language of course is not just discursive, but also underlies the sorts of collaborative ventures the West is willing to undertake with India, or the sorts of research and products emanating from India that get accepted as being of "global standard" by the West. Especially in reference to a country with a larger and more vibrant democratic structure than any that exists in the West, that is a source of such pique for many of the researchers at the Centre for Biochemical Technology (CBT), as I indicated in Chapter 5. This is because such researchers know from painful experience that this particular mode of condescension ensures that the only research

[202] Another example of a state that has done well, according to Unger, is Kerala. To quote: "Kerala has the most impressive long-term record, with the highest levels of literacy and life expectancy, and one of the lowest poverty rates in India" (Unger 2001: 20). An odd admission to make in a one-sided diatribe against

performed at CBT that gets deemed legitimate to publish by top Western journals is research that is repetitive or confirming of work already done in the West. Implicit in this condescending glorification of India as a site for back-end cheap labor is the belief that India is also *not* the site for cutting-edge innovation..

The most amazing part of *The Economist* survey, however, is its last section, which calls itself "A management guide: How to run India Inc.". It starts by saying that "[I]f India were listed on the stockmarket, it would be a juicy takeover target. A corporate raider would see an enterprise that has raised its game in the past ten years but remains constrained by caution. Surely India's assets could deliver higher returns under new management" (Unger 2001: 19).

It becomes evident that only certain prescriptions can flow from a framing of "India Inc." as a "takeover target" for a "corporate raider", in need of "correction" so that it can achieve its "full potential". The things that need "correcting", not surprisingly, are things like "wages and salaries", that need, of course, to be corrected with that wonderful attribute of the Wall Street trader, "draconian pragmatism" (*ibid.*).

"Draconian" is the key word here. For what Unger is doing, effectively, is promoting the propagation of the "free" market through profoundly anti-democratic means. It is not surprising, then, that the constant standard against which Unger measures India's "success" as a "global" economy is *not* any of the Western economies, but China, which of course manages much of its economic growth through a complete suspension of workers' rights. I shall ignore for the moment the obvious ironies inherent in the fact that it is one of the three major surviving Communist countries that should be held up as the model for economic liberalization and "growth" in the global marketplace. For of course, China also gets its "glory", most notably, from the fact that it does essential back-end work for Western corporations, primarily in manufacturing (rather than

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the state, because Kerala has of course gotten where it has through active state intervention, especially during the tenures in power of its leftist governments.

services, which is India's primary back-end strength). In other words, the glorification of China as *the* liberalized economy to emulate further emphasizes the fundamental fact that *global* capitalism, as Spivak for instance constantly emphasizes in her work, can *only* survive by exporting the draconian labor practices of the metropolitan Industrial Revolution into the periphery.

This setting up of China as the liberalized economy to emulate is also central to Rekhi's philosophy, thereby setting up, on the one hand, a *desire* that is firmly based in American mimesis, and on the other hand, a *strategy* that is firmly based in following the Chinese. It is particularly ironic that Rekhi, who, as quoted earlier, claims to be a "missionary" involved in the "economic freedom movement of India" is so enamored of precisely such a model, of doing contract work for foreign companies without sharing in their intellectual property, that mirrors V.V. Krishna's (1997) assessment of colonial science (discussed in Chapter 5), whereby Indian labs exist primarily to perform work that has been designed in the metropolis, which again is where the maximum value gets realized.

There is a fundamental contradiction then that Naidu faces in Andhra Pradesh, where he is, on the one hand, a democratically elected chief minister, and on the other, sees governance as something that needs to be undertaken on sound management principles. As the former, he cannot afford to be draconian when he depends on re-election by the people of Andhra Pradesh for his continued power. If the analogy *has* to be made to a company, then in a democracy (and certainly in a parliamentary democracy such as India), it's the *workers* and not the *stockholders* who vote. Naidu has been called, often derisively, the "laptop chief mininster". Were he the CEO of a company with the attendant stakeholders that CEOs are answerable to, he would no doubt be a very good one.

In other words, *The Economist* and TiE argue for a type of vanguard economic restructuring that is reminiscent of totalitarian communism in the means of its implementation!

This does not mean, however, that Naidu has not resorted to implementing some draconian labor measures himself. The software industry, for instance, is exempted from the provisions of a series of Acts such as the Factories Act, the Minimum Wages Act and the Workmen's Compensation Act, and is further permitted to run a three-shift operation.

The fundamental contradiction that runs through *The Economist*'s survey, of course, is the fundamental contradiction of Thatcherism, that dismantling the state requires a huge amount of state action, that is extremely evident when one looks at Naidu's strategies of governance. I explore this point in greater detail as I talk at greater length about Naidu, and biotech in Andhra Pradesh.

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To talk about Naidu, one needs to start by talking about the political party that he heads, the Telugu Desam. This is amongst the younger, and yet more powerful, of what are known as "regional parties", parties that draw their political affiliation from a particular region (usually a single state) in India. So on the one hand, these are parties whose ideologies and identities are intensely shaped by a sense of locality, in opposition to the centralizing tendencies of the Indian state that are most acutely upheld by the Congress party, which has ruled India for 44 of its 55 years of independence. On the other hand, these are parties that have become increasingly central to national governance, as the erosion of the Congress's pan-national hegemony has seen the emergence of coalition governments at the center, an emergence that is likely to persist as the norm rather than the exception in the coming years of India's parliamentary democracy.[203] What is interesting for me here is how in many ways a regional party such as the Telugu Desam is increasingly enrolling itself as a *transnational* facilitator of capital flows into India, as the upholder of the "Telugu nation" turns out to be the most aggressive and sophisticated political player in the game of globalization. At one level, of course, it isn't such a surprise that a political

party that depends on an ideology that is opposed to the centralizing tendency of the state should find natural allies in entrepreneurs who are themselves opposed to such centralization. Political decentralization and market decentralization seem to find common cause in movements such as Naidu's Telugu Desam.

Speed, information and selling are the key modes of governmentality for Naidu: "[A]n Indian chief minister in today's global economy has to be a salesman. If he rests on his pride nothing will be achieved. He also has to be like a chief executive who makes things happen. Speed is of the essence" (Naidu 2000: 9). And further: "The only course at that point was to go out and market the state. That is what I set out to do. By going to every investors' forum, domestic or foreign, making Power Point presentations on what Andhra Pradesh has to offer" (134). Naidu has learnt much from management pedagogy, as any good chief executive should. He says: "politicians must be acquainted with the managerial wisdom of Peter Drucker and Jack Welch" (21). He is trying to turn governance, as the TiE people are, into an *expert regime*. It is an expert regime, further, that is founded on mimesis. Therefore, in the time that I was in Hyderabad, a weaver committed suicide under the burden of debt, and Naidu's response was that there was a need to send psychiatrists out to the weavers. He thereby shows how things like psychiatry, like and as a part of Western (especially American) management pedagogy, can be exported in ways that have consequences, and erase a necessary attentiveness of the part of those in power to the historical material causes and consequences of crises among their constituents.

This is a governmentality, however, not of the *nation*-state but of the *state*-state: the entity that Naidu seeks to manage is, quite explicitly, Andhra Pradesh, which after all *is* the region that the Telugu Desam in its very inception claimed most directly to represent. Further, Naidu constantly emphasizes the competition *between* states, for rapid economic growth and attraction of foreign investment, as if each state was a corporate entity.

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[203] A political reality that the Congress continues to wilfully turn a blind eye to.

But even the notion of Andhra Pradesh as a single state is a problematic one. There is an increasingly strong movement for statehood for Telengana, which comprises the mostly interior parts of Andhra Pradesh. This is a movement that has existed since India's independence, with Andhra Pradesh, as a state, being the legislative conglomeration of three regions, Andhra, parts of Madras state, and Telengana. It is a movement that has gained force recently because of the continued deprivation of Telengana, and also because statehood has been given to four other regions in India that have fought for statehood for many years. This is worrying to Naidu because Telengana provides most of the minerals and raw materials that go into sustaining Hyderabad, and the relationship between the center and the periphery of this state has very much been one of pretty straightforward expropriation, with very little development being chanelled back to Telengana. Indeed, Telengana has been the site for many farmer suicides over the last decade, as a direct consequence of World Bank structural adjustment policies that ensured that most of former Chief Minister N.T. Rama Rao's populist measures were revoked.

Less disastrous proofs of World Bank intervention are seen in Hyderabad, which is now dotted with many flyovers and impeccable roads that have all come out of World Bank loans, and that are keeping the middle class happy. The problem with Naidu as far as Telengana is concerned is that Hyderabad itself is a part of Telengana, though now 80% of its population is migrant, largely Andhraite. This means that the resolution of the Telengana dispute – and there are many "global" factors having to do with ease of management that are likely to lead to an autonomous Telengana state sooner or later – is going to have direct repurcussions for Hyderabad itself. Therefore on the one hand, Naidu's own managerial principles would push for statehood for Telengana; on the other, what would then be at stake would be the control of the city that he has most developed through those principles. The Telengana issue is central to a thick understanding of Andhra Pradesh, Naidu, governmentality, globalization and India Inc.

Naidu has, as mentioned earlier, already effected a number of reversals of the founding Telugu Desam ideology. While it received its *discursive* identity from the notion of a federally strong Telugu statehood decentered from the Congress tendency to concentrate power in Delhi, it received its popularity from the populist measures of its founder and former Chief Minister N.T. Rama Rao (NTR), who was Naidu's father-in-law. Central to NTR's policy was providing cheap rice and huge agricultural subsidies, and imposing prohibition, which had been the demand of many women in urban and rural Andhra Pradesh. Naidu has brutally reversed all of these, at the altar of fiscal management, structural adjustment and pragmatism. And yet, central to his art of politics is his ability to project these brutal reversals, firstly, as policies that are not imposed by an anti-populist state, and secondly, as policies that represent the continuation of NTR's legacy while they reverse it.

Vision, then, is fundamental to Naidu's mode of governance: it allows him to project attractive futures to investors and his electorate alike, to set milestones for himself and his government to execute on, and it is precisely the mechanism that allows a silent reversal of NTR's legacy, because it implies, rhetorically, a legacy in itself, that Naidu artfully takes credit for, but always as an inheritor of a mantle, in a state where NTR's populism makes his legacy an extremely useful one for electoral purposes. Naidu posits vision in explicit opposition to planning, which has always been undertaken by the Indian state on Soviet lines, in terms of five-year plans. "For a vision", says Naidu, "a reasonable time-span is 20 years" (Naidu 2000: 12). In other words, in Gramscian terms, vision, for Naidu, is strategic, while speed is tactical: vision is the distant promissory horizon to set for oneself, while speed is the means by which to narrow that distance as energetically as possible. (The irony here is that Naidu himself can only be elected as chief minister for five-year terms).

There are direct links – of ideology, capital and locality – between Naidu and the Silicon Valley entrepreneurial community. One of the more perverse mimetic borrowings has been that

of the ideology of venture capital. Naidu has seen that venture capital was the engine that has fuelled entrepreneurialism in Silicon Valley. Ergo, he believes that Andhra Pradesh should have lots of venture capitalism. The state, therefore, has itself decided to provide venture capital, by setting up a fund to which the contributors are The Andhra Pradesh Industrial Development Corporation Ltd., the Small Industries Development Bank of India and the AP Industrial and Infrastructure Corporation Ltd. (see Naidu 2000: 139). In other words, Naidu has set up a system of *public* investment *as* "venture capital" funds! This is a completely anachronistic conception of venture capital, which by definition, comes out of huge private investment funds that expect an extremely high return on investment. Naidu's "venture capitalism" is, effectively, a euphemism for government subsidy for high-tech industry.[204] The fostering of an "entrepreneurial culture" in this way ultimately involves the removal of subsidies from one sector, agriculture,[205] and the concomitant provision of subsidies to another, high-tech – but primarily high-tech *services* rather than high-tech *innovation* – where the services themselves are invariably performed for Western corporations and exported.

Further, high technoscience doesn't occur in a vacuum on space shuttles. One of the most critical points to be made when discussing the interventionist role of states such as Naidu's – and might we call it an "intervention of no intervention", when premised on the ideology of *minimal* state intervention, an ideology, that in order to be upheld, requires *massive* state intervention? – is that things like information technology, biotechnology (together referred to in India quite commonly as IT-BT) and tourism, which are all central to Naidu's strategy for attracting foreign investment into Andhra Pradesh, all have *land* as critical to their operation. This land can only be

[204] This is not to say that there isn't a growing venture capital industry in India. The amount of VC investment in India increased from $3 million in 1995 to $342 million in 2000 (figures from United Nations Development Program 2001: 38).
[205] This has been the central dronal mantra of World Bank-IMF structural adjustment policies all over the world.

taken away from agriculture, and from peasants.[206] Let me explore this further by talking about one such state initiative to enable biotech "innovation" (I shall argue that that in itself is an inappropriate word and an unstable category in this context) in the Hyderabad area.

This is the setting up of what is known as the ICICI knowledge park, which consists of a set of infrastructure facilities developed by the state government in collaboration with the private venture capital and financial services company ICICI. It consists of a set of laboratories that can be leased out to companies who want to set up research facilities. The rationale for this, according to Naidu, is that "a lot of multinationals are interested in doing research in India because of the availability of high quality scientific manpower" (Naidu 2000: 147). This is a rationale, again, that is at complete odds with a rationale of doing *innovative* technoscience and *basic* research by local scientists. The knowledge park, indeed, is modeled on a similar software park set up near Bangalore. The Bangalore park, however, has been "successful", to the extent that it has managed to recuperate maintenance costs, because most of the office space has been bought by General Electric. Similarly, the best route for the ICICI knowledge park to be successful would be if a multinational pharmaceutical company such as Pfizer buys all the lab space. In other words, the structure of something like the ICICI knowledge park is best suited, from the perspective of the state's own investment in it, not to encourage basic, cutting-edge science locally, but to encourage the setting up of research facilities by big multi-nationals to do research at a fraction of the cost that it would take to do similar research in the West – research, of course, that will use state-subsidized infrastructure, but that will quite probably translate into scientific and commercial advances that get re-exported back to Western markets.

The ICICI knowledge park (referred to by the managers as simply The Park) is a good 40 kilometers outside Hyderabad. This part of the state, just north of Hyderabad, borders Medak

[206] According to 1991 census data, the rural population of Andhra Pradesh comprises 73% of the state's total population; there are 195.16 lakh (1 lakh = 100,000) agricultural workers as opposed to 104.48 lakh non-agricultural workers (a ratio of nearly 2:1, with the latter category including marginal workers).

district, which is amongst the less developed in India. It is also not far from the epicenter of operation of the People's War Group (PWG), a far-left revolutionary movement that has continued a violent struggle for land reform in northern Andhra Pradesh for close to 40 years.

The Park is clearly conceived as a kind of idyllic research environment. All the labs are extremely open, and a lot of the space has been given over to terraces that look out over fields, fountains and ponds, with a number of ducks thrown in for good measure. Indeed, this is an aesthetic that ICICI is very consciously trying to cultivate, as was evident from my hostess's constant and anxious questions to me throughout my visit as to whether everything looked scenic enough. It certainly did.

ICICI's job isn't to do science. Rather, it is to act as an estate agent, and provide the enabling conditions for companies to get together and do work in a workspace where a number of labs are in close proximity to one another, thereby presumably encouraging collaboration. ICICI's job is to ensure that everything these companies want is taken care of. While the job of ensuring smooth execution is ICICI's, the land has been made available by the Andhra Pradesh government (this area being very much a part of Genome Valley). The Park has its own sub-station providing the labs with electricity, and it has created its own catchment area to hold rain water, thereby taking care of the two big worries that plague any wet lab researcher in India. Also, The Park is not meant for companies with manufacturing facilities, as manufacturing may lead to pollution. The state government has declared a 25 kilometer zone around The Park as a no pollution zone.

The built-up area when I visited in summer 2001 had space for 10 labs, and there were plans to build more buildings in the future. One of the central features of The Park is a customs shed. One of the major problems that Indian researchers have is the absence of a standardized import policy for research materials, which means that quite often valuable and perishable materials languish in the customs sheds in Bombay without ever reaching their intended recipient.

ICICI however has ensured that any research materials coming to the companies housed in The Park will be delivered straight to The Park, where the customs officials will come the next day and clear the material. Another enabling feature that's "provided" by ICICI but is actually enabled by the government.

Parks like these raise a number of questions, and in India the immediate one is whether such ventures are huge steps towards becoming such things as a "developed country" or a "global player", or whether they are simply white elephants. The answer, as mentioned earlier, may well depend upon whether a big multi-national rents a significant amount of space in The Park, which means, of course, that while the stated rationale of such parks is to enable start-ups and local innovation, the route to success (or to an avoidance of a completely wasted enterprise) to to try and lure a big multi-national in with enticements of an enabling environment combined with cheap labor.

The second question has to do with start-ups themselves. If space in The Park isn't leased by big multi-national companies, then the hope is that it will be leased by small start-up companies hoping to start a biotech business. Indian industry has never been geared to take risks, as it has grown up in a largely protectionist environment. The brief IT boom and the desire of people at TiE notwithstanding, India is a long way off from having what might be called a "start-up" culture, certainly not in biotech (except for the odd notable exception). ICICI believes that providing the enabling infrastructure for starting up companies will change this, but an adequate material environment alone does little for entrepreneurship unless it articulates in creative ways with both long-term capital sources and with a certain sort of ideology of risk-taking that is central to an entrepreneurial culture taking root.[207] Another problem that industry has to tackle is the question of how to leverage academe as an incubator (something that Rekhi and the people at

[207] The role of pedagogy of course is central here, which is why initiatives of Naidu's such as setting up the Indian Business School, modeled on the lines of American schools such as Wharton, become an integral component of such emergent stratified assemblages.

TiE are acutely aware of, but the managers of The Park and the state government apparently less so). It is particularly ironic that a "start-up space" is being envisaged 40 kilometers outside Hyderabad, when the city itself has some of the top academic life science research institutions in the country, such as the Centre for Cell and Molecular Biology (CCMB). Indeed, Shanta Biotech, perhaps India's one well-known wet lab biotech company, that has managed to develop an indigenous hepatitis B vaccine, did so while it incubated at CCMB.

The third point of interest is the involvement of Silicon Valley NRI entrepreneurs. Indeed, leading members of EPPIC have taken a very active interest in The Park. For instance, EPPIC Global (headquartered in Silicon Valley) has started an Andhra Pradesh chapter, with which it has entered into an agreement to promote The Park in the West. Of course, as I said earlier, one of the things that is most marked among NRI entrepreneurs is the general contempt they have for the state, making it particularly ironic that it is the activist Andhra Pradesh government that has ultimately made The Park possible.

The biggest question however comes back to center on the role of the state government. The irony of reservoirs of water being created and used for high-tech "global" research in what is not a water-rich region is obvious enough. The bigger question is one of land, of the gifting of agricultural land by the government free of charge for The Park. The only way to so nonchalantly divest people of their land is to somehow pretend they don't exist – a discursive erasure that has material consequences, as the spate of farmers' suicides in Andhra Pradesh over the last decade testifies to. These old and tenacious manifestations of capitalism have to be taken especially seriously in Andhra Pradesh, with the fact of revolutionary peasant movements being so completely inscribed in the state's history and present. That these gifts of land by the government to private companies with NRI backing are not gleefully received in all quarters I think needs to be taken as a given.

What makes it so easy to conceive of land such as that which The Park is built on as somehow "ideal" for the setting up of high-tech enterprises is a conception of these areas as simply the extension of Hyderabad city – an extension of the city into its surrounding agricultural environs that is particularly marked in Bangalore, which also has similar high-tech areas coming up on the periphery of the city, and Delhi, which has many industrial "satellite" cities, and an increased number of upper class residential colonies, coming up on its outskirts. The Park is itself located close to Turkapalli village, which is officially a part of Rangareddy district. It is, however, close to Medak district, and is roughly half-way in between Hyderabad and Medak, the district headquarters of Medak district. A few figures from the 1991 Andhra Pradesh census indicate what a stark difference there is between urban Hyderabad and its surrounding rural districts that are being made into an extension of urban Hyderabad.

Hyderabad has a literacy rate of 71%, compared to 49% for Rangareddy district and 32% for Medak district. In a 217 square kilometer area, Hyderabad has 177 hospitals and 1062 high schools. In a nearly 7500 square kilometer area, Rangareddy district has only 45 hospitals and 1032 high schools. In a nearly 10,000 square kilometer area, Medak district has 49 hospitals and 1363 high schools.[208] 21% of the population of Rangareddy district are cultivators and agricultural laborers, as is 35% of the population of Medak district (compared to 1.4% of the population of Hyderabad). In other words, there are stark difference in levels of development

[208] All of these figures are obtained from the 1991 Andhra Pradesh census, available at www.andhrapradesh.com, and also from Andhra Pradesh Government 1997. If these figures are adjusted for the relative population densities of Hyderabad city and the adjoining rural districts, the disparities are not quite as stark, and amount to a hospital ratio, for instance, of roughly 4:1 between the city and the rural districts. Two things, however, problematize such an easy calculation. The first is that the utility of hospitals is not simply related to the number of people that they serve, but also to their ease of access. It is not sufficient to say that hospitals serving a less dense population area can thereby be concomitantly fewer than one serving a denser population area, because in the former case the question of how sick patients in parts of the rural countryside far away from hospitals access them becomes a central question for development. Further, there is the question of the qualitative difference in hospitals and medical facilities in Hyderabad compared to its surrounding districts, vital comparative parameters that census figures cannot indicate. Indeed, hospitals in Hyderabad are seen by Naidu as an integral component of the state's *tourism* strategy, as he hopes to set up a number of "five-star" hospitals in the city that can cater to rich patients from various parts of the country (and perhaps also from other countries). He explicitly refers to the setting up of hospitals as a form of "health tourism".

between the city and the countryside, that are presumably to be bridged by some inchoate notion of wealth trickling down. In many ways, the networks between Hyderabad and Silicon Valley are stronger than those between Hyderabad and Medak. That many of the industries that get set up in the area around The Park are likely to be servicing Western markets and at best a class-limited sector of local economies is another factor that needs to be re-emphasized.

Having said all of this, I do not wish to attribute to either Naidu or TiE or ICICI any cynical motives: the objective, as the former two have constantly reiterated, is development, and the uplift of what gets unproblematically referred to as "the poor" in India.[209] It is important to take these intentions seriously. It is also important to take seriously the claims that technoscience can be a vehicle for such development, investigate those claims seriously and then identify what (if any) logical lacunae, theoretical contradictions and strategic inconsistencies might exist in the way such claims are envisioned as business practice or policy initiative when these visionings naturally frame India as "India Inc." What the Andhra Pradesh government is definitely doing is decentering simple notions of East-West / North-South / rich-poor / developing-developed. The problem with visions such as Naidu's is their belief in technology as in itself capable of fixing social problems.[210]

As a means, therefore, of taking claims such as Naidu's seriously, I analyze a document that comes from the heart of the global development establishment, the United Nation's Development Program (UNDP)'s 2001 *Human Development Report* (henceforth *HDR*). The

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[209] Having said this, the state of Madhya Pradesh, one of the poorest states in India, also has a technologically savvy Chief Minister in Digvijay Singh, but has been a leader amongst Indian states in making human development an explicit part of policy discourse. Naidu, in spite of constantly mouthing the mantra of development, has not even commissioned a human development report, something which has already been commissioned by seven other states than Madhya Pradesh. Meanwhile, there is certainly no shortage of reports relating to technological or market development coming out of the Andhra Pradesh government.

[210] The question of whether technology drives history, in the manner that Naidu apparently believes it does, is explicitly treated in M.R. Smith and L. Marx (1994). See especially the articles by Merritt Roe Smith on the history of technological determinism in American culture (1-36), Bruce Bimber ("Three Faces of Technological Determinism": 79-100) and Peter Perdue on technological determinism in agrarian societies (169-200).

question that *HDR* poses that is different from that posed at any point by, for instance, *The Economist* survey, is how technology can become not just a tool of economic growth, but one for *empowerment*. The success of information technology in India, for instance, would in such a framing shift from being measured by the number of call centers for American Express that exist in Bangalore to the success of developments towards local language computing (which, to be fair, Naidu has placed a fair emphasis on), as Kenneth Keniston constantly emphasizes (Keniston forthcoming). In other words, new technologies can serve as new sources of exclusion and social stratification if their benefits are merely left to "trickle down" with the assumption that such trickling is some kind of natural phenomenon (or one guided by the market's invisible hand). Technologies, quite evidently, can contribute to exacerbating divides more easily than they can to bridging them, especially when delivered through market mechanisms that do not place a premium on equitable distribution. The challenge of making technoscience a source of progress is one that demands strategic capital repatriation and policy making. Therefore, *HDR* emphasizes how "development" through technology cannot be successful if it is simply implemented through a top-down approach without concomitant infrastructure creation on the ground to enable local innovatory capabilities.[211]

India's most dramatic example of a "technological fix" has undoubtedly been its Green Revolution of the 1960s and 70s, which has certainly been a "success" by many parameters, such as leading to decreased under-nutrition and, in large measure, to the eradication of famine. Yet, firstly, as Amartya Sen (1981, 1999) shows, food security is intimately linked to democratization and *political* mechanisms of popular empowerment, not simply to technological fixes. Secondly, the Green Revolution has hardly solved the problems of equitable and timely access to food by

[211] *HDR* explicitly uses the term "technology" through its report. When I use that term in this section, I mean it to refer to technology in the more fluid and decentered STS parlance, as technoscience. This is especially because I go on to compare the largely technologically determinist vision of Naidu with those of "basic" scientists such as S.K. Brahmachari at CBT, who also see technoscientific advances as routes to national progress and human development, and who model their strategies quite explicitly on such beliefs.

large sections of the Indian population, as India in the last few years has produced surpluses of grain that are rotting in godowns.

As Keniston argues, however, information technology in particular has the potential to increase popular participation in decision making, especially if barriers to local language computing are lowered. This indeed is explicitly acknowledged by Naidu's government, which has almost any public document easily accessible online, with Naidu himself accessible to lay people by e-mail through his electronic management division. The contradictory pictures provided by India in information technology are particularly stark: on the one hand, India's IT industry has been a significant and growing revenue earner, regardless of the nature of services performed, with $4 billion in revenues in 1999;[212] on the other, only 0.4% of South Asians are internet users. Further, 1.3 million of the 1.4 million internet connections in India are concentrated in the cities of Delhi and Bombay, and the states of Karnataka, Maharashtra (the state that Bombay is the capital of) and Tamilnadu (*HDR* Feature 2.3: 40; no Andhra Pradesh or Hyderabad in this list). And India is not even one of the 30 leading exporters of high-tech products: in spite of its software exports, high-tech exports still constitute less than 5% of India's total exports.

It is an oft remarked fact that these high technoscientific achievements have to be set in the context of what are some of the lowest human resource indices in the world. In almost all human resource indices, *HDR* shows that South Asia (which, of course, also includes Pakistan, Bangladesh and Nepal, which are significantly less developed than India, and Sri Lanka, which has been fighting a civil war for nearly two decades) lags behind Latin America, with adult literacy rates lower than those of sub-Saharan Africa (see *HDR* Feature 1.2: 12), and GDP per capita income only marginally higher than sub-Saharan Africa's. Further, adult literacy is marked

[212] Most of this revenue comes from Western companies outsourcing their software requirements to India. Indeed, only 0.6% of South Asia's GDP is invested in R & D (*HDR*: 39)

by huge disparities between male and female literacy (the former being approximately 15% higher than the latter).

Countering these are figures that show that inequality in India has been falling (*HDR* Figure 1.7: 18). *HDR* also shows India as being on track to halving the number of people living in extreme poverty by 2015. The question that then needs to be asked is how technological growth hubs such as Bangalore and Hyderabad interact with the overall situation of *national* development, and also, simultaneously, with "global" hubs such as Silicon Valley. Bangalore, indeed, was rated by *Wired* magazine as the world's 11th largest technology hub,[213] begging the question of what such a rating means in the context of *national* development. It seems possible to suggest, from these disparities, that the nation as the territorial unit on the basis of which progress is measured is being decentered (in spite of Bangalore being recognized thus, India ranks only 63rd in *HDR*'s technology achievement index [TAI]). Certainly Naidu's politics, as mentioned earlier, are all about marketing the *state* of Andhra Pradesh. Nationalism needs to be understood in this context, of, as mentioned earlier, increased state-state competition for investment as if each was a market entity, and of the fact that Naidu's *state* level development projects are always already layered upon the fact that the Telugu Desam is the second largest constituent (after the BJP) of the ruling coalition at the center. Politics that emphasize the development of cities, in the name of enhancing the competitiveness of states with respect to one another, by state political parties that are significant constituents of ruling national coalitions, beg for new theorizations of democratic governmentality. These must be attentive to the stratifications among different levels of government, stratifications that call into question a simple assumption of state as subset of nation, but that rather point to the different assemblages that get constituted by each level of

[213] The parameters that *Wired* used to evaluate these hubs were: the abilities of area universities and research facilities to train skilled workers and develop new technologies; the presence of established domestic and multi-national companies to provide expertise and economic stability; the population's entrepreneurial drive, and the availability of venture capital. In this rating, Bangalore scored higher than cities such as New York, Seattle, Los Angeles, Cambridge (UK), Tokyo, Chicago and Hong Kong. It had the highest score amongst "developing country" cities along with Taipei.

government, assemblages that might be reinforcing, might be at odds with one another, but that are often constituted by the same actors playing different institutional and strategic roles. It is only by understanding such differential assemblages that seemingly contradictory actions can begin to be made sense of -- such as, for instance, Naidu being a part of a coalition government led by a Hindu nationalist party, when Muslims have always been a significant vote bank for his party; or his refusal to take the ruling party to task for its complicity in the recent violence in Gujarat, in spite of his professed displeasure with those events.

The notion of making any sense of figures using the Indian nation as reference is further problematized if one analyzes the question of explaining technology hubs in the context of national development by looking at disparities between states. In Punjab, for instance, 83.5% of households had access to electricity in 1994, whereas that figure is 20.1% in Uttar Pradesh, 18.8% in Orissa and 15.6% in West Bengal. 47 per 1000 people had telephones in Punjab in 1999, compared to 10 in Uttar Pradesh, 9 in Orissa and 16 in West Bengal. 8.21 per 1000 people had internet connections in 1999 in Maharashtra, while 0.12 per 1000 did in Uttar Pradesh and Orissa. (There were fewer people in Punjab – 1.24 per 1000 – with internet connections, a reflection of the fact that much of Punjab's prosperity has come from agriculture rather than services or high-tech commercial activities; Maharashtra's prosperity comes from a combination of cash-crop agriculture in the rural areas, and its capital, Bombay, India's commercial nerve center). In literacy, meanwhile, Kerala is way ahead of other Indian states, with 83% gross attendance ratio in secondary education in 1996, compared to 43% in Uttar Pradesh, and 44% in another bastion of communist party rule (like Kerala), West Bengal (all figures from *HDR* Feature 2.3: 41). These figures suggest, quite evidently, the extent to which development in India is uneven, an unevenness that can with some level of accuracy be reflected in state-wise analyses; but also that it is impossible to discern any sort of simple causal pattern that links development to

either technology, or agriculture, or certain sorts of ideology, without being attentive to the historical, geographical and socio-political contexts within which different states develop.

As I had mentioned earlier while critiquing some of *The Economist's* state-wise diagnoses, it is relatively banal to talk of states like Maharashtra and Gujarat as high-growth states *because* of liberalization, when one equally has counter-examples like Kerala that have high human resource indices in spite of not liberalizing aggressively, and states like Karnataka and Andhra Pradesh that are still relatively poor in spite of having hubs such as Bangalore and Hyderabad. It is equally reductionist to counter such rhetoric with a simple attribution of state investment as leading to human development by citing Kerala, which in spite of its high human resource indices has not attracted the sort of growth or technological infrastructure that some of its neighboring states have, and especially since West Bengal, which like Kerala has been ruled by democratically elected Marxist governments for a number of years (in fact, uninterruptedly since 1977, making Bengal's the longest continuously serving state government in the history of India), has much poorer human resource indices. Further apparent contradictions abound simply from a perusal of such statistics, such as, indeed, the longevity of Bengal's Marxist government, compared to the relatively tenuous position of Naidu's (by all accounts, he is predicted to lose his attempt at re-election for a third term in 2004) in spite of the former's poor development record, which has been offset by the fact that the Marxists in Bengal have pushed along some of the most aggressive land reform measures in the history of independent India, making them extremely popular in rural Bengal. Quite simply, innovation and growth do not translate in any simple measure into democratic popularity (which is why, of course, calls for aggressive market reform have necessarily to be anti-democratic at some level), but neither does democratic popularity translate in any simple way into high-technology investment or innovation.

Therefore, it is quite difficult to come to generalized conclusions about the "correctness" or "incorrectness" of a certain form of envisioning India by a set of actors with related

perspectives, such as TiE and Naidu (though their *situated* perspectives – the contexts from which their respective perspectives emanate – are, as I've tried to explain, quite different from one another). Indeed, making such a straightforward diagnosis would run counter to the very sorts of deconstructive attention that I have been arguing for throughout this dissertation. This does not, however, mean that one has to lapse into a complicated relativism that argues for "nuance" while simply refusing to stake out an opinion on what are, after all, questions of development, technology and democracy that have significant consequences for people depending on how their interrelated politics get played out.

As mentioned earlier, India's contradiction is not just the low *human* resource indices it has alongside technological hubs like Bangalore and Hyderabad, but the fact that its *HDR technology* achievement index (TAI) is equally unimpressive. What the TAI shows most powerfully is the problem of technology *diffusion*. Just as high foodgrain productivity without adequate distributive mechanisms nullifies the effects of technological revolutions such as the Green Revolution, so too does high productivity / growth of technology without its diffusion hinder "revolutions" such as India's purported IT-BT revolution from actually empowering people. What results from a mode of envisioning India as India Inc. – which is a mode of envisioning India solely as an engine of production to generate revenues that are an end in itself – is that a few very productive and increasingly powerful nodes, such as Bangalore and Hyderabad, get created, but that doesn't translate into development for the rest of the country – let alone for other "backward" states, even for those rural districts that abut such powerful nodes. This is what anti-globalization activists point to, perhaps in a reductionist manner but certainly with a good deal of diagnostic accuracy, as the "failure" of globalization, or its function to increase disparity (see for instance Bircham 2001).

Indeed, even China, that *The Economist* and Rekhi alike want India Inc. to model itself on, has a similarly dismal TAI, suggesting that the envisioned India Inc. is not one where the

diffusion of technological capabilities is a part of the program. What is envisioned, rather, are local concentrations of technoscientific power through "globalization" – for after all, Silicon Valley is precisely such a local concentration of technoscientific power, and even in the US, technological diffusion hasn't been accorded the highest priority, as is evidenced from the relative neglect of rural areas in much of the American mid-west. These intensely networked, almost anachronistically *local*, pockets then stand in for "the globe", as long as their productivity is vibrant enough to generate statistics that suggest "progress".

This, then, is a certain envisioning, that is mired in good intentions, and what are definitely certain (by no means invariant) forms of what might be called nationalism – forms that in the process decenter the nation as the natural unit whose "development" is at stake. One would imagine, however, that such decenterings would be much harder to effect if one was in fact an agency of the central government, whose mandate *is* in fact national. Therefore, I talk in the next section about the Council for Scientific and Industrial Research (CSIR) and two of its constituent laboratories, the Centre for Biochemical Technology (CBT) and the National Chemical Laboratories (NCL), as precisely such national public actors, who are also extremely invested in adopting market ideologies and becoming "globally competitive". How does such a "global" vision articulate itself in relation to one espoused by Naidu or TiE?

Getting an appointment with Chandrababu Naidu had been quite a revelation, because all I had to do was to e-mail him out of the blue. His office has an electronic cell, which forwarded my message to his joint secretary, who told me that he would try and slot me in to meet Naidu, and sure enough he did once I got into Hyderabad. Of course, this sort of thing is quite unheard of in Indian politics, but Naidu has a reputation of responding to peoples' e-mails, especially if they are from outside Hyderabad, but even more so if they are from outside the US, and / or have anything to do with science and technology.

Much of the "meeting" was, not surprisingly, waiting, but that too was quite an interesting experience. It seems Naidu meets with people every evening, and there are two separate rooms outside his

office where people wait: one for the "common man" and the other for "VIPs": I had been classified in the latter category. It reminded me of the Mughal emperor's court, with the separate Diwan-e-am and Diwan-e-khas for public and special audiences respectively. My Diwan-e-khas companions were the sorts of people whom I expected to see. One was a prosperous looking NRI from Washington DC who works for Sylvan Learning Centers. The second was an even more prosperous looking NRI from Denver, who was chaperoning an elderly, clearly "local", gentleman who was rehearsing his presentation to the Chief Minister from a bright pink folder called "Tirumala: Vision 2020". Tirumala is the site of the Tirupati temple, arguably the most sacred pilgrimage spot for South Indian Hindus. If, as I argued in Section 7.1, visions are religious, then clearly religions and religious institutions have to be visionary too. No doubt the Prosperous Denver Man was a major devotee and donor, and had used his NRI offices to get an audience with the Chief Minister.

Not surprisingly, I only got a couple of minutes with Naidu, and not surprisingly, he didn't say very much. At many levels, his giving me and appointment was mainly a managerial acknowledgement that he had registered my existence and the existence of my interests in his biotech policy. At some level, that's all I could and did expect.

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In Chapter 5, I talked about CSIR labs such as CBT and NCL. The Director of NCL, S. Sivaram, as I described in Chapter 5, is one such national public actor who is explicitly looking to move his institution beyond a contract research mode into a mode of what he calls "entrepreneurial" research. In other words, Sivaram is acutely aware of the fact that going "global" is not simply measurable in quantitative terms by the amount of foreign direct investment, or the amount of current revenues, but has to be measured by the amount of intellectual property that can be locally acquired, and the amount of revenue that can be sustained and grown over a period of time in a manner that isn't completely dependent on economic or

strategic changes in other countries or companies. In other words, I have already argued how, on the one hand, opposing "global" to "local" is not very useful when a certain predominant form of globalization in Indian technoscientific worlds occurs precisely through the creation of networked localities. On the other hand, the simple opposition of "global" to "national", made by proponents and opponents of globalization alike, is not a very useful binary through which to understand the *strategic mechanisms* by which global playing fields get envisioned as being in national interests. Naidu in particular too quickly equates "successful" globalization with increased foreign investment alone. TiE as well has similar tendencies, but adopts more contradictory positions: on the one hand, for instance, Rekhi's setting up of China as a certain model to emulate does suggest that his immediate interest is in revenue flow into India rather than the generation of local entrepreneurship. On the other hand, he is also involved in setting up entrepreneurial incubators in places like IIT Bombay, that are much more clearly modeled on American entrepreneurial ideals.

The real issue in teasing these strategies out, I argue, lies in getting at the way vision *works* in these different cases, in spite of their similar enunciations. Ironically, Rekhi and Naidu, by placing an accent on immediate revenue generation in order to generate future growth, are in fact inverting the rationale on which the biotechnology industry and Silicon Valley dot com boom worked, which, as argued in Chapter 6, depended upon the conjuration of futures in order to create the presents that enabled those futures to be realized (albeit in contingent and unpredictable ways). While there is such an element of conjuration in Naidu's designation of Genome Valley, for instance, it does not extend to the types of technoscientific endeavors that are ultimately supported by such actors – endeavors, such as contract work, that are all about assured short-term revenue, with long-term revenue therefore completely dependent on the contracting party and its economic and strategic constraints and contingencies.

Sivaram, on the other hand, espouses a mode of envisioning that is much more closely akin to that of the US biotech industry, which suggests that the way to do entrepreneurial science is to set far-fetched (but realizable) technoscientific goals, and *then* provide whatever incentives are necessary to realize them. This in principle is not different from Naidu's strategy of generating "20 year visions" as opposed to 5-year plans. The question then becomes one of explaining the way apparently similar structures of envisioning manifest themselves in contradictory and heterogenous ways on the ground, and also of staying attentive to the ways in which the institutional spaces from which such structures of envisioning emanate influence these contingent manifestations of visionary articulation.

When I asked Sivaram to articulate his vision, his response was almost entirely tactical, not visionary, and I reproduce it at some length:

> No, I don't have a particular, unique strategy except to keep challenging people all the time, in different disciplines, asking what we can do.... And much of this is dependent on human beings, individuals, well, willing to apply their mind. That's it. I asked someone one day why we can't make optical fibers from polycarbonate. I asked him, you know, GE is a manufacturer of polycarbonate. If I can open up a market like optical fibers, for polycarbonates, that's a huge market. Each one of us in some domain in which we are experts can surely come up with one of these "what if" scenarios. I think we need to focus more on "what if" type of scenarios.
>
> Probably one thing you want to know is what is our strategy to institutionalize such things – like is it going to be individual driven or what?
>
> See, I'll tell you what. As a publicly funded external R & D organization, we are not targeted. Knowledge generation requires a combination of business acumen and knowledge coming in partnership. Otherwise knowledge stays isolated, it doesn't find its logical end-point. So you need a combination of some amount of business acumen plus knowledge generation abilities. One of the problems which we have is that not many

people have that strong business acumen, because they have come from universities and they have just started research here. So I think that's a weakness we have. What I basically do is pose questions in a broad way, and I think people should come up with answers. I don't think there is a single method by which you can, there is no linear method by which you can approach this problem. I haven't seen a linear method in companies, it is an extremely tortuous method. And if success comes it is later on converted into a linear article in Harvard Business Review.... Look up discoveries like the discovery of nylon by Carruthers and Dupont. Do you think the process was linear? Absolutely not. The idea was shot down for seven years by managers who thought it was a useless idea, until one manager kept it going....

I think all you can do is make sure that you have people who are open-minded, and keep their ears and eyes open. It's easy to kill something early. And very difficult to persist with an idea whose future and promise you do not know and at the same time to have the articulation to sustain it. Especially with companies it is a big problem.

I don't know what a lab like NCL can do. We are not a company. We are not drawn by long-term business goals. We are basically a group of scientifically minded people who can perform experimental research. So the first thing we do is to look at the people who have high quality minds, I mean the highest quality minds. That's the only thing I can assure upfront. Then of course we need to let them do good work, and if something comes up, that's where somebody has to be able to pick up, hold hands, push. And all that depends upon the people at that point of time.

People have to understand even how to present ideas to make them attractive enough so that someone even listens to it. Sometimes our fellows have very good ideas, but they don't know how to say it, and it probably misses everybody's attention. So that's lacking. Something must be done to convert scientists into entrepreneurs. How to provide them [with the] environment for entrepreneurship, that's a big thing.[214]

[214] S. Sivaram, interview with the author, June 13 2001.

Sivaram, in many ways, completely echoes people like Naidu and Rekhi in their diagnosis of what is lacking, and in their vision of both what needs to be sets right, and, in broad terms, how one can go about doing so. They all agree that there isn't enough of an interaction between academe and industry, for instance; they all agree on the absence of an "entrepreneurial culture"; they also all agree that stifling and excessive bureaucracy and regulation contribute to the absence of such a culture; and they very much agree on the importance of training and pedagogy, as ways of indoctrinating people into a culture where they believe, from the get-go, that the "logical" end-point of scientific activity ought to be commercial benefit. Indeed, Sivaram agrees with many of Naidu's initiatives, including the help provided in setting up the ICICI knowledge park.

The difference, however, is that Sivaram explicitly sees these as problems of *hegemonic articulation*, rather than simply problems of having the right prescriptions and the right material and ideological conditions of possibility in place. The conception of leadership that he, as Director of an institute has, is very different from especially Rekhi's belief in the non-resident vanguard who can "import" an entrepreneurial culture through his personal message, his role in networking, the repatriation of capital and the establishment of modes of pedagogy in consonance with his own ideology. Naidu, in addition, is explicitly in a position to realize the importance of legislative changes that can enable entrepreneurialism to take root, and is in a position to effect those changes. Sivaram merely sees these as necessary, not sufficient, for a cultural transformation. Ultimately, what he feels is necessary is hands-on leadership and mentoring *within* organizations, that do not depend on mimetic institutional structures as much as they do with individual leadership qualities, such as open-mindedness, or a Weberian charisma.

Indeed, parallels to Sivaram's mode of thinking are clearly shown to be necessary in Paul Rabinow's (1997) history of the development of polymerase chain reaction (PCR) in the labs of Cetus Corporation, *Making PCR*. Rabinow shows how the development of PCR was not just the

work of the solitary genius inventor, Kary Mullis (who won the Nobel Prize for "his" invention), but needed a number of enabling contributions and factors, one of the major ones being supportive management in the form of Mullis's manager, Tom White. While Rabinow's primary attempt is to decenter the trope of romantic inventor, he also makes another suggestion which is relevant in the context of the vanguard envisionings of the likes of Rekhi. PCR, he indicates, would not have been developed even in the entrepreneurial culture of a biotechnology start-up in 1980s America simply because adequate facilities, capital and a generalized culture that naturalized and encouraged innovation prevailed in American society. All of those had to be translated, specifically, into the habitus of Cetus, in particular labs, in particular ways, that were conflictual, contradictory and could by no means have happened simply by following a pedagogical program of "entrepreneurial advancement" designed by a vanguard leadership.

This once again points to the difference between a vision and a strategy, that is enunciated quite clearly by the Director General of the CSIR, Ramesh Mashelkar. Mashelkar, unlike Naidu, does not stake everything on vision, and says: "But vision is not that important, the road map to achieve that vision becomes important. And the time that we've spent in the last five years is in creating that roadmap".[215]

Mashelkar, therefore, uses a notion of *mindset*, which he describes as follows:

> I believe there are two important things. One is mind, and second is the mindset. The two are distinctly different, many people do not recognize the difference. As far as mind, I think our Indian mind there was never a doubt, quality of Indian mind. I mean you wouldn't have had mathematics without zero, and zero came from the Indian mind. Our children win Mathematics Olympiads. Although we don't win gold medals in Olympics, we do that. That means when it comes to Olympics of mind, we are superior. The nation has shown what we can do. It is not that alone that is important, it is the *mindset*, which describes the process, that becomes important. And there is a continued battle of Indian

> mind versus Indian mindset, where Indian mind is trying to take us to 21st century – you and the several others who are in the Caltechs and the Harvards and the MITs and Cambridge and Oxford, the people who make a difference in Silicon Valley are there, etc. So there's mind. But when it comes to mindset, there is an issue. That mindset is typified by hesitancy, by self-doubt, by pessimism, by negativism. A mindset which does not allow you to make a leap. So what we've tried to do in the last five years, my major interest is that we change the mindset.[216]

Mashelkar's notion is uncannily similar to the Marxist notion of consciousness. Indeed, the parallels run slightly deeper, since the conditions of possibility for a "revolution" exist both in Marxian communist manifestoes and the CSIR's desire to transform Indian technoscience into an entrepreneurial endeavor. In both cases, a transformation in consciousness is still needed, which is why both Rekhi and Naidu are also attentive to the importance of pedagogy (the setting up of entrepreneurial incubators at IIT by the former, the setting up of a Wharton-style Indian Business School by the latter). Mashelkar feels in addition that changes in mindset comes form changes in incentive structures within organizations such as CSIR.

Perhaps the biggest difference between the CSIR on the one hand, and TiE and Naidu on the other, is that at the end of the day the latter do not, directly, invest in *science*, but in *business*, in the enabling infrastructure for science, in conditions that encourage people to think of science as a means to a commercial end. While all of these are aims shared by the CSIR, they are, as Sivaram says, basically scientific research institutions, and any institional investment that CSIR as a governing body makes is into the research conducted by these institutions. Ironically, it is business that has largely not become entrepreneurial in India, except for the odd glorious exceptions such as Ranbaxy, Dr. Reddy's Laboratories, Infosys, Tata Consultancy Services or

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[215] Ramesh Mashelkar, interview with the author, July 20 2001.
[216] *Ibid.*

Reliance. It can be argued, then, that paying attention to basic science is also part of a necessary mindset change. Indeed, nearly 80% of R & D money in India is still spent by public institutions.

Therefore, again, while there are broad similarities in diagnosis between the likes of Mashelkar and Sivaram on the one hand, and TiE and Naidu on the other, there are different causal explanations put forward by the two. Mashelkar, in an explanation that is quite typical of most public scientists I have talked to in India, claims that the failure to develop entrepreneurial science is not a failure of the state (as Rekhi sees it, and even Naidu subscribes to), but a failure of Indian industry to network with the state. He points to the fact that some of the biggest multi-nationals in the world are willing to do business with CSIR labs such as NCL – and indeed, the client-list for CSIR labs includes companies such as GE, DuPont, Amoco and Boeing – but that Indian companies, by and large, are not proactive in forming academic-industrial partnerships, attributing this once again to a question of "mindset". Indeed, as I mentioned in Chapter 3, the Director of Dr. Reddy's Foundation, R. Rajagopal, also said that the reason the Reddys have so aggressively pursued an R & D focussed strategy is because their founder, Anji Reddy, is a scientist, and not a businessperson (incidentally, Anji Reddy is also a scientist from NCL, which is Mashelkar's parent institution). As shown in Chapter 3 in my discussion of drug discovery and development in the United States, academic networking has everything to do with industrial R & D.

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I have, in the last two chapters, made arguments both for the importance of vision and for its insufficiency, on its own, in shaping the outcomes envisaged by the vision. It is indeed in the gap between vision and its unfulfilled realization that events take place, and politics manifests itself. I wish to now spend some time on the structure of the visionary policy document itself in the Indian technoscientific context.

The one Indian scientific policy resolution to date was drafted in 1958 (Government of India 1958, henceforth GoI). There is a salience in the word "resolution" itself, which implies an undertaking, in opposition to vision, which, as I have argued, is a conjuration of promissory horizons. The Indian Government is currently working on another Science Policy Resolution, which will be the first such document made since 1958, and is therefore a really interesting marker of the vision of post-liberalization India Inc. The context of emergence of the current science policy document has to be seen as not simply one of economic liberalization, but also of a ruling political ideology of Hindu cultural nationalism.

The 1958 document was drafted entirely by Nehru and the atomic physicist Homi Bhabha, and is quite different from anything that Mashelkar is likely to come up with. The focus of the 1958 document is on basic research, and important components of it are what might now be deemed to be completely arcane issues, such as the importance of doing science for pleasure. For instance, it says: "[Science] has not only radically altered man's material environment, but, what is of still deeper significance, it has provided new tools of thought and has extended man's mental horizon. It has thus influenced even the basic values of life, and given to civilization a new vitality and a new dynamism" (GoI: 1).

The 1958 document, then, saw the "scientific approach" as the pre-condition for the *welfare* state; it did not assume the "development of the poor" by a trickle down from industrial development to overall human resource development. This "scientific approach", then, involved paying attention to aspects of the dimensions, effects and affects of science that don't merit attention anymore when science is assumed always already to exist for an application that is always already presumed to be commercial. The first aim of the Government's science policy as enunciated by the 1958 document therefore is to "foster, promote, and sustain, by all appropriate means, the cultivation of science, and scientific research in all its aspects – pure, applied and educational" (GoI: 2). Paradoxically, such a statement seems more visionary and entrepreneurial

than an approach that stresses increased revenue as the primary aim, and that therefore ends up pursuing contract research often more aggressively than local innovative science.

The reason for the present science policy document is political, and is because the Minister for Science and Technology, Murli Manohar Joshi, wants to leave his historical imprint through this document. Therefore, this will eventually be publicized as Joshi's document. But Brahmachari wants to have a hand in drafting it, and while various committees to draft the document have been set up, the final version is likely to emerge through a couple of people like Mashelkar and Brahmachari sitting in a room on their own and writing it up.

Joshi himself has been very controversial, being a leading Hindu nationalist ideologue in the ruling Bharatiya Janata Party (BJP). He has been particularly so among historians with his blatant attempts to rewrite school history books in ways that portray Indian history as a history of Hindu glory punctuated by Muslim and Christian invasion, but he has also been so among scientists because of his push to introduce astrology into high school curricula. Many scientists have indeed been openly critical of him, the most vocal being Pushpa Bhargava, the founder-director of CCMB (who, as I mentioned in Chapter 5, has been actively involved in peoples' science movements). Current directors, however, are in much more vulnerable positions than retired ones, and can't openly voice any criticisms of him that they might feel. As mentioned in Chapter 5, science policy in India has always operated through tacit relationships between politicians and scientists.

Brahmachari at no point himself exhibits an explicit cultural nationalism. His brand of nationalism, as described in Chapter 5, comes much more from an anger at the global inequities in the conduct of science, but it is an anger tempered with both an institutional mandate and a personal longing to be a "global player". In his presentations, for instance, he constantly focuses on the range of institutions needed, including the state and western companies, in order for this to happen (see for instance Brahmachari 2001). Perhaps most importantly, from the point of view of

vision, he positions India as what he calls a "knowledge partner", in explicit opposition to either service provider or source of "raw" material (which in his case, often refers to genetic resources).

CHAPTER 8: RISK AND SUBJECTIVITY

One ought not to make 'cause' and 'effect' *into material things*, as natural scientists do...one ought to employ 'cause' and 'effect' only as pure *concepts*, that is to say as conventional fictions for purposes of designation, mutual understanding, *not* explanation.[217]

Because no one knows which venture will succeed, which number will win the lottery, a society ruled by risk and freedom rather than by rational calculus, a society open to the future rather than planning it, can call forth an endless stream of invention, enterprise, and art.[218]

In the first part of this chapter, I will discuss the possibilities and potential difficulties associated with personalized medicine, which in the hype of promissory life sciences is at some level the "ultimate" dream of genomics (implicitly replacing, therefore, the genome sequence as its Holy Grail). I will start the first part by providing an overview of personalized medicine. I will discuss the various sorts of knowledge that are required to make personalized medicine a reality, alongside the technologies that are being developed to generate that knowledge, and the upstream business models that are based on providing different types of pharmacogenomic input into drug development. I will study a couple of examples where personalized medicine has already been developed for particular diseases. I will then discuss how personalized medicine is likely to effect downstream drug development. The idea in this part of the chapter is to accentuate the differences I have highlighted so far in this thesis between upstream and downstream terrains of drug development, by trying to provide situated perspectives on an emergent form of life that is likely

[217] Nietzsche 1973 (1886): 33 (emphases in original).
[218] Gilder 1981: 296.

to have revolutionary implications for both. In the process, I will continue to explore the fragmented, contested and inherently contradictory nature of capitalism, and the imbrications of such contradictory practice on the production of scientific knowledge *as* fact.

This will lead me to the second part of the chapter, where I will talk about genomics *as* scientific fact, and argue for its ability to constitute subjectivity by virtue of the fetishism attendant to its commodifiable facticity. I will conclude by reflecting upon what insights these can provide into understanding relationships or production, consumption and subjectivity in biocapitalism.

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8.1: Pharmacogenomics and Personalized Medicine

The question of personalized medicine really does get to the heart of what exactly "post-genomic" drug development is all about. Quite simply, the steps involved in what might be called a "genetic approach" to the diagnosis and treatment of disease could be said to consist of the following: first, the identification of a disease with a genetic component; second, the mapping of the gene(s) involved in the disease to specific chromosomal regions; and third, the identification of the involved gene(s). At this point, one could develop diagnostics to identify the presence or expression of the involved gene(s) in patients to determine predisposition to the disease in question; use the gene itself as a drug (gene therapy); or understand the underlying biology of the disease to "rationally" develop therapeutics to target the molecular mechanisms of disease etiology. The diagnostic tests could further be a precursor either to steps taken to prevent the onset of disease (that could either be interventionist or involve lifestyle changes), or to what is known as pharmacogenomics, which involves tailoring prescriptions and drug regimens to individuals based on their likely, genetically determined, response to these drugs (these steps are summarized from Collins and McCusick 2001). Of course, some of these advances are likely to

be more easily realized than others. The development of diagnostic tests, for instance, is relatively straightforward (and indeed, as I argue below, is likely to be the one realizable goal of "genomic" or "personalized" medicine for some time to come). Targeted therapeutics based on understandings of the underlying biology of disease is much more complicated, since diseases are always complicated multi-factorial events that are difficult to understand at the molecular level, and further not necessarily easy to target and set right even if ever properly understood. Gene therapy, too, has been hindered by the lack of finding optimal methods of gene delivery, and was further hindered by the death of a volunteer, Jesse Gelsinger, in a trial in 1999.

Most scientists, when they write or speak of "histories of" or "prospects for" genomics, do admit that some of these advances are more immediately realizable than others. Francis Collins and Victor MuCusick's way of summarizing this is that "[t]he rate of progress for applying a genetic approach to the diagnosis and treatment of each disease will be different depending on the research investment and the degree of biological complexity underlying the disease.... Diagnostic opportunities may then come along rather quickly, but will be of greatest clinical usefulness [*sic*] once prevention measures are developed that have proven benefit to those at high risk.... In general, full-blown therapeutic benefits from identification of gene variants will take longer to reach mainstream medicine" (Collins and McCusick 2001: 543). And yet I argue that it is this temporality – the different likely rates of realization of each of these genomic advances – that is the real issue, and that gets elided over as a relatively linear and equivalent set of outcomes in accounts such as Collins'. It is this what might be called therapeutic lag that is actually both the ethnographic window and the political terrain of "post-genomic" drug development, and it is the ensemble of events in the world that happen during the therapeutic lag that will determine whether, how and what "full-blown" therapeutic development actually takes place, and when. Making what seem suspiciously like Soviet-style 5-year and 10-year predictive plans, as Collins and McCusick do in their article, closes down this ethnographic window at the

expense of relatively banal crystal-ball gazing (though, as I have argued in Chapter 6, such modes of prediction themselves have powerful influences in creating ethnographic windows and political terrains).[219]

Both intuitively, and from the hype that surrounds personalized medicine, it seems evident that there are many potential benefits. There is the obvious potential benefit to patients if drug treatment can be tailored to each one: more effective drugs, more precise prescriptions and better therapeutic outcomes. But there are also benefits at various stages of drug development for companies involved in the process. These include a higher success rate, faster time to market, reduced costs and greater market share.

There are various stages of drug discovery and development at which pharmacogenomics could have an impact; and for this, it is useful to recall from chapter 2 that drug *discovery* and drug *development* are two distinct phases in the genesis and taking to market of a therapeutic compound. The difference between the two phases is obvious from their nomenclature: drug discovery is about the identification of compounds, and drug development is the ensemble of research, testing and commercial activities attendant to taking the compound through clinical trials and to market. A key problem during drug discovery is the prioritization of what might be a number of promising compounds, whose therapeutic efficacy in humans can really at that stage only be predicted intuitively, if at all. Genomics promises a way to rationalize lead compound prioritization at early stages of discovery. Up till now, this has been the primary area in which the benefits of genomics have been realized. This is the area of focus of what might be called "first-generation" genome companies that have been focused on target identification (companies such as Celera Genomics, Incyte Genomics, Human Genome Sciences and CuraGen).

[219] Indeed, I consistently noted during my fieldwork that it was the corporate actors who had a better conception of these ethnographic windows than public scientists, and who are often therefore forced to take account, however problematically, of society.

The effect of genomics on *drug development*, however, is likely to be quite distinct, and the benefits of genomics on this process are only beginning to be recognized and realized (Ledley 1999). While drug discovery primarily focuses research on the *mechanisms of disease*, the selection of biological *targets* and the identification of *compounds* that could modulate the disease, drug development is focused on establishing *safety and efficacy* of existing compounds.

Therefore, during *clinical trials,* pharmacogenomic approaches could reduce costs by genetically pre-selecting trial populations, which would lead to reduced sample size and a shorter duration for the trials. Lowering adverse events during clinical trials improves the drug profile. At *launch*, it can help market drug to ideal target populations. A higher efficacy in target populations would lead to a marketing advantage over competing drugs whose lower response rates would have been measured in traditional clinical trials conducted across broad populations. In addition, it would be possible to launch pharmacogenomically based *diagnostic tests*, which are likely to constitute a major component of personalized medicine.

There is a huge market opportunity for what might broadly be called "pharmacogenomic" companies. This is because of a number of factors in the current drug development environment that make the benefits of personalized medicine outlined above seem particularly attractive. These factors include:

- The *pipeline and profit void*: big pharmaceutical companies face a $20 billion void because of the number of drugs going off patent in the next 5 years.
- The *innovation deficit*: in 1995, 75 of the top 100 drugs on the market targeted only 4 families of molecular targets: G-protein coupled receptors (60% of drugs on the market), ion channels, nuclear hormone receptors and enzymes (Norton 2001). The number of targets addressed today is less than 450, compared to the roughly 10000 targets that are estimated to exist in the human genome. Further, these targets are not medically very diverse: excluding

antibiotics, one-third of the drugs on the market address CNS disorders, while another third address cancer and blood diseases.

- *Time* (12-15 years) and *cost* ($500 million) to bring drugs to market.[220] The financial community expects a pharmaceutical industry growth rate of 13% earnings per share (EPS) annually. Using traditional methods of drug development, the industry growth rate is about 8% EPS. To reach even a 10% growth rate requires 3-5 new chemical entities (NCEs) to be approved each year (figures from Norton 2001).

- *Risk.* Only 1 in 5 drugs that enters the clinic makes it to market. These could be due to problems characterising dose-effect relationships; issues in experimental design and clinical development plans; and difficulties in measuring risk : benefit endpoints.

Pharmacogenomics-enhanced therapeutics, goes the pitch, could benefit pharmaceutical companies to the order of $200 million to $500 million in revenue for each drug by helping to address some of the problems mentioned above. This section of the chapter investigates the hype that proclaims these benefits, especially when set against the contradiction at the heart of the pharmacogenomic promise, which is the fragmentation of pharmaceutical markets, that in an era of personalized medicine would be defined not just by the disease but also by the target population. What I want to emphasize at the outset, however, is that, as mentioned in Chapter 6, an "investigation of hype" cannot simply be an expose of its hollow promises. Rather, it enables a tracking of what is from the get-go an imbrication of possible therapeutic benefit with market opportunity, as the "win-win" of biocapital. I will elaborate upon the argument for this imbrication, its effects and affects, in the second part of this chapter while developing the notion of genomic fetishism.

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It is important, even within the short life history of genomics, to locate this emergent pharmacogenomic moment historically. One could argue for three reasons why this is a time when many people in scientific-industrial communities are thinking about and turning to pharmacogenomics and personalized medicine as possible solutions to knotty therapeutic problems (Housman and Ledley 1998):

a. There is an increased *recognition* of the importance of systematic discovery of genetic variation as a means to developing therapeutic and diagnostic products.

b. Appropriate *methods* for the discovery and analysis of genetic variation within the timelines of drug discovery and development have emerged.

c. The emergence of managed care has provided an *economic context* within which personalized medicine makes enormous sense.

It is important at this point to escape conflating pharmacogenomics and personalized medicine (and I will argue later in the chapter that there are implications for such conflations in understanding etiologies of genetic determinism as well). Personalized medicine is not equivalent to pharmacogenomics, but is, rather, a combination of pharmacogenomics and predictive testing. Pharmacogenomics does not aim to provide deep insights into proximal causes of disease: its primary aim is to maximize the efficiency of therapeutic intervention, both at the level of pharmacokinetics (what the body does to the drug) and pharmacodynamics (what the drug does to the body). Nonetheless, pharmacogenomics is likely to be the most immediately realizable and practical manifestation of personalized medicine for some time to come. The reason for this is that there are important differences between genetic effects on diseases and on drug action. The major difference has to do with the fact that the genetic etiologies of disease are often extremely complex. The combination of this complexity with the extreme rarity with which disease-causing

[220] As mentioned in chapter 3, the figure of $500 million is a contentious one, but it is the figure that has commonly been used in the industry to rationalize, and sell, approaches that might cut costs. I therefore use

mutations occur makes the therapeutic or predictive value of any single gene relatively limited. Rather, arrays of potential disease markers have to be determined or studied in an integrative fashion.

On the other hand, it has been realized that single-gene effects significantly modulate the action of many common drugs. These include genetic effects on metabolism that alter pharmacokinetics and effects on pathways of drug action that alter pharmacodynamics. Most of the former can be localized to genes that code for drug metabolizing enzymes (DMEs), mainly belonging to the cytochrome P450 (CYP450) class of oxidative enzymes (though there is a small minority of drugs that do not undergo transformation by CYP450 prior to elimination). [See Table 8.1 for percentages of drugs metabolized by different CYP450 isozymes].

Pharmacogenomics can be used to understand pharmacodynamics by enabling associations between genetic polymorphisms in drug targets and disease pathways. Some examples of these associations have already been discovered. For example, a polymorphism in cholesteryl ester transfer protein (CETP) determines the efficacy of pravastatin in patients with coronary atherosclerosis (Kuivenhoven et al 1998); polymorphisms in β-adrenoreceptors affect their sensitivity to albuterol (an association that is of consequence in the treatment of asthma) (Martinez et al 1997); and polymorphisms in serotonin neurotransmitter receptors are related to the efficacy of the anti-psychotic drug clozapine (Arranz et al 1998).

Therefore, genetic studies of drug action are likely to provide more therapeutic insights of commercial value than similar genetic studies of the pathogenesis of disease.

Table 8.1: Drug metabolism by the major families of CYP450 enzymes (reproduced from Norton 2001)

CYP 450 isoform	Percentage of drugs metabolized

this figure in this portion of my argument.

CYP3A4	55
CYP2D6	20
CYP2C19	15
CYP1A2	5
CYP2E1	1
Others	4

There is a second reason why pharmacogenomics is likely to emerge as a more attractive strategy of personalizing medicine than target identification and discovery approaches. The biggest current problem with clinical trials is their limited statistical power. The average number of patients who receive a drug before a new drug application is less than 4000. However the number of patients required for statistically meaningful clinical trials in a post-genomic era would increase exponentially with the number of genes studied and the number of variations located within each gene. In other words, genomic *discovery* can actually *increase* the time and cost of conventional clinical trials. This suggests that there is even less of a commercial incentive for discovery based genomic medicine compared to pharmacogenomics.

Therefore, while personalized medicine might be about the discovery of more disease causing genes eventually, it is likely to be about the ability to use medicines more effectively in the immediate future.

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The study of molecular genetic variation and its relationship to drug response is not new. There is, however, a historical shift from *pharmacogenetics*, which is a basic study of genetic variance, to *pharmacogenomics*, which is a commercially driven, industrialized, high-throughput

science that has emerged consequent to the genomics revolution. Therefore the shift from pharmacogenetics to pharmacogenomics is a shift to an approach that is driven by *process* from one that was driven by *observation*. Once again, I emphasize the importance of high-throughputness -- speed, its desire and actualization -- in industrializing life sciences such as genomics, as changing not just the paradigms of knowledge *production*, but also, as I will elaborate later in the chapter, the very *facticity* of the knowledge produced.

Pharmacogenetics as a concept was put forth as early as 1957 by Motulsky, the term was coined in 1959 by Vogel and the first book on the subject was written as early as 1962 by Werner Kalow, in which Kalow documented several examples of inherited traits that he confirmed as affecting drug response or toxicity in human populations. Indeed, the very long entrenched notion of taking a family history as part of a conventional medical examination is itself based on an understanding that a patient's genetic make-up, however little known, has a bearing on decisions regarding therapeutic intervention.

The shift to a process driven pharmacogenomic approach has the advantage of not anymore requiring an *a priori* detection of an altered phenotype. In other words, one doesn't have to have a pathology before studying the underlying genetic causes; one can study genetic variability in order to predict future pathology (and I will elaborate upon this is the second part of this chapter). The major driving force behind this shift is largely technological, with the availability of high-throughput methods for genetic analysis.

There are two broad pharmacogenomic strategies that can be adopted (Pfost 2000). The first strategy is to adopt a *broad screening approach*, which is adopted most notably by Millennium Pharmaceuticals, whereas the second is to adopt a more *focused hypothesis driven approach*, adopted by companies such as Variagenics, to correlate precisely defined phenotypes with genetic variations in the genes most likely to produce them. The latter approach is less random than a large-scale screening exercise, but might miss key elements in a complicated

pathway that might not have been predicted in the hypothesis. A more comprehensive screening approach is likely to leave more room for unexpected findings, but will be technologically much more challenging, requiring ultra-high throughputs for the discovery, scoring and processing of genetic variants.

There are three steps to a pharmacogenomic process. The first step is the *discovery and definition of the multiple variations within genes*. A powerful marker that enables such discovery is the single nucleotide polymorphism (SNP), which will be described below. SNPs after discovery must be *correlated* with clinically documented variations in drug response. They can then be used to develop *diagnostic tests* to determine whether or not a patient has a genetic profile that is predicted to correlate to a specific drug response.

SNPs (as mentioned in chapter 4) are single base variations in the genetic code that occur about once every 1000 bases along the 3 billion base human genome. Knowing the locations of these closely spaced DNA landmarks both eases the sequencing of the human genome and aids in the discovery of genes variably linked to different traits. A map of all the SNPs in the human species would provide the basic database to perform association studies, which compare the prevalence of particular genetic markers in individuals that possess a certain trait (which may be a disease trait, a predisposition to a disease or side effects to certain drugs) to those who don't. Association studies are a potential gold mine through the insights they might provide in unearthing obscure disease-related genes or in helping preventive diagnosis. SNPs, therefore, have a potential value as tools leading to therapy, in a more pinpointed and versatile way than a random DNA sequence. Not surprisingly, SNPs are key informational artifacts that make the realization of personalized medicine possible.

The steps leading from the analysis of genetic variations to the creation of the best drugs as a consequence of that analysis has three steps: *target identification, target characterization and target validation* (Jazwinska 2001). Each of these steps correlates to different technologies and

business models. Most importantly for my larger arguments about biocapital, however, is the manifestation of a basic contradiction of speed and information when one tracks these different steps. This is that the bottleneck very quickly shifts away from being a problem of *inadequate* information to being one of *too much* information.

Target identification is the conventional (one can almost now say "historical") conception of the role of genomics, made famous by what I call "first-generation" genome companies, or target ID companies. However, within a year after the generation of the working draft sequence of the human genome, and 5-7 years into the lives of many of these companies, it became clear that target identification had ceased to be the major bottleneck in drug discovery and development through genomics. In fact, target identification has created with it a new host of problems, in large measure because of its success: the problem now is not the generation of new targets as much as it to trim early discovery portfolios to manageable proportions and to identify those targets that have the largest probability of success. Further, the identification of molecular defects is useful in early diagnosis of disease and gives clues as to the biochemical pathways through which disease onset progresses. However, there is no guarantee that this information is useful in any way in the development of therapy. Indeed, as mentioned earlier in a discussion of the promise of pharmacogenomics, strategies that focus on target identification do not necessarily make drug development easier. On the contrary, they can often make drug development harder by demanding larger sample sizes in clinical trials in order to generate statistically meaningful information. A brief list of some of the major target ID companies is given in Table 8.2.

Table 8.2: Representative Target ID companies

Company	Year Founded	Major focus
Celera Genomics (www.celera.com)	1998	Generating and commercializing genomic

		information to accelerate the pace of drug discovery. Has recently expanded its informatics focused business model to include diagnostics and drug discovery programs.
Incyte Genomics (www.incyte.com)	1993	Provider of an integrated platform of genomic technologies designed to aid in the understanding of the molecular basis of disease.
Human Genome Sciences (www.hgsi.com)	1992	Uses genomic information to develop its own in-house genomic-based pharmaceutical products.
CuraGen Corporation (www.curagen.com)	1997	Combines biology and information technology to systematically develop genomic-derived biopharmaceutical products

Of course, questioning the continued immediate scientific utility of target identification approaches in venture science worlds immediately means asking whether target identification is no longer a valid business model. Of the four companies mentioned in Table 8.2, Celera Genomics and Incyte Genomics have focused primarily on being information providers for other pharmaceutical companies. On the other hand, Human Genome Sciences and CuraGen

Corporation, who have very similar business models, decided that in addition to strategic alliances with pharmaceutical companies, they would set up in-house drug discovery capabilities to channel their informatics efforts into biopharmaceutical development.

It is possible that a stage has been reached at which the success of target ID companies might have signalled the beginning of their own irrelevance. Target identification is no longer the bottleneck in genomic drug discovery efforts. On the contrary, the challenge has shifted to making sense of the huge amount of target information that is available, and streamlining that information into something that can be meaningful for drug development. This is not an automatic or easy transition.

This is not to completely belittle the achievements of these companies. Human Genome Sciences has been particularly successful amongst target ID companies in moving forward with its own drug discovery programs, and currently has five products in clinical trials. CuraGen meanwhile recently signed a $124 million pharmacogenomic and toxicogenomic alliance with Bayer, indicating the strategic interest in the pharmaceutical industry for such types of target identification and data mining tools as CuraGen has on offer. Nonetheless, it is clear that the eventual pressure on these companies will be to shift their business models away from target identification and towards in-house biopharmaceutical development, as is evidenced by Celera opening a new branch of its company focusing on drug development called Celera Therapeutics.

Target characterization can be defined as the use of genetic analysis to define the degree of variation within a gene encoding a potential drug target (Jazwinska 2001). Therefore, target characterization involves firstly the definition of variants and secondly the definition of the *impacts* of variants. A recent analysis of variation in 75 candidate genes involves in hypertension identified SNPs in 74 of them (Halushka et al 1999). This study suggests that there is a high likelihood of finding genetic variation in any gene selected as a potential drug target. Understanding the impacts of variants becomes crucial, but is a highly predictive process for

which very few business models exist. This is where structural genomics becomes important. There are a number of possible structural genomics approaches that one could conceive of to predict how variation in gene sequence might lead to variation in impact of the drug that is targeted to that variation. Broadly however structural genomics involves the definition of protein crystal structure as a means to predictively model the impact of variation within a protein. Structural genomics is still in its infancy, and Table 8.3 identifies two of the most exciting structural genomics companies.

Table 8.3: Emergent Structural Genomics Companies

Company	Year Founded	Focus
Syrrx (www.syrrx.com)	1999	A leader in the field of structural proteomics, it is involved in the high-throughput generation of protein structures from genetic information.
Structural Bioinformatics Inc. (www.strubix.com)	1997	Focus on computational proteomics, the large-scale generation and use of protein structural information.

Target validation can be defined as a process by which knowledge of genetic variation is exploited to show an association between particular targets and disease processes (Jazwinska 2001). This is typically useful to save costs during clinical trials by predicting before the clinical trials process whether the pharmaceutical intervention might have a desired therapeutic effect by demonstrating the association between target gene variation and clinical process. Target

validation steps are two-fold: first, the identification of well-characterized clinical populations of specific relevance, and second, the identification of variants within or close to the test gene.

Unlike traditional clinical trials, target validation procedures do not require that patients actually be treated with the compound. Therefore, these procedures are extremely useful at early stages of discovery.

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The technical challenge of pharmacogenomics is very different from genomic sequencing. The focus here moves away from new gene *discovery* (which underlies the business models of the target ID companies) and towards the elucidation of correlations and statistical analyses between genetic variations and various types of response. In other words, pharmacogenomics and personalized medicine constitute a different scientific-corporate enterprise from the "genomics" of 1999-2000.

SNP discovery strategies have generally involved the large-scale repetitive sequencing of cloned DNA segments from defined subject pools followed by computer alignment of the sequences to detect variation (Pfost 2000). It is important to subsequently confirm that the variation is a genuine population variant and not a sequencing artifact. Sequencing approaches, however, become extremely inefficient when large-scale confirmations are required. Further, SNP discovery alone does not enable the correlation of genotypes with clinical phenotypes, a process referred to as SNP scoring.

There are over 21 SNP technology providers of various sorts in addition to those offering data and services. The question that faces this industry in terms of the development of personalized medicine strategies is whether this explosion is sustainable, whether a consolidation of the industry is likely in the near future, and what that consolidation might involve. As of now, pharmaceutical companies still seem generally reluctant to utilize genotypic information in their

drug discovery efforts. A major market driver of this reluctance is cost and time, and a PriceWaterhouseCoopers study suggests that genotyping technologies are unlikely to be wholeheartedly embraced by pharmaceutical companies until costs get down to a penny a SNP and assays can be performed with a nanogram or less or DNA (cited in Burke 2001). What might be bad news for SNP technology providers could be good news for SNP service providers, as it is likely that pharmaceutical companies, even if they do include the use of genotypic information in their drug discovery programs, are likely to outsource genotyping rather than perform them in-house.[221]

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So far in this section, I have talked about how the *upstream* scientific and corporate issue for genomics, as genomics comes to be about personalizing medicine, shifts away from the identification of targets to their characterization and validation. In the second part of this chapter, as I have mentioned, I want to theoretically ponder some of the subjective consequences of these emergent sorts of genomic knowledge operating *as* scientific fact. The ability to create diagnostic tests based on information relating to genetic variability is a major part of this shift. I therefore now move on to discussing how the impetus to further move towards a testing society originates in upstream technoscientific and business genome worlds. This is, implicitly, an attempt to engage ethnographically with the possibility of a genetically determinist society, as feared by such ideologically distant biotech watchers as Jeremy Rifkin (1998) and Richard Lewontin (1993).

Historically, as I have argued above, the success of breaking through a bottleneck in genomic drug discovery can, by virtue of the amount of information generated by that very success, provide a fresh bottleneck. This has been the case with target identification, which has

[221] Some major SNP service providers that could be beneficiaries of this outsourcing include CuraGen, DNA Sciences, Genaissance, Genometrix, Lark Technologies, Lynx, Orchid Biosciences, PolyGenyx,

necessitated the need to move onto methods that can actually characterize the targets identified. A major reason why target identification is only a very preliminary step towards personalized medicine is that identifying a target provides no guarantee that it can be therapeutically targeted. With the explosion of SNP identification technologies, a similar bottleneck is arising: a huge volume of SNP information, with no guarantee that any particular SNP is going to be predictive of an actual therapeutic target, or even therapeutic response at a chromosomal level. It is in this context that *haplotyping* assumes increased importance.

A "haplotype" means a combination of SNPs on a particular chromosome, usually within a particular gene. Common haplotypes exist because in most genes SNPs tend to be co-inherited. While SNP genotyping, as outlined above, has many benefits in terms of generating information that could be used towards personalized medicine, haplotyping has greater promise for two reasons. Firstly, haplotype analysis greatly reduces the complexity of genetic analysis. Due to linkage disequilibrium, only a small number of haplotypes are generally found in a population, in contrast to the up to 10 million SNPs that are said to exist in the genome. For example, 13 SNPs have been identified in the β2-adrenergic receptor. Theoretically, these could assort into 2^{13}, or 8192, haplotypes. However, the β2-adrenergic receptor has been found to have only 12 haplotypes, with only four of these found commonly in the population. More importantly, haplotypes are thought to predict gene *activity* more precisely than genotypes. This is because individual polymorphisms may have different effects on the functioning of a gene. Therefore, the predictive therapeutic value of any single SNP within a gene is relatively limited. A haplotype integrates these effects, and thereby provides the *sum of the effects of all the polymorphisms*. The move from genotyping to haplotyping is a move away from assaying arrays of potential mutations and towards generating integrative markers of disease (Housman and Ledley 1998).

Qiagen, Sequenom, Telechem / arrayit.com and Variagenics.

The major challenge for haplotype prediction is the generation of bioinformatic tools that can make sense of this extremely complex data in an accurate manner. Conventional genotyping technologies are not applicable to haplotyping. So far, the accuracy of most computational methods for haplotype analysis has not been very well established.

There are other challenges in addition to technological limitations that face haplotype analysis in the context of actually developing personalized medicine (Jazwinska 2001). Some of these challenges are:

1. Even if drug metabolism, as mentioned earlier, is often a monogenic response, the totality of drug response is a complex phenotype. Identifying haplotypes merely reduces the complexity of analysis. However, the relative value of multiple genetic and environmental factors and the importance of their interaction is drug response is still largely unknown. The feasibility of identifying genetic associations with complex phenotypes is still a matter of considerable debate.

2. There are issues affecting the *practicality* of integrating haplotype analysis into a program of therapeutic development. Haplotypes are markers. They are *closely linked* to disorders, but that does not mean that they *contribute to* them. Therefore, haplotype analysis is most likely to be used as a *diagnostic tool*, as indeed it has been done in the past. The greatest application for haplotype analysis is to define the risk of inheritance of a disorder such as haemachromatosis or rheumatoid arthritis within a family unit.

Therefore, haplotypes could diagnose likely inheritance of a disease, but still be poorly predictive of drug response. In other words, there is a logical move towards a diagnostic test as an "end-point" of personalized medicine from an upstream perspective, as haplotypes emerge as manageable scientific knowledge about genetic variability as it corresponds to chromosomal location and co-inheritance.

3. Cost. The acceptance of haplotype analysis will basically imply the need to routinize genetic testing, which will have implications for healthcare delivery systems in terms of the cost that will accrue from increased diagnostic load. This cost will have to be weighed against proposed benefits by healthcare providers. These providers, given the increased load brought about by wide-scale genetic testing, will expect a greater level of success in therapeutic delivery in order for the entire personalized medicine process to be deemed cost-effective. Therefore, the irony here is that it is health insurance companies that are *least* likely to be enamored of a testing society, at least in the short term, because of the economics involved. This goes against the grain of the intuitive institutionalized bioethics concern about genetic discrimination by insurance companies, articulated most forcefully again by writers like Rifkin. I am not saying here that insurance companies are uninterested in the results of diagnostic tests. What I am suggesting is that the political economic context in which diagnostic tests are emerging and likely to operate will place an immediate economic burden on health management organizations (HMOs), whereby the benefits of supporting large-scale diagnostic testing *before* the availability (or even the likelihood of availability) of corresponding therapeutics will have to be weighed against the immediate cost of having to financially support such large-scale testing.

As mentioned earlier in this chapter, personalized medicine is likely to be extremely cost effective for pharmaceutical companies because they can streamline their clinical trials process. Pharmacogenomics can save substantial money for companies during the development phase of a drug, particularly between phases II & III of development, in two ways:

- Streamlining clinical trials: Clinical trials could be greatly reduced in size and cost by identifying and excluding in advance those patients unlikely to respond to the candidate drug. With a preselected patient population, the trials could assess a drug's positive therapeutic effects far more effectively.

- Salvaging compounds that would have otherwise failed: Genetic analyses could identify and exclude in advance those patients unlikely to respond to the drug, or likely to suffer from negative side effects.

However, personalized medicine will not necessarily be cost-effective for health management organizations. *In the long term*, the promise of personalized medicine will lead to more effective healthcare, which is good for HMOs. But *in the short term*, an increased diagnostic load without concomitant therapeutic benefit could be a financial strain on the health management system. Therefore, while the *promise* of personalized medicine, as mentioned earlier, makes perfect sense in the managed care environment, the route to *realizing* that promise may not, especially when there is no guarantee that the promise will actually be realized. This is a fundamental contradiction of personalized medicine as promissory science.

What this contradiction does imply, in terms of medical practices upstream of therapeutic development, is the shortening of the loop between diagnosis, prognosis, monitoring and management of disease. Personalized medicine, as I explore in greater detail in the following section, leads to a blurring between a number of oppositional categories, such as normal and pathological, risk of disease and disease, and preventive medicine and curative medicine, that are constitutive of the practice of medicine as it is understood today. It is the sort of blurring that, were a Foucauldian genealogy to be written a century from now, would probably suggest itself as an epistemic shift.

But what this contradiction does *not* necessarily imply is that HMOs will oppose genetic testing, even though there might be short-term rationality as I outlined above that would make it tempting for them to do so. There are, for instance, many other strategic recourses that one could imagine HMOs adopting in order to have their cake – knowledge of predisposition amongst their insurees to various diseases – and eat it – not having to pay for the generation of that knowledge. One could, for instance, envision a tiering of the US health insurance system, whereby HMOs

might pay for the cheapest tests but encourage people to pay themselves for more expensive tests (such tiering is already beginning to be evidenced in terms of therapeutics, where HMOs are starting to not pay for the most expensive treatments in some cases, and only providing more basic coverage).[222] Alternatively, HMOs might still insist on people taking diagnostic tests as a pre-condition for providing coverage, but refuse to pay for the tests themselves.

I am, throughout this thesis, less explicitly interested in what *will* happen or not, and when, which is the preferred concern of writers like Rifkin or Lee Silver (1999). Rather, I am interested in tracing the forms that various emergences take. The promise of personalized medicine, my topic for this chapter, isn't just a series of predictions about futures that will or won't dawn. Indeed, a major problem with such prophecy as mode of critical analysis is that it sets up the assumption of a temporal break between a present and a future -- it suggests that certain things will happen in the manner of a singular event. Personalized medicine, however, is already happening, and contradictions at the heart of promises do not preclude their realization, even if (indeed, necessarily) such realization is contingent, partial and unpredictable. Below, I will briefly mention a couple of examples of diseases towards which personalized medicine approaches are already being adopted, before going on to look at personalized medicine from a downstream perspective.

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A striking and well-known example of personalized medicine is the breast cancer drug Herceptin, developed by Genentech (which isn't even a conventional "genome" company, in that its business isn't the mining of various sorts of genetic information) and approved by the FDA in

[222] Of course, this is precisely the crisis of Britain's public National Health Service (NHS), that it is unable to pay for anything but the more basic services and therapeutics, thereby encouraging those who can afford it to go to private health services. It is ironical, though not at all surprising, that US HMOs might well wittingly create precisely such a multiple tiered environment for healthcare access that they claim is a failure of public supported healthcare (a claim that was so forcefully articulated in the US in 1994 that it caused then President Bill Clinton to abandon his controversial health plan, and managed to win for the opposition Republican Party a huge victory in that year's elections to the Senate).

1998. Herceptin is designed to treat patients whose tumors over-express a protein called HER2. However, for those patients with normal HER2 levels, Herceptin is completely useless.

A more interesting combination of strategies towards personalizing medicine is evidenced in anti-HIV therapeutics, and indicates much better the complexity that can be faced in devising such personalized strategies.

The basic rationale for personalizing anti-HIV therapy is as follows:

1. There is as yet no cure for HIV.
2. Most of the 15 available HIV medications were developed quickly and rushed to market. Thus, many remain difficult to take and can be associated with serious short-term and long-term side effects.
3. HIV is a challenging adversary that quickly develops resistance to medications.

Anti-HIV therapy is an interesting case, because individualization of therapeutic regimes already occurs, as it does with other complex multi-drug regimes for diseases such as tuberculosis or some forms of cancer. The shift that genomics marks is towards a certain *rationality* of individualization, wherein genotypes become predictors of the best *form* of individualization to adopt.

There are a number of problems with individualizing anti-HIV therapy (also called anti-retroviral therapy, or ARV) in practice. Many of these are based on the logistics of the regimen. Current multi-drug regimens, especially in late-stage patients, may require the administration of as many as 40 pills in one day. Some drugs require administration with food for optimal absorption while others need to be taken on an empty stomach. Some agents require separation from each other while others can be taken concomitantly. Additionally, there are some combinations that result in drug interactions with serious toxicity. All of these issues, combined with the large pill burden, can result in non-adherence. Constructing and managing drug regimens

for HIV-infected patients can be overwhelming for clinicians. Therefore, a truly personalized approach to treatment of patient, although currently appreciated as the best possible way to manage the disease, is rarely accomplished in practice.

There are two major strategies that can be adopted to personalize anti-HIV therapy using genomics. The first is by assessing HIV pathogenicity based on viral genotype (which might involve assessing HIV virulence or HIV drug resistance); the second is by genotypic and phenotypic evaluation of the patient. A number of possible ways of doing the latter exist: one can assess possible HIV virulence based on individual genotype; evaluate drug dosage / metabolism / toxicity based on the patient's genetic make-up; or optimize drug exposure in a manner fitted to each individual (pharmacoenhancement).

A major problem with anti-HIV therapeutic regimes has to do with the development of resistance of HIV strains to the drugs. This occurs through viral mutations that lead to variants called quasi-species. The environmental pressures that lead to the generation of these variants includes selective pressures created by drug therapy and the host's immune response. Therefore, evaluating the genetic composition of HIV has become an important component of the clinical management of HIV disease progression (Bean 2001). Such genotypic analysis can identify in well characterized regions of the HIV-1 genome such as the reverse transcriptase and protease genes that are likely to confer resistance to drug therapy, thereby helping in the identification drugs less likely to be therapeutically effective. This enables the personalized customization of anti-retroviral therapy.

A very common problem is the emergence of multiple-drug resistant strains. This problem indicates the desirability of resistance testing in the initial selection and management of ARV therapy in all newly infected patients. New technologies like DNA microarrays can increase the sensitivity of strain characterization and address the concern of poor predictability of

therapeutically success of initial genotype testing. A hypothetical benefit of a genotypic and phenotypic analysis of HIV variant is the development of strain-specific drugs.

Personalized medicine can also go beyond the characterization of the virus to analyze the genotype of the patient as well. The purpose of this different approach to the same problem is to minimize adverse drug-drug interactions and enhance metabolism of the HIV drug. HIV is not treated with just one drug, but a combination of several anti-retrovirals for the disease. The anti-retroviral regimen may be accompanied by a long list of maintenance and prophylactic agents for opportunistic diseases. These complex drug regimens are decreasing mortality and morbidity and inducing favorable changes in surrogate markers such as viral load in plasma, but they may cause other problems such as drug toxicity, difficulties with compliance, and pharmacological drug interactions. Enormous numbers of drug interactions involving anti-retroviral agents have been reported in both animal and human studies. Some of these interactions are clinically significant, while the significance of others is unknown. Other potential interactions may be anticipated because a potential mechanism of interaction is known.

Creating an integrated approach towards the effective treatment of HIV with pharmacogenomics will be a daunting task. The first step, which is currently being practiced in health care, is to characterize the nature of the virus and its potency. More virulent strains will need different combinations of therapy relative to weaker strains. By analyzing the existing mutations, the strain's resistance to a particular drug can be discovered making the creation of a regimen more effective. After deciding *what* drugs to give to the patient, a genetic analysis can subsequently give information concerning the metabolic state, thus determining *how much* of each drug to give to each patient. This latter stage will be somewhat more complex, requiring significant mathematical modeling to determine:

1. How the altered genetic profile affects rate of metabolism

2. How drug-drug interaction affect metabolism and

3. The rate of release of the drugs administered.

Therefore, the case of personalized anti-HIV therapy highlights the scientific and statistical complexity of a pharmacogenomic regime. Personalized medicine using genomic rationales is not just about looking at a gene and predicting a response to it, or "taking action" against it in any direct way.

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Personalized medicine brings with it a whole host of ethical, legal and regulatory issues, some of which, especially as it pertains to ownership and intellectual property, I have already discussed at various points in this thesis. However, they bear being repeated, in the context specifically of personalized medicine as a corporate technoscientific venture, and in the context of some other issues that I haven't yet touched upon.

Sample collection

Two major genotyping strategies are likely to be employed in clinical trials: the first is *prospective genotyping*, the second *retrospective genotyping* (Murphy 2000). Prospective genotyping will be done on Phase I volunteers to ensure the inclusion of volunteers with poor or ultra-rapid drug metabolizing enzyme (DME) phenotypes, and on Phase II and III subjects for their stratification into different phenotypic sub-groups and possible exclusion from the trial.

Retrospective genotyping can be used both to match clinical outcomes of drugs already taken with the patient's genotype (this is useful, for instance, in evaluating adverse drug reactions), or as a research tool to identify new candidate genes. Retrospective genotyping, however, brings with it a whole host of informed consent issues that need to be addressed at the time of sample collection, which I have hinted at in Chapter 5. How can proper informed consent procedures be designed that allow future use of the sample that may not even be envisaged in the original experimental protocol? What sorts of sample anonymization procedures must be

followed to adequately protect the donor's privacy? What sorts of scientific value are lost if samples must be anonymized before storage and banking?[223]

Intellectual property issues

In addition to informed consent issues, a number of knotty intellectual property (IP) issues surround sample collection, issues that could impact downstream economics and strategies of drug development. This is because donors are often not averse to donating their genetic samples for the cause of research, but are more averse to knowing that companies can take out ownership rights on the donated samples. Therefore, there are a number of difficult political issues that companies involved in genotyping are facing and will continue to face while collecting samples. Again, these are discussed more fully in Chapter 5.

In addition to IP issues at the time of sample collection, significant controversies exist over the strategies of upstream companies to patent various types of genetic information that public researchers and pharmaceutical companies believe should be in the public domain in order to facilitate downstream innovation. This is an area of particular concern with respect to SNPs, since no proper guidelines for their public disclosure exist. One strategy that has been devised is the formation of a public consortium in 1999 called The SNP consortium (see Chapter 4 for a discussion of The SNP consortium). This consortium is an alliance of five major academic sequencing centers with ten of the major multinational pharmaceutical companies, with the aim of placing any SNPs generated by consortium members into the public domain. There do, however, remain a number of upstream companies that continue to take patents out on SNPs.[224] In other words, issues of speed and information are completely tied in to the contexts in which personalized medicine emerges.

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[223] The importance of privacy and informed consent issues is evidenced by the passing of the Genetic Non-Discrimination in Health and Employment Act (S. 318) in early 2001 to prohibit discrimination in healthcare services and employment on the basis of genetic information.

Food and Drug Administration (FDA and other regulatory) guidelines

While the FDA has shown enthusiasm for genetic applications in drug development (FDA 1997), it has issued no clear guidelines on the use of genetic data, nor are there any genomics-specific rules or policies (Czaban 2001). It is likely that the FDA will adopt an incremental, case-by-case approach rather than committing to a single broad policy. In some cases, FDA's existing regulatory authority will suffice. For example, current investigational new drug (IND) applications already require protocols specifying the criteria used for patient selection and exclusion and the kinds of control groups to be used. Genetic criteria could easily be incorporated into this protocol without requiring any change to the application procedure.

Also, there are already FDA approved products that have been the result of pharmacogenomics (examples taken from Czaban 2001). Examples include Dako's HercepTest, a breast cancer assay that tests for the over-expression of the HER-2/neu protein that can be treated with herceptin. The approval of herceptin itself was based on pharmacogenomic factors, as only HER-2/neu over-expressing patients were admitted to the study, and only these over-expressers are eligible for treatment. Other drugs that incorporate pharmacogenomic considerations in their approval and labeling include Prilosec (omeprozole), where dosing decisions are based on genetic and racial factors, and BiDil, which has been found to be effective in African Americans but not Caucasians.

Another challenge for the FDA will be intra-organizational reordering to tackle the regulatory challenges posed by personalized medicine. Personalized medicine is likely to see not just new drugs and diagnostic kits, but also new biologics and devices, which will involve jurisdictional co-ordination between the Center for Biologics Evaluation and Research, the Center

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[224] Some of the major private sellers of SNP data include Biobase, Celera Genomics, DNA Print, DeCode Genetics, Genomics Collaborative / Netgenics, Gemini Genomics, Incyte Genomics, Orchid Biosciences, Qiagen and Variagenics

for Devices and Radiological Health and the Center for Drug Evaluation and Research (Czaban 2001).

Strategic Issues for the Pharmaceutical Industry

Without a doubt, the increased attention towards personalized medicine will confront the downstream pharmaceutical industry, an industry that has generally known to be conservative in adopting new management styles, with a whole array of strategic challenges. A few of these are briefly summarized below.

Personalized medicine is a form of outcomes-based medicine, which brings into focus the cost-effectiveness of healthcare delivery. This could have a huge impact on pharmaceutical R & D, necessitating changes in pharmaceutical company processes, systems and organization (Arlington and Peakman 2001). The bottom line is that the productivity of R & D will have to increase, especially if therapeutic delivery is to match and offset the increased load on HMOs to provide diagnostic services that pharmacogenomics makes possible. Productivity increase demands the adoption of rational approaches for early target validation, which implies a further industrialization of the early stages of drug development. In the clinical trials arena, pharmacogenomics will drive increased patient stratification. Choosing the right clinical trials centers to outsource trials to will become a crucial strategic decision for big pharmaceutical companies. Even within the organization, however, the need for greater integration of R & D with marketing will be felt as economic decisions drive portfolio considerations more and more.

There are likely to be larger market consequences of pharmacogenomics (Arlington and Peakman 2001). It will be much harder for single companies to monopolize technologies and disease areas. Strategic decisions will have to be made within each company about their core skills and weaknesses in order to prioritize strategic foci. Entry barriers to smaller and newer competitors may also be lowered, which is the reason for the confidence expressed by aggressive young genomics based drug development companies such as Millennium Pharmaceuticals and

Human Genome Sciences (the latter already with five products in various stages of clinical trials). Therefore, big pharmaceutical companies will be driven to outsource their non-core competencies and will need to adopt an extremely strategic approach to partnering and in-licensing. Increased numbers of consortia (such as The SNP consortium, but set up to fulfill a much wider range of strategic activities) are likely to emerge. Pharmaceutical companies will also have to confront human resources issues, and make sure that they are able to hire and retain the best workers who can compete in a post-genomic environment. This may involve changing the reward structure within organizations to further incentives and attract the best humanpower available.

Another set of challenges will be to management systems. The standardization and automization of R & D and manufacturing IT systems will need to become a high priority. IT systems will also need to be designed that can cope with and make non-intuitive links across the masses of data that R & D divisions will increasingly have to deal with and make sense of. The integration of data into regulatory dossiers will also need to be streamlined.

In other words, personalized medicine is not simply about promise. The opportunities for downstream companies to lower costs in clinical trials will be offset by market fragmentation, lower barriers to entry for small competitors and decreased competitive advantage for the pharmaceutical giants across whole disease areas.

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To sum up this part of the chapter, then. What we have, on the one hand, is the downstream therapeutic, therapeutic intervention often being viewed as the "end-point" of the practice of medicine. On the other hand, there is an upstream ensemble of diagnosis, prognosis, monitoring and management of disease, what might collectively be called preventive medicine. It is in between these upstream and downstream assemblages of material-semiotic objects and practices that historical and ethnographic windows open up to strategic praxis on the parts of the

involved players, and analytic intervention on the parts of anthropologists, historians and social theorists.

Meanwhile, both upstream and downstream assemblages have invested in them significant corporate interests with considerable capital and political muscle. While the emergent diagnostics industry is heavily invested in preventive medicine, downstream pharmaceutical companies are heavily invested in therapeutic development. Where HMOs will heavily invest, and how, remains one of the crucial empirical questions to ask in a tracing of these emergent sets of practices. Equally important to ask is what will consequently happen to the patient / consumer-in-waiting and her subjectivity.

One can see, however, that there is a pressure on pharmaceutical companies that stems from a downstream logic to move *therapeutic* intervention to earlier and earlier stages of disease manifestation, indeed towards a regime of therapeutic intervention at the *suggestion* rather than explicit manifestation of disease, that has been seen particularly in the increased prescription and use of psychotropic drugs such as Prozac for depression, or Ritalin for the recently constructed "epidemic" of attention deficit hyperactivity disorder (ADHD) (see for instance Kramer 1997, Healy 1997, 2002). This move, I argue on the basis of my analysis of the emergence of the upstream diagnostic ensemble as key corporate actors in the practice of medicine, stems not just from a desire on the part of pharmaceutical companies to enlarge markets, but also from a manifestation of the pharmaceutical industry *acting as its own insurance industry*. The only way for big pharmaceutical companies to insure against diagnostic encroachment on the domain of therapeutics is to shift that domain of what gets to count as disease into earlier and earlier stages of its manifestation – to the point, of course, that new diseases often get created, and old ones get significantly redefined on the basis of the shifting of the moment that demands therapeutic intervention. This is a rationality of "self"-governance – a larger cultural shift in notions of when it is desirable to care for the self, through diagnostic testing and therapeutic intervention – that in

fact originates very much in a governance *of* selves by the complex of strategic actors that constitute the emerging moment of "post"-genomic medicine: a rationality of pharmaceutical governmentality that Foucault may well have called pharmamentality.

This part of the chapter has focused on the productive aspect of personalized medicine, looking at what sort of technoscientific production it is, and what the various stakes are for the producers. Indeed, production has been the focus of much of this thesis so far. In the second part of the chapter, I will explore how genomics quite literally translates to consumers, as a set of scientific-corporate practices and consumables, but also, more importantly, *as* scientific fact. I am interested in concluding this thesis by looking at the *affects* of genomics, as corporate venture and as science, and thereby highlighting the importance of understanding and theorizing *risk* as the defining heuristic with which to make sense of the way biocapital constitutes both business opportunity and subjectivity.

The company that perhaps epitomizes an ambitious, broad-spectrum approach towards the development of personalized medicine is also the epitome of venture science writ large, and that is Millennium Pharmaceuticals. Millennium has a three-pronged organizational strategy, based on a science and technology platform, and working towards predictive medicine (largely diagnostic) and therapeutic development. Millennium, like a good venture science company, realizes from the get-go that such science is co-produced by a host of actors: corporate partners (both small and big), patients, doctors, managed care systems, academia, healthcare providers, information technology systems and providers and tools providers, to name but some. This explicit recognition of the co-production of science and business -- indeed, of science *as* business -- as venture science is evident in their insistence that Millennium is about the science of business, and the business of science.

Millennium is one of those companies that might be called "genome companies", but that from the very beginning have sought to identify themselves as being in the business of drug development. This is in contrast to other well known genome companies like Celera Genomics or Incyte Genomics, that primarily

identified themselves as genomic information providers (a strategy that is clearly back-firing on them in the medium term, as Celera scrambles to reinvent itself as Celera Therapeutics). Millennium's approach more closely mirrors that of the fourth big genome player, Human Genome Sciences (HGS), which has also very successfully made moves from early on to get into the business of drug development rather than simply remain an upstream information or service provider. Millennium's primary strategy to go downstream has however been different from that of HGS, and has been driven by mergers and acquisitions rather than by in-house therapeutic development. This has made Millennium's growth towards being a drug development company seem much more rapid than that of the early biotech companies like Genentech, Amgen or Biogen, that, in spite of successes in their early days, have really taken a couple of decades to establish themselves as major players in the drug development marketplace. HGS, on the other hand, has gone much further towards developing drugs on its own.

What is most relevant from the point of view of understanding personalized medicine as business model is Millennium's predictive medicine strategy, which consists of pharmacogenomics on the one hand, and what it calls Diagnomics™ on the other. The former, as mentioned in the body of the chapter, correlates genotype information with drug response, and Millennium, in a typical model, has tied up with big pharmaceutical companies in pharmacogenomic alliances. An example of this model is Millennium's tie-up with Bristol-Myers Squibb (BMS), the downstream market leader in oncology therapeutics and manufacturer of the major anti-cancer drug Taxol. Millennium has also signed what is probably the largest pharmacogenomic alliance in the industry in 1998 with Bayer AG, wherein Bayer will invest a total of $465 million (including a 14% equity investment) in Millennium in exchange for access to a broad range of genomic technologies and genomic-based targets for drug development. The latter involves correlating genes with particular stages of disease, which really is no different from other genomics-based diagnostic platforms adopted by a number of companies, most famously Myriad Genetics, who have developed a proprietary test for the detection of the *brca* genes, that are over-expressed in some breast cancers.

Millennium's approach to personalized medicine, as mentioned in the body of the chapter, is ambitious, large-scale and high throughput, in contrast to the approaches of companies like Variagenics and Genaissance, who adopt more focused strategies. Millennium's science and technology platform for personalized medicine is probably the most comprehensive in the industry, and attempts to do everything from gene identification, functional elucidation of the identified genes, target validation and diagnostic and therapeutic product development. Millennium's stated attempt, therefore, is to do everything, all the way to drug development.

Indeed, Millennium and Variagenics offer contrasting perspectives on venture science, genomics business models and on scientist-entrepreneurs in way that are almost a caricature of contrasts. As already mentioned, Millennium's aggressive, large-scale, broad-platform approach contrasts with Variagenics' more hypothesis driven approach. Both companies owe their allegiance to MIT. Millennium was co-founded by Eric Lander of the Whitehead Center, while Variagenics' co-founder is David Housman of the MIT Biology department. These are two of the most well known academic genome scientists. Lander has been both a scientific and a political leader of the public genome sequencing effort, and the Whitehead sequencing center has been the largest public sequencing center in the US. Housman, meanwhile, was one of the first scientists to develop techniques for the positional cloning of disease genes, something that is particularly important in haplotype analysis and association studies of complex genetic diseases.

Lander and Housman are almost anti-types. Lander is aggressive, brash, loud-spoken and a major public figure and spokesman for genomics. He is a glamorous scientist. Housman, on the other hand, is soft-spoken and mild mannered. It is almost impossible to have a conversation with Lander on one's own terms, because it is evident that he constantly has another eighteen things on his mind at the same time, and is very good therefore in reframing conversations in terms of his own thought processes. Housman, on the other hand, is an extremely attentive listener, carefully frames everything that he says and conveys the impression of being completely wrapped up in the conversation he is having. Lander's academic center is almost by definition an industrial enterprise because of its location in the Genome Project. Housman is very

careful to keep his academic work distinct from his company work, and takes great care to ensure that his students aren't conflicted between the two in any way. The different images that Millennium and Variagenics project -- the former as *the* ambitious biopharmaceutical company of the future, the latter as a small biotech company that focuses on specific problems that are likely to be of interest to drug development -- uncannily mirror not only the personalities of the respective founders, but also the respective status of the academic centers that the founders are affiliated to. While MIT's Biology department is one of the most prestigious in the world, it doesn't quite have the corporate glamour that the Whitehead has managed to cultivate for itself.

The difference between a broad spectrum approach such as Millennium's and a more focused approach such as Variagenics' is that in the former case the primary onus is on screening a large amount of DNA, and seeing what emerges, whereas in the latter case the focus is on specific biological impacts, and the correlation of various genomic parameters to those impacts. Looking from the get-go for just those polymorphisms that have biological impact is an extremely useful way of reducing costs, though as mentioned in the body of the chapter, it might lead to an overlooking of factors that aren't expected from biological impact hypotheses that are generated by studying parameters such as allele frequency, linkage disequilibrium and structural modeling. Haplotype analysis is major strategy to narrow SNP information into data sets that are more manageable, and also perhaps more informative about co-inheritance patterns of various SNPs, and therefore their likely association with complex disease states. It therefore is a cornerstone of Variagenics' strategy, and much of the challenge there is to come up with bioinformatic haplotype prediction algorithms. However, as mentioned in the body of the chapter, haplotyping can be an extremely useful diagnostic tool because haplotypes can serve as genomic markers for various diseases. They are, however, much poorer predictors of drug response. This again hints at the relatively limited utility that haplotyping would have for a company whose primary long-term aim really is drug development. While every biotech company says they would like eventually like to produce drugs, Variagenics' strategy does suggest that its longer term evolution, if it continues this way, will be primarily into a diagnostic company rather than one that develops therapeutics as its primary focus. Ironically, as Myriad's continuing success

with its diagnostic kit for the *brca* genes shows, diagnostics may well be a more profitable and less risky business strategy than therapeutic development, given the greater ease of diagnostic development compared to drug development, and given the larger market size: in a testing society, as I will further argue in the next section, *every* individual becomes a likely candidate for a diagnostic test, whereas one needs to have a pathology (or a significant likelihood of pathology) before one becomes a therapeutic consumer. I will use this comparison of Millennium and Variagenics as a springboard into the next part of my chapter, which precisely talks about the *affects* of genomic information operating as scientific fact on (would-be) patients-as-consumers.

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8.2: Genomic Fetishism and Polymorphic Subjects

This part of the chapter asks the question of the relationality of epistemic shifts to the constitution of subjects, where scientific knowledge, the episteme in question, derives its authority from its perceived objectivity, making this a question, similar to that asked by Joseph Dumit in his analysis of what he calls "objective self-fashioning", of the relationship between what he calls (using Merleau-Ponty) the objective and the lived body (Dumit 1998). It is a question that demands the understanding of the functioning of facts as "facts-in-the-world" (86). Dumit defines objective self-fashioning as follows:

> The objective self is an active category of the person that is developed through references to expert knowledge and is invoked through facts. The objective self is also an embodied theory of human nature, both scientific and popular. Objective self-fashioning calls attention to the equivocal site of this production of new objective knowledge of the self. From one perspective, science produces facts that define who our selves are objectively, which we then accept. From another perspective, our selves are fashioned by us out of the facts available to us through the media, and these categories of persons are in turn the cultural basis from which new theories of human nature are constructed (88-89).

What is at stake, no less, from these factual configurations, are individual identity formations, collective identity formations, and what (and who) gets counted – as humans, normal, diseased, patients, consumers and so on – in various ways and multiple institutional contexts. I am interested here in tracing some of the mechanisms by which such configurations, of identity and subjectivity through scientific fact, take place.

The (implicit?) Foucauldian argument is that epistemic shifts *directly* lead to the constitution of subjects. My argument will be that it is precisely the interstices between epistemic shift and subject constitution that need to be examined in order to understand the *constructed* and *contingent* relationship between knowledge and subjectivity, in this case between the subject (as in discipline) and the subject (as in constituted person) of genetics. Paul Rabinow has used the term biosociality to point to the phenomenon of the increased co-production of biology and society (Rabinow 1992). My question regards the *mechanisms of articulation* of the "bio" and the "social" that allow emergent manifestations of biosociality.

I ask these questions around the node of SNPs. I divide this section into three parts. In the first two parts, I will analyze the epistemic shift that SNPs reflect, from the earlier related concept of mutant; firstly by looking at the types of meanings embedded in the mutant subject, and then by looking at how those meanings reconstitute themselves into a discursive framework of risk with the emergence of SNPs. I then ask the question of how SNP information becomes accepted as legitimate scientific fact, leading to a genetically deterministic conception of the human subject.

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Epistemic Shift: From Mutants to SNPs

SNPs have emerged as much more than informational artifacts. They have emerged as targets of ownership that structure institutional reconfigurations, and are equally new forms of

knowledge, representing and identifying individual human beings as particular collections of specific genetic variations. But first, let me briefly outline the epistemic shift that SNPs mark in the understanding of genetic subjects, by contrasting them to mutants.

I shall start by making the distinction between the study of mutants and mutagenesis. Mutants have always been important to genetics, and before. But the ability to generate mutants intentionally is quite a different thing, and has become more and more directed, more pinpointed, through the past century. In a mutation, a gene gets knocked out. Prior to recombinant DNA technology, however, there was no way of knowing where in the gene the mutation had occurred, and how -- single base change, insertion of DNA or deletion of DNA. Gene cloning and sequencing therefore empowered mutagenesis by allowing the knocked-out gene to be *localized.* This means that recombinant DNA technology (RDT) allows the isolation and study of *single* genes. Mutagenesis is not new, but the specificity and *site-directedness* that RDT allows brings the gene into play as the mutated subject. While specificity is the key term here, the level of specificity is at the level of the individual gene.

In other words, mutants now aren't there to just be studied: they can be precisely, at the level of genetic engineering, be *created.*

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Conceptualizing a world of mutants: A world of normality and pathology

The first thing to make clear is that a mutant subject *cannot* exist without the formulation of the corresponding concept of the *wild-type.* Now the wild-type is an interesting term: a term that in its most simplistic guise is one used to denote an unmutated organism, but is often understood, by its very construction, to denote an organism as it is found in the wild. A wild-type organism is, however, very much an artificial construct. Nature is extremely unlikely to have wild-types (indeed, the very concept of an "unmutated" genotype is an anachronism, since

genotypes themselves have arisen as a consequence of both natural selection and mutation), only a range of uncontrolled and uncharacterized mutants, some with a greater selective advantage than others. "Wild-type" strains, therefore, like so many other constructions of the laboratory, are analytical tools rather than replicas of nature, as their name would have us assume. Equally, and more important for the argument here, they are *essential* analytical tools in a world of mutagenesis, where the mutant needs to be in oppositional relationship to a "normal" referral point, of which the mutant is an error. But a mutant, further, is an error of a particular type – a type that has *value* attached to it. Mutants are not just different from wild-types: they are *deviants* from the wild-type norm.

A wild-type, therefore, is not a "normal" entity, in the sense that it is not an entity that one would normally find in nature. But it is a norm. A norm, according to Georges Canguilhem, "does not exist, it plays its role which is to devalue existence by allowing its correction" (Canguilhem 1989 [1989]: 77). A norm is also, as Derrida points out, an extremely equivocal concept, since "it encompasses both the concept of moral, ethical, political law as well as the concept of factuality. The norm is also sometimes imposed as a fact, in the name of which one normalizes precisely" (Derrida 2002a: 199). A wild-type serves as the reference point compared to which mutants are devalued.

Mutants are studied in order to understand relationships between gene structure and function. A far-fetched, but certainly not untrue, extension of this latter function in the context of the laboratory / clinic interface is that they can thus tell scientists of disease. A state of "unwellness" is identified, studied and treated as a disease because there were people who fell sick, who told doctors of their disease. A way of understanding disease without requiring people to fall ill first is to use model organisms – so scientists *create* mutants (or study appropriately existing ones) so that abnormalities can be better detected and understood when manifested as human disease. The mutant helps advance knowledge about normal organisms – research on

Oncomice, for example, will hopefully help researchers understand normal cell differentiation. And that is where the distinction between the normal and the norm can be teased out: an Oncomouse needs a wild-type, non-Oncomouse in order for it to be an Oncomouse, but the insights into normality that it provides are not necessarily facets of "normality" that any particular wild-type mouse actually exhibits – it is an idealized normality that is only defined itself in terms of the pathological Oncomouse, a normality that is defined in terms not of natural occurrence but in terms of absence of pathology. In other words, a mutant serves to tell us how a non-mutant would not work, rather than telling us how a wild-type works.

Lab mutants, therefore, operate on a *terrain* of normality versus pathology and have attached to them the (generally negative) *value* of deviance with respect to a referent norm.

The minute one grants that genes, and pathways, interact with one another (i.e. the minute one looks up from the level of single genes to see what they are doing at a larger cellular level – one doesn't even need to look as far up as the organism), one must acknowledge the existence of feedback effects mediated by various components on the activities of others. Mutants, as metaphorical constructions, and genes, as conceptual vantage points, offer vital perspectives on biological systems, but these are at best partial perspectives that pose as complete.

One limitation, then, of a mutant / single gene – eye view of the world is that phenotypes tend to get equated with the existence of single genes, rather than with their interactions with others. The other limitation is that one needs a phenotype in the first place to get talking. In the language of mutants, if you don't have a phenotype, you don't have a conversation.

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From model organisms to human diseases: the emergence of SNPs

The shift from classical to molecular genetics accords a new place for and understanding of mutants: from anomalous organisms that help understand evolution to specifically altered

genes that help simulate deviance in order to understand normality. But when one goes beyond the study of model organisms to the understanding of diseases in humans, many of the imperfections in the mutants-eye view of the world could be damning imperfections. Even without entering the nature – nurture debate, the well established polygenicity of most diseases makes it impossible to evolve an understanding of human disease on the basis of human gene information that doesn't take into account interactions and pleiotropy.

There is a *discontinuity* in molecular biology that allows this necessary discontinuity in perspective, and that is the SNP. At one level the discontinuity from mutant to SNP is one that has technological causes and consequences: SNPs become possible and feasible markers because of the Human Genome Project, but simultaneously are landmarks that both make human genome sequencing easier and potentially more lucrative (in terms of helping generate pegs upon which the translation from gene sequence to therapy can be made). There is a subtle change in perspective that SNPs bring about from mutants. An equation of one mutation with one phenotype in the former case gets subtly altered to become an equation of a number of variations with the probability of a particular phenotype. SNPs, therefore, bring about discursive and conceptual shifts in the language and understanding of molecular biology. Further, SNPs bring a different perspective to light, a perspective that has to do with *risk* rather than deviance. SNPs talk about susceptibilities and predispositions, rather than abnormalities or aberrations. The key difference between mutations and SNPs is one between *deviation* and *difference*. Obviously SNPs, unlike mutants, do not show a strict correlation between individual phenotype and genetic aberration. A human who is considered in every respect to be healthy could well have variations at the nucleotide level, but these variations do not constitute deviance against a constructed standard of normality – they do, however, constitute the possibility of risk, of future pathology. A SNP is not a pathology, but an *anomaly*: something that, according to Canguilhem (1989 [1966]), can "shade into disease but does not constitute one" (140).

SNPs are not about the simple correlation of a mutation to its phenotype: they are about variations in genomes, rather than differences in genes; and variations within and between whole populations, rather than differences between a "normal" and a "mutant" individual. In terms of level, therefore, SNPs provide a peculiar bifocality: on the one hand, the immediate level of analysis is even smaller than the gene, it is the nucleotide; but on the other hand, it is an analysis that can only be undertaken when the nucleotide is set in the context of whole populations. Few SNPs are likely to be involved in disease, the way a mutation is involved in giving rise to an aberrant phenotype: what SNPs allow is the identification of patterns of inheritance that affect health.

This implies a contradiction at the very heart of the sorts of knowledge personalized medicine relies upon, a contradiction that has to do with the fact that this is a knowledge gained from an increasedly molecular understanding of life itself. The more things get molecularized, however, the more one needs to rely on statistical, population-based data in order to "individualize" therapy. So one can *only* individualize therapy on the basis of population classifications. These are classifications that are extremely difficult to construct, as Jenny Reardon's (2000) work on the history of the Human Genome Diversity Project shows. In fact, what is at stake, from the get-go, is the question of what in fact "populations" are, as opposed to "races", or other forms of ethnic categorization, in order to be subjects for genetic analysis.

These dilemmas of classifying populations, and defining what sort of categorizations need to be assumed as "populations" in the first place before the subsequent of act of classifying *within* those categories can take place, is particularly evident in India, where something like race, as a "natural" unit within which to classify populations, doesn't have the same ready-made social-scientific valence as it does in the United States. Classifying populations for genetic studies on the basis of caste is equally fraught, both politically and epistemologically, and is made more complicated by the fact that kinship patterns, that would profoundly effect the purported genetic

"homogeneity" of the population in question, vary widely between different parts of India (North Indian communities being traditionally more exogamous than South Indian communities). And yet, classifying populations for genetic studies is absolutely essential for a genomic endeavor, such as that of the Indian state as driven by the Centre for Biochemical Technology (CBT), that has identified population genetics as the way to go to establish India's presence in global genomic knowledge production. Research at CBT has population genetics as its cornerstone, which means that researchers at CBT really need to be able to define what populations are in order to even begin to tackle the scientific agenda that they have set for themselves.

Such definitions, I discovered, are usually made by taking recourse to the Anthropological Survey of India's voluminous atlas, *People of India* (Singh 1992-). However, sometimes more random and violent classificatory methods are adopted. Therefore, I encountered one project that claimed an attempt to discover the genetic differences between Aryans and Dravidians, categories that are not merely politically fraught (especially when expressed in those very terms), but also, in the real world, quite difficult to establish, since it excludes a wide range of non-Brahmin, non-Dravidian people who might well trace back to "Aryan" and "Dravidian" (or some combination of both) roots. The DNA samples of "Aryans" and "Dravidians" that this particular researcher was collecting, further, came from students who were identified as belonging to one or the other category in nearby Delhi University: a particularly cosmopolitan site for sample collection, in all probability teaming with donors containing all manners of genetically hybrid DNA. Six months into the project, this researcher, himself a Brahmin (and thereby, I suppose, of the population category "Aryan") abandoned it because he couldn't find genetic differences of statistical significance between the two groups. Instead of acknowledging this as a possible consequence of the genetic *similarity* between different population groups, as Lewontin (1993), for instance, argues for, this researcher indicated his frustration that the samples probably came from "genetically impure" people, descendants of such – to the researcher –

unthinking foreparents who intermarried across these wonderfully convenient (and probably for the researcher, sacrosanct) population binaries. It was hard to discern whether this researcher felt greater contempt because his experiments couldn't provide elegant answers to the fundamental genetic differences between Aryans and Dravidians, or at the thought that the Aryan forebears of his experimental subjects might have been "contaminated" by Dravidian blood.

While much of this chapter focusses on genetic determinism as *individualized* (and that especially plays out thus in regimes of personalized medicine), the purpose of this above argument is to show that myths of genetic homogeneity amongst populations are an equally powerful constituent of this determinist knowledge producing enterprise. Indeed, this tension between the genetic myths that underlie population genomic projects that seek ultimately to be vehicles towards the generation of personalized medicine, and the individualized risk of genetic determinism as a consequence of regimes of personalized medicine that imply personalized DNA diagnostic profiles, is seen equally powerfully in the controversial case of the Icelandic Health Sector Database of DeCode Genetics. DeCode really was a company that was pitched as unique *because* its DNA samples came from the "genetically homogenous" Icelandic population. On the one hand, the myth of the *value* of genetic homogeneity in order to do population genetics experiments has been questioned by such companies as the Irish population genomics company Hibergen, which claims that it can still generate population genetic information as valuable as DeCode's even though the Irish population is less genetically homogenous than the Icelandic is supposed to be[225] (indicating, in other words, that the purported homogeity of the Icelandic population is not DeCode's most significant competitive advantage); and indeed has been questioned by population genetics enterprises such as CBT's, who believe, in contradiction to DeCode, that it is the genetic *heterogeneity* of the Indian population, coupled with large Indian family sizes, and as yet very little genetic counseling, that allows CBT to do the sorts of extensive

[225] Based on a conversation with one of the co-founders of Hibergen, Patrick Vaughan.

linkage analyses across families that are just not possible to the same extent in places like Iceland, Ireland or the US. On the other hand, the myth of *genetic homogeneity itself* seems to be getting eroded from the sorts of knowledge DeCode has started producing, which suggests, rather like the experiments of the CBT researcher I mentioned do, that more contaminating mischief was probably happening in the Icelandic ports with sailors of non-Icelandic stock than the Icelandic myths of genetic homogeneity are willing to admit.

Of course, the purpose of this argument is not simply to show how classificatory categories may take recourse to mythical and ideological conceptions of pure population histories that are debunked by the very impure stories that the DNA tells, but also to show the epistemic violence that can get enacted when these classificatory artefacts might start operating as scientific fact (see Bowker and Star 2000) – a violence that might very well have both been enacted, and been more than simply epistemic, had the CBT researcher in fact claimed to find genetic differences between Aryans and Dravidians.

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But a little bit more about discontinuity – how do discontinuities, and shifts in concepts, metaphors and perspectives occur? One way I have alluded to is technological. But another way of looking at discursive shifts within science is by locating them in the context of discursive shifts without, as Ludwig Fleck's studies on the course of syphilis research do (Fleck 1979 [1935]). A similar relationship between macro-cultural anxieties and the rhetorical practices of science might be posed for the risk discourse surrounding SNPs, by situating them in the contemporary societal context of what Ulrich Beck calls the Risk Society.

In his book *Risk Society*, Beck (1986) describes how contemporary society can be visualized not in terms of the class-based logic of wealth distribution, but in terms of a new inverse logic of risk distribution. What he brings out that is important and relevant in the context of this chapter is, firstly, the importance in contemporary (at least Western) society of having a

knowledge of the risk one is at; and secondly, of the breakdown of traditional class alliances and a concomitant *individuation* of society. Even though the risks of disease that SNPs foretell aren't specifically risks of modernization, that is the theme of Beck's thesis, the importance of SNPs highlight the pervasive influence and importance of risk discourse in late modernity. Indeed, comparing the risk discourse around SNPs with the risk discourse that Beck traces shows how risk discourse, that starts becoming important in the 1960s and 1970s around issues of environmental risk, gets displaced by a risk discourse that gets intensely associated with lifestyle and genetics. In the process, as Ilana Lowy suggests, risk operates as a *moral technology*, and is very much a part of the ethical terrain of biocapitalism.

A number of facets of Beck's vision of Risk Society play interestingly with a SNP-eye view of the world. For Beck, Risk Society is a society that always has potential catastrophe within its calculus – the "exceptional condition", according to him, "becomes the norm" (Beck 1986: 24); as indeed is the case with SNPs, where variability, rather than a constructed "normality", is the norm. Secondly, according to Beck, "sciences' monopoly on rationality is broken" (29). And so with SNPs: SNPs do not tell us the *truth* about a human condition as much as they express probabilities of how that human condition might evolve in the future – SNPs ultimately operate within a framework of probability statements. For Beck, Risk Society has "no perfect system, no perfect human being" (30); and indeed, SNPs do not have room for wild-types.

The other important perspective is the individuation of contemporary risk society, in which there are no "natural" class-based alliances. The risks associated with possible disease are intensely individual risks, and theoretically, each individual has her own risk / probability illness profile, that could be calculated from her SNP profile. And indeed, that is what the ultimate aim of SNP research is: pharmacogenomics, or individualized prophylaxis or therapy based on each individual's unique genetic profile – a profile whose uniqueness can *only* be established at the nucleotide level.

The rationale of SNPs is ultimately to generate individualized therapy. So SNPs are not just situatable in a discursive context of risk, but also in the social context of capitalism – individuals, in a SNP's-eye view of the world, aren't classified as "normal" or "diseased", but *every* individual is a potential target for therapy, and every individual's genetic profile is a potential commodity.

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Knowledge → Subjectivity I: Commodification

The therapeutic intervention that gets envisaged by SNPs is personalized medicine. As the contemporary discursive terrain of knowledge production is also inevitably the capitalist terrain of value generation, each probabilistically interpellated polymorphic subject becomes not just a target of possible intervention but also a consumer – in – waiting. Personalized medicine, should it ever be realized, is undoubtedly envisaged as a commodity. Further, the *possibility* of personalized medicine is *insurance* (for the patient, against future illness), just as the always-already existent patient-as-consumer is insurance for the pharmaceutical company. As Francois Ewald has argued, the concept of risk is deeply tied into the concept of insurance, to the extent that risk itself is capital (see Burchell et al 1991: 197-210). In other words, SNPs are imbricated in two distinct types of risk discourse: the patient's risk of future disease (the individuation that Beck speaks of) is inseparable from the pharmaceutical company's risk of high investment in therapeutic development that must be realized in an eventual commodity.

My divergence from Beck is similar to that of other more "Foucauldian" theorists of risk such as Robert Castel, Francois Ewald or Pat O'Malley. In Beck's *Risk Society* scenario, potential catastrophes are foreseeable, but their potential governability by insurance and other statistical calculations of risk is not explicitly theorized. I am, on the other hand, precisely interested in the relationship of this foreseeability to governability, and to governmentality.

Knowledge → Subjectivity II: Interpellation

My argument so far has been that a particular discursive – epistemic shift allows a reconfiguration of subject categories away from normality and pathology towards variability and risk, thereby placing *every* individual within a probability calculus of becoming a potential target for therapeutic intervention. This is quite compatible with a Foucauldian analysis. There is, however, a major denial that gets effected through the standard Foucauldian collapse of epistemic shift with subject constitution, and that is the denial of ideology, one of the major points of divergence between Foucault and Marxism.

I use ideology in a much broader sense here than the classical Marxist formulation initially allowed. In my definition, I consider the ideological as the reification as "real" of something that is not necessarily just ideational but *constructed.* The ideological step in such a broadened conception is not *illusion* but *the naturalized and apparently independent thingification of something that is historically, contingently and relationally constructed.* This is closer indeed to the notion, central to the later Marx, of *fetishism.* The distinctness of capitalist (commodity) fetishism from pre-capitalist fetishism is taken for granted in much Marxist theorizing of fetishism. The basic difference between the two forms of fetishism that emerges is the alienation from human association that marks the fetishized commodity, an alienation that finds expression through expropriation, divestiture and the ideological masking of capitalist exchange processes as natural rather than contingent and relational.

Knowledge → Subjectivity III: Subjective Fetishism

Let me shift analysis now from the fetishism of the commodity to the fetishism of scientific knowledge, before moving on to analyze how the two articulate in the case of commodified scientific knowledges such as around SNPs to in-form subjects. The fetishism of scientific knowledge operates by mechanisms similar to commodity fetishism. Indeed the moment of mystification through fetishism is less through the "illusory" appearance of scientific

knowledge as *true* than through the appearance as *natural* something that is contingent and socially constructed. I call this mystification of scientific knowledge as a natural thing-in-itself that merely awaits ready-made discovery rather than the material-semiotic-conceptual outcome of real historical processes of knowledge production *epistemic fetishism.*[226]

The ideological power of epistemic fetishism comes from the fact that the mystification that elevates a statement established by rigorous scientific method into that natural and ahistorical thing-in-itself the Scientific Fact is invisible. Genetic determinism acquires the status of scientific "fact" at the same time that scientists hasten to tell us that SNPs are merely a set of probability statements. The irony – and power – of epistemic fetishism is that probability statements start operating with determinate legitimacy. Probability statements, therefore, acquire performative force. When confronted with the question of what one *does* when confronted with a probability statement, the absence of an obvious response allows the probability statement to harden into a reified statement of prophecy. Therefore, it is a fetishism that is at once an operation of *naturalization* (the denial of the history of construction of a statement) as it is an operation that, while naturalizing the statement, shifts it from being a statement of *association* to one of *causality*. This mode of discursive operation is nicely described by Foucault (1989: 12), as he describes the nature of questions posed by such philosophers as Cavaillès, Koyré, Bachelard and Canguilhem, or by members of the Frankfurt School:

> These questionings are those which must be addressed to a rationality which makes universal claims while developing in contingency; which asserts its unity and yet proceeds only by means of partial modification when not by general recastings; which authenticates itself through its own sovereignity but which in its history is perhaps not dissociated from inertias, weights which coerce it, subjugate it.... [W]hat we are to

[226] Of course the power of epistemic fetishism cannot be divorced from its functioning as truth-claim; rather than using the apparent "truthfulness" consequent to epistemic fetishism of the scientific fact as the explanation, however, it is precisely such a functioning as truth-claim that I wish to ultimately attempt to explain.

> examine essentially is a reason whose autonomy of structures carries with itself the history of dogmatisms and despotisms – a reason which, consequently, has the effect of emancipation only on the condition that it succeeds in freeing itself of itself.

Yet the question still remains -- how does this reification happen?

An example of an understanding of the "facts" represented by SNPs that emerges from the blurred boundaries of scientific-business articulation is encapsulated in the following quote from *Signals* magazine, an online magazine for biotechnology executives:

> Coming soon: A global genomic map of single-nucleotide polymorphisms (SNPs), the tiny differences between two people's DNA that largely determine everything from who's the natural athlete to who's the klutz to who's likely to get lung cancer from smoking and who's not. In the not-so-distant future, scientists will also be able to tell who's at risk for cardiovascular disease, whatever their lifestyle, as well as who will respond, or not, to this drug or that. But the techniques now used for discovering or mapping SNPs are costly, tedious and Ph.D.-intensive. The real mark of a SNP-detection assay scale-up will be its downward mobility: For characterizing huge numbers of SNPs among large populations, cheap, fast and easy is the way to go.[227]

Statements like these, on the "margins" of science, occupy a liminal space, where they can be comfortably disavowed by scientists as not "their" facts while being allowed legitimate co-existence. It is in this liminal space that "unscientific" statements undergo factuosclerosis to harden into legitimate fact,[228] and the epistemically fetishized object gets formed.

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[227] From *Signals* magazine, an online magazine that analyses biotechnology for executives. www.signalsmag.com/signalsmag.nsf/0/DEC74B56C34589DC882567D1006C676E. The genetic determinism in this quote is particularly striking: it is interesting and vital to see how it is precisely such deterministic language that is shed in, for instance, the promotion of cloning. It is also striking to note how SNPs simultaneously seem to represent information about individuals, populations and the "globe".

[228] The inspiration for this ugly but I think rather evocative word is Helen Watson-Verran's wonderful phrase "hardening of the categories" (Watson-Verran 1995). It is important to remember, however, that genetic determinism does not merely occupy the "margins" of science; nor is such construction disavowed by all scientists. Many sociobiologists, most notably Richard Dawkins, swear by it. Also see Chapter 3 for an account of articles in journals such as *Nature Genetics* that subscribe to the ideological notion of single-gene diseases.

And yet statements alone are often necessary yet insufficient to in-form subjects. For that the (quasi-)scientific statement of genetic determinism needs material-semiotic allies. It is the articulation of the deterministic statement to / as an artefactual representational device, the DNA chip, that ties the statement not just to the constitution of facts but to the constitution of subjects (the DNA chip, as described in the Prologue, being a 1cm x 1cm silicon chip on which it is possible to represent an individual's entire SNP profile).

My analysis of epistemic fetishism so far owes much to Donna Haraway's concept of gene fetishism (Haraway 1997)[229]. Gene fetishism, operating as it does in a capitalist framework that naturalizes gene-as-property, is a capitalist fetish, and yet is distinct from commodity fetishism. For Haraway, the moment of fetishization is not just the naturalization but the *corporealization* of the gene as not just a thing-in-itself, but as a thing-in-itself that stands in for and completely represents what is essentially a relationally constituted subject (whether gene or organism). I would like to take Haraway's notion a little further, to argue that gene fetishism is a form of *subjective* fetishism, in which the fetishism of the object (which is simultaneously, in case of SNPs, the chip, the information on the chip, and the facticity of the information on the chip) operates *not by alienation* – the assumption of a transcendental thing-in-itself status – *but by interpellation*. It is through the constitution of a polymorphic subject that the ideological-scientific "fact" of genetic determinism gets constituted. However, this subject constitution occurs in an epistemic and ideological space in which the determinants – information, representational device, subject – are always-already over-determined as "naturally" commodifiable. In other words, the oppositional tension between commodity fetishism as alienating from subjective association, and non-capitalist ("pre-capitalist") fetishism as intensely subject-associated implode through scientific-capitalist technologies of representation such as SNPs, SNP databases and DNA chips, and constitute subjects as genetically determined sets of

[229] Haraway (1998) indeed in her analysis of gene fetishism refers to it as "epistemological fetishism".

probability statements (as statements of risk) simultaneous to their constitution as always-already future (x%) probable targets of individual therapeutic intervention. In the latter case, they are constituted not (just) as subjects of the state in a Foucauldian / Althusserian manner, but also as *consumers* – as (future) buyers or (future) therapies. Thereby, the ideology of the inevitability, beneficence and naturalness of the pharmaceutical market as the means to therapy gets constituted simultaneously with the constitution of subjects and of scientific facts. Genomic fetishes are market(able)s.

Before moving further, then, it would be worthwhile to summarize the various fetishistic operations that I have alluded to, in this chapter and earlier in the thesis, as constitutive of biocapitalism. There is, firstly, the fetishism of technoscientific production as simply an outcome of private intellectual labor, which underlies regimes of intellectual property protection that I have described in Chapters 4 and 5. Secondly, there is the fetishization of time, as having material value. Thirdly, there is the reification of scientific fact, and fourthly, the fetishization of humans as patients- and consumers-in-waiting, along with the fetishization of the gene as constitutive of humans in the first place, the latter three fetishes together constitutive of what I call genomic fetishism. In other words, understanding the fetishistic ensembles that constitute the modes of abstraction in biocapitalism involves understanding the articulations not just of an alienating (commodity) fetishism and an interpellating (subjective) fetishism that marks genomic fetishism, but further understanding how these articulate with the fetishization of time, when speed *itself* represents capital.

In outlining the history of the discovery and functional elucidation of tRNA, Hans-Jorg Rheinberger argues that the material culture in which experimental biology is situated profoundly impacts both the type of and the manner in which "knowledge" gets produced (Rheinberger 1997). It is equally clear, by looking at a SNP lab, how agendas for the type of and manner in which experimental biology gets produced has implications for a lab's material culture. The latter, indeed, is intuitive, but even so the material culture of

what should more properly be called a "functional genomics" lab, is a dramatic representation of the sorts of transformations, technological and disciplinary, that genomics marks.

An example of this is the Whitehead Institute's center for functional genomics, one of the major basic research labs working on SNPs, and one of the early users of Affymetrix DNA chips.

The Whitehead Institute is one of the most prestigious centers for academic biology research in the world. It is a semi-autonomous institute with links to MIT, so that Whitehead faculty members all have dual appointments at MIT (the inverse isn't necessarily true). Much of the Whitehead's recent clout comes from its involvement as one of the major centers in the Human Genome Project (HGP). Indeed, the Whitehead has been responsible for generating about 30% of the public genome sequence, making it the largest of the public sequencing centers in the US.[230] There is a lot more to the Whitehead Institute than its Genome Center, but in terms of space the Genome Center has rather "taken over" the Whitehead. So, in addition to the original Whitehead Institute building on Main Street are two other buildings in different parts of Cambridge that house the Genome Center. There is a building where sequencing takes place, and then there is the building that houses the functional genomics unit. It is the latter that is responsible for making sense, in some of the many ways that it is possible to make sense, of genome sequence information, and it is this center that done a lot of research on gene expression using Affymetrix chip technology. Both buildings of the Genome Center are part of what might be called the "Lander lab" (or the multiple Lander labs), Eric Lander being the head of genomics at the Whitehead in addition to being one of the superstars of the HGP, and a co-founder of Millennium Pharmaceuticals.

The Whitehead functional genomics lab is at 1 Kendall Square, which is what my informant there calls a "vanity address".[231] It is a rather characterless and incongruous block of offices rising up in the

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[230] The Sanger Centre in the UK has also sequenced about a third of the genome, making it the other major contributor to the public sequence.

[231] Getting access to the Whitehead is about as difficult as getting access to a biotech company. Unlike the latter, the Whitehead's fears aren't about an anthropologist having access to proprietary information, but about the amount of time an anthropologist's presence might waste there. I was, therefore, formally refused permission to do extended participant observation at the Whitehead by one of the lab supervisors at the

middle of an otherwise rather characterful array of shops and restaurants around a lively red-brick square tenanted by lots of brunch eaters and hot-dog stalls.

The inside of the center looks more like a corporate office than a lab: plush orange carpeting, a reception-hall with a secretary: no smells or lab-coats or chemical muck here. No signs of any of that even on the bench of the post-doc showing me around, which only had a computer as testimony of any work: this could have been a cubicle out of Dilbert. But there were a few, perhaps three, rather sterile workbenches behind her "bench", and it was on one of these that I got my first glimpse of the famed Affymetrix chips. Pretty much like I expected them to look, small and rectangular and looking like fancy microscope slides. But the process of hybridizing and detecting on them is a complicated one, and completely automated. There is a whole, rather large, room that just houses the machines into which the chips are locked in, buttons turned on, and readouts obtained. There were also, on the post-doc's bench, some glass slides that were in the process of being turned into more inexpensive, homemade DNA chips.

In the center of the floor was a bizarre spiral staircase that looked like something out of a spaceship in a 1960s version of "Star Trek". Downstairs is what is called the "variant" group, which does a lot of comparative genomics work. Now this looked like what a molecular biology lab pre-genomics would look like, though much larger and more spacious -- more like a factory than a lab almost. Known appropriately as a "wet lab" (in contrast to bioinformatics labs that have just computers in them), this floor had an area to pour gels in, and shelves stacked with measuring cylinders, and proper lab benches. Much of the upstairs, as I said, just housed offices with computers in them, many of them very plush and secluded. Much of my conversation with the post-doc did indeed revolve around organizational structure, and it is a peculiarly organized place, with these two groups, that seem hardly to interact at all, constituting the interdisciplinary space of "functional genomics".[232]

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functional genomics centre. This makes me particularly grateful to the post-doc who took the time to show me around the center on her own initiative.

[232] The gendering of this space, I think, is particularly striking, with the "intellectual" computational work taking place upstairs and the "wet" lab work taking place downstairs. Indeed, intuitively, one would think that it would make sense to have the space arranged the other way around, since it is the wet lab that

The big question for me then is how the biologists and the informaticists talk, and I think it is the peculiar combination of these two sets of people that contributes to the peculiar architecture, and the peculiar patterns of conversation – it must be weird working on what might be called the same thing, but coming from completely different universes; and that's reflected just in the different natures of the two floors, with the spiral (helical???) staircase in between. The meeting point, really, is "making sense out of data", which of course works two ways: the informaticists trying to make sense of and generate databases out of the chip results, and the biologists helping to give biological meaning to the vast amounts of computer information the informaticists generate.

There are then the larger institutional relationships, with the group's lab meetings often being attended by people from Millennium Pharmaceuticals, which is housed a few floors below in the same building. As mentioned earlier, Eric Lander is one of the co-founders of Millennium, which is one of the leading genome companies anywhere. The Whitehead lab meetings are quite literally physical sites of diffusion of academic research into industry, and in my opinion (as well as the opinions of many private genome scientists that I have talked to), a major source of competitive advantage for Millennium.[233] The interaction between the Whitehead and Millennium, indeed, is not just at the level of architecture or informal interaction. The Whitehead functional genomics group is funded by a consortium that comprises Millennium, Affymetrix (whose DNA chips are extensively used at the Whitehead) and Bristol-Myers Squibb (with whom

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produces noxious chemical waste that one presumably wouldn't want to have wafting up into the bioinformatics area. This abstract question of gendering hardened into quite an explicit division of labor at CBT, India's flagship public sector genome lab that I write about elsewhere in this dissertation. The head of CBT, Sameer Brahmachari, is quite clear that it is men who make good bioinformaticians, and women who make good wet lab workers, because the former are "genetically" better equipped for mental work, the latter so for the more tedious, manual wet lab work. This determinist (and pre-determined) division has some consequence for his hiring practices at CBT. While there are a few women in the CBT bioinformatics facility, there are no men at all in its sequencing and genotyping unit, and I was assured that that was a conscious policy and not coincidence. Many thanks to Alexandru Balasescu for drawing my attention to the gendered nature of the Whitehead's spatial organization

[233] Of course, such sites also immediately complexify Lander's extremely public image as a "public" scientist opposed to private genome companies patenting gene sequences. It must be mentioned here that Millennium, while broadly speaking a genome company, doesn't have the generation of sequence databases as its primary locus of value, but rather concentrates on more downstream parts of the value chain, and ultimately is trying to become a drug development company itself. Therefore, there is no business contradiction in Lander's opposition to gene patenting as a "public" scientist while being on the Board of a

Millennium has close ties in the area of oncology pharmacogenomics and therapeutics). The Whitehead consortium therefore brings together, in essence, the major components and actors of the drug development marketplace, with a functional genomics company, a tool company (as two distinct types of upstream providers), a big pharmaceutical company downstream, and an academic lab that gets funded by all three and that feeds basic research into the development programs of its industrial partners. Such arrangements typify the venture science worlds epitomized by genomics.

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8.3: Consumptive Power

Paul Virilio (1977) in *Speed and Politics* talks about the consumption of security in contemporary, what he calls dromocratic, society (a society run by speed). He says: "We will see the creation of a common feeling of insecurity that will lead to a new kind of consumption, the consumption of protection; this latter will progressively come to the fore and become *the target of the whole merchandizing system*" (122; emphasis in original). High-throughput diagnostic capabilities, such as those provided by DNA chips, fit exactly into such a dromological regime. This is why personalized medicine, genomics and biocapital are all about governmentality in a Foucauldian sense (see Burchell et al 1991). The consumption of diagnostic tests and drugs are a means of ensuring security. The consumer of the diagnostic tests quite precisely fits the description of Virilio's dromocratic consumer: "no longer the one who enriches the nation by consuming, but the one who invests first and foremost in security, manages his own protection as best as he can, and finally pays more to consume less" (123).

I begin this section by thinking of Foucault through Virilio to emphasize the importance of generating a more elaborate theory of consumption without reducing capitalist dynamics today to the dynamics of consumption. Specifically, we need to understand new modes of consumption

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genome company. Rather, his opposition to aggressive gene patenters like Celera and Incyte could be seen as being not just in the interests of public researchers, but also in Millennium's interests.

of surplus, see whether and how surplus consumption is a defining dynamic of biocapitalism, and further position risk distribution as itself a perverse form of surplus consumption.

I would like to begin such an analysis by recounting and identifying Marx's analysis of surplus *production* (and I will talk later about the importance of still focusing on these dynamics of production to "get at" a dynamics of consumption, which itself, in the process, is a term that I will try to decenter and deconstruct at the same time as I try to uphold and explain it).

The key source of exploitation that Marx identifies in the capitalist system is its generation of surplus value. In order to understand how surplus value leads to exploitation, one has to firstly understand that the fundamental economic contradiction that Marx is trying to resolve is the question of how it is that an exchange of equivalents can lead to a generation of surplus, and secondly to understand Marx's concept of labor power.

That it is labor power rather than labor that the worker exchanges with the capitalist is crucial, because labor power, as creative *potential*, is *not* pre-determined value – it has the potential for generating surplus ingrained within it. Therefore the apparent act of equivalent exchange – worker's labor for capitalist's wages – has hidden within it an element of non-equivalence, because wages are fixed remuneration, but the labor, which is actually labor power, is the potential for the creation of value that is *over and above* the money expended in wages. Surplus value "in general, is value in excess of the equivalent" (Marx 1973 [1857] [henceforth *Grundrisse*]: 324). Wages, therefore, constitute for the capitalist *productive consumption*: "*Living labor belongs just as much among capital's conditions of existence as do raw material and instrument. Thus it reproduces itself doubly, in its own form, [and] in the worker's consumption, but only to the extent that it reproduces him as living labor capacity*...[T]he payment of wages is an act of circulation which proceeds simultaneously with and alongside the act of production. Or, as Sismondi says from this perspective – the worker consumes his wages unreproductively; but the capitalist consumes them productively, since he gets labor in the exchange, which reproduces

the wages and more than the wages" (*Grundrisse*: 676, emphasis in original). "If the worker needs only half a working day in order to live a whole day, then, in order to keep alive as a worker, he needs to work only half a day. The second half of the labor day is forced labor; surplus-labour" (*Grundrisse*: 324).[234] Further, as long as the worker is given enough wages to sustain himself, labor power is constantly renewable.

This is how, therefore, the exchange of equivalents leads to the creation of surplus, which is the fundamental mystery that Marx is seeking to unravel, and which is something that political economy has tended always to leave in the realm of mystery. "By virtue of having acquired labor capacity in exchange as an equivalent, capital has acquired labor time – to the extent that it exceeds the labor time contained in labor capacity – in exchange *without equivalent*; it has appropriated alien labor time *without exchange* by means of the *form* of exchange...[T]he use-value of labor capacity, as value, is itself the value-creating force; the substance of value, and the value-increasing substance. In this exchange, then, the worker receives the equivalent of the labor time objectified in him, and gives his value-creating, value-increasing living labor time" (*Grundrisse*: 674, emphases in original).

Marx therefore distinguishes between necessary and surplus labor-time, the former being the labor-time required for the worker to reproduce his means of existence i.e. that goes into the production of use-values. Everything over and above that is surplus labor-time, and leads to surplus value for the capitalist. In order to generate maximal surplus value, the worker is only remunerated with enough wages to maintain his subsistence; the attempt of the capitalist is always to maximize surplus labor-time. It is here that the exploitation of the worker takes place, in the creation of surplus value.

[234] This formulation is central to the articulation of the politics of negation advocated by Antonio Negri and his *Autonomia* movement; see Negri (1991 [1984]).

If the first step in developing an understanding of "consumption" relevant to biocapitalism (and I purposely hold consumption, for the time being, in quotes) is an understanding of surplus value from the productive process as being the node of exploitation of the worker, then the second step is to understand what is meant by subject, which, after all, does not at all necessarily mean worker. It is this gap between political economic, mainly Marxian, analyses of *labor* (as somehow having to do with class, proletariat, relations of production, and so on), and Foucauldian analyses of *subjectivity* (which is a word that I have used extensively in this chapter, and ought definitely to demand problematization by now; but which is also a word that has becomes integral to the lexicon of what have becomes disciplines such as cultural studies and medical anthropology, and therefore get bandied about in the unreflexive fashion that any "canonical" term gets used, and consequently reified and abused), that needs to be bridged if one is to attempt, as I have been doing, a theorizing that is equally attentive to a Foucauldian politics of "life, labor and value" (*as* subjectivity) as it is to a Marxian politics that emphasizes relations of production.

I ask, then, a set of questions that I ask again in my concluding reflections: If there are three categories of beings / classes, workers, capitalists and consumers, then who are the consumers? Both workers and capitalists? To whom then is labor / exploitation invisible? Certainly not to the workers? To whom is it made invisible? If not to the workers, then how does ideology operate to manufacture their consent, even enthusiastic participation, in the capitalist economy? Is this where gendering takes place, worker and capitalist as male, consumer as female? To whom is the "reality" hidden and how? What life does the commodity take on in this masking? Is the life of the commodity in this process of invisibility the point at which the distinction between ideology and fetishism becomes crucial to talk about? (I respond to some of these questions at greater length than I do here in my concluding reflections).

Let me, then, digress from the question of the consumer to move on to the question of the subject, who has been posed as a consumer-in-waiting through this chapter, but who has also, especially in Chapters 5 and 7 when I have talked about genomics enterprises in India, been implicitly the subject-as-*citizen*. If one is to pose the question of the relationship between subjectivity and consumption at all, it is equally necessary to pose the question of the relationship between subjectivity and citizenship, and the role of the nation-state in the formation of subjects as *both* citizens and consumers, and citizens by virtue of their consumptive capability, sometimes, though not always (in Chapter 5, for instance, the mode of citizenship that gets conceived is one of citizen as genetic resource: if genetic material is deemed unproblematically to be the "property" of the nation-state, then surely that is both by virtue of and leads to a certain form of citizenship conferred upon the bearers of that genetic material).

I make the claim here, then, in an apparent digression from the *subject* (in all senses) of *this* chapter, that the problem of subjectivity cannot be *reduced* to the problem of the potentially consumptive subject without, at least partly, posing the problem in terms of citizenship. If one cannot understand biosociality without theorizing biocapitalism, one can equally not do so without theorizing what Adriana Petryna calls *biological citizenship* (see Petryna 1999, 2002). Biological citizenship can be conferred by disaster (as Petryna shows in her work on the fall-out, radiological and political, of the Chernobyl disaster in Ukraine); by a medical intervention such as an operation (as Lawrence Cohen shows in his analysis of the ethical-political issues surrounding organ transplantation in South India; see Cohen 1999); by genetic constitution, or by being the experimental site of clinical trials (the former in the case of the logic of population genetics as it gets employed by the Indian state and elsewhere; the latter as illustrated by my vignette on Wellspring Hospital in Parel in Chapter 5). This is because biocapital is not just about *ontological* emergence, it is also about *political* emergence. As Balibar poses the relationship between subject and citizen (before going on to problematize the relationship as posed in this

way): "*[A]fter the subject comes the citizen.* For the 'subject', which has haunted the whole problematic of liberty and of the individual...for fifteen centuries, is not an ontological figure..., but a legal, political, theological, and moral figure, that os a *subjectus* or *subditus*, i.e., a dependent, believing, and obedient individual" (Balibar 1995: 152).

If the subject, then, transitions into the political being that is citizen, then, equally, the citizen is always already a subject, again; she is the newly *re*-emerged subject. So in the transition from subject to citizen, as Balibar continues, nothing changes, to the extent that the citizen, that which the subject has *become*, is still a subject. And yet everything changes: the modes of subjectivation, the subject categories, the normativities associated with those categorizations, and so on. Therefore, as we move towards a diagnostic regime with the patient-in-waiting as always already a consumer-in-waiting, the question is not what "new subjectivity" is created in the process (as if that "subjectivity" can be defined entirely with reference to itself), but rather is what changes in the entire system of normative structures that combine to create a citizen-subject *as* consumer, subjected to corporate evaluations and (their own and others') risk calculus? Further, what is at stake in a regime of personalized medicine, that always sees the *practice* of medicine as a practice of diagnostic knowledge preceding therapeutic (which may be preventive) action, is not just management or insurance, for undergirding such regimes are deep-rooted questions about the relationships of identity to survival.

In other words, I am not interested in investigating *subjectivity per se* as much as I am, like Balibar (1995), in exploring the *modes of subjection*: which further, I argue, is the dialectic inverse of modes of production. Trying to understand the dynamics of consumption without reducing capitalism to a process of consumption has to involve rereading the assumed binary of production and consumption as a process of cause and effect as, instead, *a dialectic of production and subjection*, where, as Marx is fundamentally concerned with showing, production is always already subjected to modes of subjection. Indeed, he says as much in the *Grundrisse*:

> Consumption creates the motive for production; it also creates the object which is active in production as its determinate aim. If it is clear that production offers consumption its external object, it is therefore equally clear that consumption *ideally posits* the object of production as an internal image, as a need, as drive and as purpose. It creates the objects of production in a still subjective form.... Production thus creates not only an object for the subject, but also a subject for the object.[235]

The question then becomes one of how modes of subjection extend beyond simply subjectivizing modes of production, while staying attentive to the ways in which modes of production are themselves subject to changing modes of subjection (as I have explored in Chapter 4 while talking about labor). The task is to understand, *together*, modes of production and modes of subjection, where a mode of production is *always already* a mode of subjection, and a mode of subjection is *always already* a mode of production. Consumption, then, is a *particular, produced* mode of subjection, with all the ambivalences of subjugation on the one hand, and becoming subject (as agent, articulate) on the other, just as citizenship is a *particular, produced* mode of subjection.

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With this context, I move back to talk about risk, which, as I argued in section 8.2, is the defininining heuristic around which the consumptive subjectivity of personalized medicine takes shape. As I have just posed the question above, it becomes important to explore how, as we move towards a diagnostic regime with the patient-in-waiting as always already a consumer-in-waiting, the question is not what "new subjectivity" is created in the process (as if that "subjectivity" can be defined entirely with reference to itself), but rather is what changes in the entire system of normative structures that combine to create a citizen-subject *as* consumer, subjected to corporate evaluations and (their own and others') risk calculus? For this, it is important to talk about risk in

[235] Marx 1973 (1858): 91-92.

terms of some of the questions I posed in Chapters 6 and 7, regarding vision, hype, nation and salvation.

Fundamentally, risk is imbricated in a dialectical relationship between prophecy and contingency, where prophecy is a way of both *calculating* contingency (through risk:benefit analyses, calculations of insurance premiums, investment decisions based on "due diligence" and so on – and remember, that the patient-consumptive subject's risk of future illness can *only* be situated *as* risk when it is acknowledged that it is a risk that is calculated in the midst of a whole range of calculations of risk that see risk *as* capital), and of *taming* it, at least partly by conjuring a tendential future *through* the prophecy. Therefore, the calculation of risk as a mode of prophecy, which is always already a process of prophesizing as a mode of coming to terms with risk, could be about getting investors to invest in companies through investor pitches and story stocks (see Chapter 5), but could also, *in the same way*, be about getting patients-in-waiting to undertake pre-emptive or prophylactic actions on the basis of diagnostic tests. These tests can offset the risk to the drug developer of:

a. The patient-in-waiting never falling ill and becoming a patient (and thereby never becoming part of the market segment that consumes drugs upon falling ill),

b. A drug never getting developed in the first place for the diagnosis (failure to find adequate targets, or failures in clinical trials), and

c. A particular drug in question not being the prescription of choice for a particular patient (market competition).

In other words, a diagnostic test, which is a marker of an individual's risk of future illness, is *also* a strategy to offset the drug development company's risk of limited market size

(not enough patients with a disease), limited market share (too many other drugs for that indication) and failures in drug development or adverse events after marketing.

Pat O'Malley's distinction between risk and uncertainty in the thought of the 1920s economist Frank Knight is useful for thinking about the difference between prophecy and contingency (O'Malley 2000). He refers to Knight's distinction between risk as the "statistically calculable or predictive model that is descended from positivism" and uncertainty "the non-statistically calculable model that is relevant to the creative activity of the entrepreneur" (462). In other words, the binary that O'Malley sees Knight as setting up between risk and uncertainty can map on, as a binary, to corporations versus entrepreneurs, probability versus possibility.

I purposely do not point to either biotech or pharma here, because of course the different market niches that are likely to be at stake for different sorts of companies involved in drug discovery and development is very much at stake. But the type of company for which this sort of rationality – of diagnostic development *offsetting* the risk of being in the business of therapeutic development – is most likely to manifest itself as central to its business strategy is a company like Millennium Pharmaceuticals, that is not yet a well-entrenched big pharmaceutical company, that depends on genomic technologies in large measure for its drug discovery efforts, that claims it wants to become a drug development company, that needs to continue to generate short-term revenue on its route to becoming one in order to survive long enough to become one, and that also has a diagnostics business lurking quite centrally in its business model. If genomic medicine, broadly defined, is a "revolution" or a "paradigm shift" of any sort, then it is of a sort where the companies that hope to be the vanguards of the "revolution" like Millennium, are most likely to exhibit its attributes.

Perhaps the most interesting corporate marker of an emergent regime of "post-genomic" medicine, that explicitly sees itself as changing and operating upon changed institutional and normative structures, changed grounds upon which citizens, consumers and subjects get defined,

is Genomic Health, which is a company I have mentioned in Chapter 5 while talking about Randy Scott and Patrick Terry. To talk more about Genomic Health, it is important to revisit Scott's modes of prophecy, that I have talked about at some length in Chapter 6 in connection to his role as founder and Chief Scientific Officer of Incyte. When Scott was pitching Incyte, for example at The Institute of Genomic Research (TIGR)'s industrial conference in Miami in 1999, it was an investor pitch where his potential consumers were pharmaceutical companies. With Genomic Health, his potential consumers are lay people, the patients and consumers-in-waiting that I have talked about in this chapter. This leads to a whole different understanding, different time-lines, analogies with the computer industry, and a coincidence with Patrick Terry's line about patients and consumers that I mentioned in Chapter 5, when Scott pitches Genomic Health.[236]

Scott's conception of historical phases was always, as I mentioned in Chapter 6, central to his mode of pitching stories, even for Incyte. His pitches for Genomic Health see him periodize the "history" of genomics into decades – the 1980s, when the first companies bring products into the market based on classical DNA efforts; the 1990s, an era of industrialization and high-throughput technologies; and the 2000s, which he calls the era of consumer genomics, where biological information merged with internet capabilities will be key. In other words, the driving assemblages of emergent, "post-genomic" medicine, in Scott's opinion, are biological information (such as diagnostics), communications technologies that mediate such information as they travel to lay patients (the internet), and the consequent networking of biosocial communities such as patient advocacy groups as a consequence. It is a vision that has as its kernel the sort of consumptive power that is evidenced by groups such as PXE International (see Chapters 5 and 7).

Scott, therefore, has a vision of "consumer genomics" that is completely entwined with his vision of Genomic Health as a company, and which sees patients directly buying access to

[236] I draw my account of Scott's pitch for Genomic Health from a talk given at a session on "Post-Genomic Medicine", at the 2001 Genome TriConference, an investor conference held in San Francisco, on 7 March 2001.

information and technologies, thereby seriously decentering the role of physicians. Pharmaceutical companies, in this vision, are still involved in therapeutic development, but Scott realizes that the lag between the development of diagnostic and therapeutic capabilities creates an ethnographic window, an ethnographic window that is absolutely critical to the existence of Genomic Health as a company.

Scott, then, outlines his individuized notion of consumer genomics as follows:

> Genomics is inherently personal. This is not about big industrial units that are bringing out products for other companies.[237] Everyone of us sits here with a genome, and a genome is our own particular story. My family has its story...they were a perfectly normal family, they thought they had no genetic disease, no genetic defects..... [But] no matter how healthy we may think we are, ultimately we will all face the reality of our genetic faults, and the diseases that are coming at us in the future. So we are all in this together.[238]

In this one quote, Scott points to many of the themes that I have covered in this thesis. He encapsulates his own visionary biography, superimposed upon the history, as he sees it, of genomics – moving away from and beyond the vision of Incyte (which he leaves at a moment when its own business model threatens it with obsolescence, as I've mentioned earlier), a movement that is portrayed as a natural following of the course of the history of a science that is always already a corporate endeavor. But it is also a personal voyage, an individuation whose limitations are immediately evident, in that it is an individuation that cannot be made sense of without being placed in larger population contexts. Avoiding adroitly the fundamental difficulties of classifying populations that I have pointed to earlier in this chapter, difficulties that are an acute scientific and business reality for those who invest in population genomics as their vision of and route to future monetary and therapeutic salvation, Scott automatically uses the family as the

[237] Which of course exactly is what Incyte is.
[238] Randy Scott, talk given at the Genome TriConference, San Francisco, CA, March 7 2001.

basis of his relevant population unit – a unit, of course, that is comfortably Christian, moral and value-laden, for one who himself is driven considerably (as mentioned in Chapter 7) by his Christian faith. Ultimately, everyone is enrolled as part of a Christian odyssey towards their respective genetic days of reckoning, but in the process, as Scott managed to do for his employees at Incyte (see Chapters 3 and 5), he conjures up the image of a community, the community of patients-in-waiting, who are always already consumers-in-waiting. For lest we forget this voyage is over-determined by the market, Scott immediately proceeds: "So the issue is how we bring these products to the market, how we bring them to the consumer".[239]

Scott's conception of consumer genomics reflects what Pat O'Malley (2000) describes as an emergent "enterprising prudentialism". O'Malley says: "the subjects of this technology of risk are imagined as *consumers* (albeit 'sovereign consumers'), for, as elsewhere in discourses of the freedom of choice, their liberty exists in the capacity to choose rationally among available options and to assemble from these the risk-minimizing elements of a responsible lifestyle" (465). While the latter part of this description is inherent to the very rationale of personalized medicine as a practice of medicine that is, in the first instance, *preventive*, the key addition that Scott explicitly makes, and which forms the basis of potential value for Genomic Health, is that risk-minimization and prevention is *not* dictated by the discriminatory practices of employers or health management organizations, or by the expert (and thereby, it is implied, forcible) interventions of physicians, but by patients themselves, who necessarily have to be configured as rational actors in the way that advertising conceives of them thus, and have to be given the appearance of "free choice" amongst a highly constrained set of options that are available, in any case, only to those who occupy the class position from which to exercise such "free" choice. Diagnostic tests and preventive or therapeutic options, in Scott's business model, become consumables in exactly the same way that soap or perfumes are. The DNA chip, that I introduced

[239] *Ibid.*

this dissertation with, is precisely such a technology that creates "free" (in the utilitarian sense of having rational choices of self-governance) subjects of uncertainty, who get subjected to a rationality of perpetual possible consumption, and a rationality that simultaneously demands "rational" self-governance – a governance itself that gets effected through further consumption.

In this situation, then, one comes back to the question of governmentality that I started this section with. For after all, "rational" consumer choice, as assumed by corporations selling to those consumers, cannot afford to be quite as banal or simplistic in its assumptions of consumer rationality as rational choice sociology or political science can, since the very future of the company is at stake if consumers act "irrationally". Indeed, there are clearly many ways in which people can respond to the results of genetic tests, as responses to Myriad's breast cancer tests for the *brca* genes has shown. What a range of business models – not just Genomic Health's, but also those of diagnostics companies', drug discovery and development companies', health management organizations' and so on – depend upon in an era of personalized medicine is not so much rational action as *reasonable* action – and it is, indeed, in a notion of *reasonable* rather than rational (as propounded by rational choice theorists) governance that Foucault concerns himself with in his exposition on governmentality (see Foucault 1990; this notion of "reasonable" rather than "rational" governance also figures prominently in O'Malley 2000). Indeed, throughout this dissertation I have mentioned actors – including venture capitalists, entrepreneurs, pharmaceutical companies, biosocial agents, policy makers and patients as / and consumers – who need constantly to calculate their futures precisely *because* of the difficulty of calculating them. The question that is important to stay attentive to, and trace answers to, is how such "reasonable" governances articulate, at and through different institutional sites, national contexts and historical and strategic conjunctures.

My opposition of the "rational" to the "reasonable" brings to the fore the notion of common sense. Indeed, O'Malley points to the "deep well of assumptions about common-sense

reasoning and uncertainty as fundamental conditions of the autonomy of the rationally calculating, free subjects of liberalism" (O'Malley 2000: 479). I however also point to common-sense in the sense that Gramsci used it, as the grounds for hegemonic praxis. Personalized medicine, or genomics, or drug development is not the teleological outcome of technoscientific progress, as scientists like Francis Collins and Victor McCusick portray it, but is, ultimately, a hegemonic struggle. I have tried in this dissertation to stay attentive both to the structural constraints that form the grounds for such struggle, and to the strategic and contingent articulations that give it shape.

Appendix 1: Dissertation field sites in the United States and India

Long-term participant observation (few weeks to few months)

- GeneEd, Inc. Start-up company in San Francisco, CA, January - May 2001
- Entrepreneurial Pharmaceutical Professionals of the Indian Continent (EPPIC). Organization of Indian entrepreneurs based in the Silicon Valley, seeking to create and sustain biotechnological transfer between the United States and India, and also to mentor young Indian entrepreneurs in the United States. January - May 2001
- Ongoing research with PXE International, a patient advocacy group organized to advocate the cause of sufferers of the rare genetic disorder pseudoxanthoma elasticum. PXE International advances the case for research on PXE by biotech companies, and has further entered into agreements with biotech companies in which intellectual property for such research using samples from PXE patients gets shared with the patient group.
- National Bureau of Plant Genetic Resources (NBPGR), New Delhi, India. A public repository of plant germplasm. July - August 1999.
- Centre for Biochemical Technology (CBT), Delhi, India. The major public laboratory in India that is focussing on genomics related work. December 2001 - January 2002.
- Genomed, Delhi, India. Genomics start-up seeded by CBT in collaboration with the pharmaceutical company Nicholas Piramal, to focus to commercialization of genomic research undertaken at CBT. Represents new model of academic - industrial partnership in India. December 2001 - January 2002.

Short visits (1 - 2 days)

- National Center for Biotechnology Information, National Institutes of Health, Bethesda, MD. Repository for GenBank, the major public DNA sequence repository.

- Cold Spring Harbor Genome Sequence and Analysis Meetings, 1999 and 2000. This is the major annual gathering of researchers of the public Human Genome Project (HGP).
- The Institute of Genomic Research (TIGR)'s Genome Sequencing and Biology Meetings, Miami, FL, 1999 and 2000. Organized by J. Craig Venter's non-profit research organization TIGR, this is one of the largest annual industrial genome conferences.
- Cambridge Healthtech Institute's Genome TriConference, San Francisco, CA, 2001. This is one of the largest annual genomic investor meetings.
- Whitehead Center for Functional Genomics, Cambridge, MA. One of the major academic centers of the HGP.
- Genomics Collaborative, Inc., Cambridge, MA. Company that hopes to become the world's largest commercial DNA repository, which it hopes to leverage towards in-house and out-licensed genomics based therapeutic development.
- Variagenics, Cambridge, MA. A leading functional genomics company that is developing pharmacogenomic strategies towards the development of personalized medicine.
- Incyte Genomics, Palo Alto, CA. One of the major genome companies that sells sequencing services and sequence databases.
- Affymetrix, Santa Clara, CA. The company that developed the DNA (SNP) Chip, a major tool that enables high-throughput genetic variation studies (known as single nucleotide polymorphism, or SNP, analysis).
- National Chemical Laboratories, Pune, India. The most successful business sector specific lab of India's Council for Scientific and Industrial Research (CSIR).
- Centre for Biochemical Technology (CBT), Delhi, India (see above).
- Genomed, Delhi, India (see above).

- Centre for Cellular and Molecular Biology (CCMB), Hyderabad, India. One of the most prestigious molecular biology research institutes of the CSIR.
- Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad, India. A CSIR lab that provides DNA testing services for forensics and diagnostics.
- Dr. Reddy's Laboratories (DRL), Hyderabad, India. One of India's largest pharmaceutical companies, and the earliest to set up its own R & D foundation.
- Orchid Pharmaceuticals, Chennai, India. A smaller and newer pharmaceutical company than its more established competitor DRL.
- Astra-Zeneca Research Foundation, Bangalore, India. A subsidiary of the global multinational pharmaceutical giant Astra-Zeneca.
- Biocon, Bangalore, India. One of India's oldest biotech companies.
- Strand Genomics, Bangalore, India. Start-up bioinformatics company that does contract work for American companies as well as develops its own proprietary algorithms.
- Tata Consultancy Services (TCS), Hyderabad, India. One of India's most powerful software companies and now increasingly interested in moving into bioinformatics.
- ICICI Knowledge Park, Hyderabad, India. Set up by the government of Andhra Pradesh and the financial service provider ICICI, this is a research park that enables companies to lease space on subsidized land and have access to state-of-the-art research facilities in a collaborative environment. Modeled upon similar knowledge parks in Singapore.

Appendix 2: Texts of agreements for access at GeneEd and CBT

Reproduced below are the texts of the two modified "non-disclosure agreements" that I signed, with GeneEd and CBT. Hopefully, they will both provide a template for other work of this sort, and also highlight the issues that are of most concern to the actors in these two different institutional and national environments.

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Agreement relating to confidentiality issues arising from information exchange in the course of academic research program

This agreement is made between GeneEd, Inc. ("GENEED, INC."), a California Corporation, and Kaushik Sunder Rajan / Michael M.J. Fischer / Joseph Dumit / Sheila Jasanoff (Recipient). GENEED, INC. and Recipient hereby agree that it may be necessary to provide the Recipient with certain technical or business information considered to be proprietary or confidential information of GENEED, INC.

The term "Information", as used in this agreement, shall mean any and all GENEED,INC. technical and business information, whether written, oral or graphic, that GENEED, INC. may disclose or reveal to the Recipient, including but not limited to financial plans and records, marketing plans, business strategies and relationships with third parties, client lists, present and proposed products, trade secrets, computer software programs and descriptions of functions and features of software, source code, computer hardware designs, information regarding customers and suppliers, founders, employees and affiliates.

NOW THEREFORE, the Recipient hereby agrees to receive such information of GENEED, INC. subject to the following terms and conditions:

1. Recipient agrees not to use any Information for any purpose except as part of an academic project that includes interactions between Recipient and GENEED, INC. Recipient shall not

reverse engineer, disassemble or decompile any prototypes, software or other tangible objects which embody GENEED, INC.'s information and which are provided to recipient hereunder.

2. The Recipient will not make more copies of the Information than is necessary. Recipient shall reproduce GENEED, INC.'s proprietary rights notices on any such copies, in the same manner in which such notices were set forth in or on the original. Recipient agrees that it shall take all reasonable measures to protect the secrecy of and avoid the unauthorized use of the Information. Without limiting the foregoing, Recipient shall take at least those measures that Recipient takes to protect its own most highly confidential information. Recipient shall immediately notify GENEED, INC. in the event of any unauthorized use of the Information.

3. The Recipient shall not have any obligation with respect to any Information or any portion thereof which the Recipient can demonstrate by competent evidence:

(i) was already known to the receiving party, other than under an obligation of confidentiality, at the time of disclosure;

(ii) was generally known to the public or was otherwise part of the public domain at the time of disclosure to the receiving party;

(iii) became generally available to the public or otherwise part of the public domain after its disclosure and other than any act or omission of the receiving party in breach of this Agreement;

(iv) was independently developed by the receiving party without reference to any information or materials disclosed by the disclosing party; or

(v) was subsequently disclosed to the receiving party by a person other than a party without breach of any legal obligation to the disclosing party.

4. No license to the Recipient for the Information for any trademark, patent or copyright, or other rights which are now or may thereafter be owned or asserted by GENEED, INC. or any subsidiary thereof is either granted or implied by this Agreement. This excludes any audio

recordings (henceforth "Recordings") that the Recipient might make of the voice of employees of GENEED, INC. as well as written or oral descriptions of GENEED, INC.'s employees and their activities for use in the Recipient's research and educational activities. GENEED, INC. acknowledges that the Recipient is the sole author of the Recordings, and owns the entire right, title and interest in and to all copyrights in the Recordings, including the right to create derivative works based on the Recordings. GENEED, INC. acknowledges that it owns no copyright or any other right in or to the Recordings. GENEED, INC. does, however, have the right to request erasure of any part of a Recording at the time of its creation or within twenty-one days of being provided with a transcript of the Recording; however, this right shall apply only to Recordings on which the voice or a description of activities of GENEED, INC.'s employee is first fixed, and shall not apply to Recordings which contain no material concerning GENEED, INC. other than material contained in an earlier completed Recording.

5. A copy of any Recording will be made available to GENEED, INC. for viewing if requested, in order that GENEED, INC. may address issues of proprietary technical and business information only that may be contained in the Recording. GENEED, INC. does not have the right to dictate to the Recipient any views that the Recipient might express that are not the views of GENEED, INC. or its employees, as long as the Recipient makes clear that the views expressed are either those of the Recipient itself or of third parties not party to this Agreement.

6. GENEED, INC. does not wish to receive any confidential information from Recipient, and GENEED, INC. assumes no obligation, either express or implied, with respect to any information disclosed by Recipient.

7. Nothing herein shall obligate GENEED, INC. or Recipient to proceed with any interaction between them, and each party reserves the right, in its sole discretion, to terminate the discussions contemplated by this Agreement concerning the academic relationship.

8. ALL INFORMATION IS PROVIDED "AS IS". GENEED, INC. MAKES NO WARRANTIES, EXPRESS, IMPLIED OR OTHERWISE, REGARDING ITS ACCURACY, COMPLETENESS OR PERFORMANCE.

9. The Recipient recognizes and acknowledges that the Information may have competitive value and be of a confidential nature and that irreparable damage might result to GENEED, INC. if Information is improperly disclosed by the Recipient to a third party. Accordingly, the Recipient agrees that legal proceedings at law or in equity, including injunctive relief, may be appropriate in the event of a breach thereof. THIS, HOWEVER, DOES NOT APPLY TO THE PROPER USE OF THIS INFORMATION BY THE RECIPIENT THROUGH VARIOUS CHANNELS FOR ACADEMIC AND EDUCATIONAL PURPOSES ONLY ONCE ISSUES OF CONFIDENTIALITY RELATING TO THE RECORDINGS MADE BY THE RECIPIENT HAVE BEEN ADDRESSED BY GENEED, INC. AS SET OUT IN SECTIONS 4 AND 5 ABOVE. Such proper use includes the textual but not audio use of the Information in modified or unmodified form in academic journal publications, academic conference presentations, academic theses or dissertations, newspaper articles, artistic presentations or books that the Recipient might author or contribute to.

10. GENEED, INC. also releases the Recipient from any and all claims of any nature whatsoever which GENEED, INC. may now or hereafter have in connection with the Recordings, including but not limited to claims based on defamation, copyright infringement, trademark infringement, or infringement of any rights of privacy or rights to publicity of GENEED, INC. or its employees. At GENEED, INC.'s request, the Recipient will anonymize the name of the company and identifying features of the company, as well as anonymize the individuals in the company who talk to the Recipient or grant the Recipient interviews. Employees of GENEED, INC. who grant the Recipient permission to tape interviews will always have the right to ask the Recipient to turn off the tape recorder.

11. The Recipient wishes to have as full access as possible to personnel, daily activities and meetings at GENEED, INC., including taping some interviews, but will grant confidentiality to all individuals who request it. If the Recipient quotes excerpts from taped interviews, it will only name the interviewees with their express permission and only do so as long as it does not compromise their anonymity as outlined in section 10.

12. This Agreement shall bind and inure to the benefit of the parties hereto and their successors and assigns. This document contains the entire agreement between the parties with respect to the subject matter hereof. Additional agreements relating to recordings of conversations between the Recipient and individual employees of GENEED, INC. will be entered into in order to address issues of confidentiality and copyright relating to the Recordings, so long as such agreements do not violate the terms and conditions of this Agreement. The terms and conditions specified in sections 1, 2, 4, 5, 6 and 8 of this Agreement shall survive termination of this Agreement. This Agreement may not be amended, nor any obligation waived, except by a writing signed by both parties hereto.

13. This Agreement shall be governed by the laws of the State of California.

14. This Agreement shall survive until such time as all Information disclosed hereunder becomes publicly known and made generally available, including through actions of the Recipient through appropriate channels as outlined in sections 9, 10 and 11 of this Agreement.

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Text of Agreement with CBT

This agreement made and entered into on this 17th day of January 2002 between Council of Scientific and Industrial Research, a Society registered under the societies registration Act (XXI of 1860), having its registered office at Anusandhan Bhawan, 2, Rafi Marg, New Delhi – 110001 through its laboratory Centre for Biochemical Technology located at Mall Road, Delhi –

110007 (hereinafter called CSIR / CBT which expression shall where the context so admits include its successors and permitted assigns) on the one part.

And

Mr. Kaushik Sunder Rajan, Research Scholar and his advisors, Michael M.J. Fischer, Joseph Dumit, Sheila Jasanoff and Donna Haraway, from Science, Technology and Society Program at Massachusetts Institute of Technology [*sic*], Cambridge, MA 02139, USA (hereinafter collectively called "Investigators").

PREAMBLE

Investigators are involved in a research project which looks at emergent models of post genomic research in the United States and India and leading to Ph.D. title. CBT has been identified as the key site for this study because of its pioneering role in conducting and coordinating Genomics research in India and also because of the lead CBT has taken in initiating development of novel methods of academic-industrial interaction in the field of Genomics.

This agreement spells out the terms and conditions of confidentiality and anonymity under which Investigators shall conduct the studied cited above at CBT.

TERMS AND CONDITIONS

1. The Investigators agree to keep confidential any proprietary information of CBT that they might obtain in the course of their research project. Disclosure of any proprietary information of CSIR / CBT shall be made only with the prior written consent of the Director, CBT. Meanwhile, CSIR / CBT will allow the Investigators to make public any non-proprietary information for academic purposes. These academic purposes include, but are not restricted to, conference presentations, journal and newspaper articles and grant proposals.

2. During the course of research, the Investigators will conduct many tape-recorded interviews with employees at CBT. The Investigators will respect any requests for anonymity by the

interviewees and / or CSIR / CBT during these interviews. Further, the Investigators will conduct tape recorded interviews only with the express permission of the interviewees, and will turn off the tape recorder whenever requested by the interviewee.

3. The Investigators will make available to the interviewees' [*sic*] copies of tape & transcripts of their interviews within a reasonable period of time. The interviewees and CSIR / CBT will have 30 days after the receipt of the transcripts to address with the Investigators issues of confidentiality arising from the interviews. Any request to erase portions of the interviews because of sensitive, confidential or proprietary information therein will be complied by the Investigators.

4. There will be no monetary payment by CSIR / CBT to the Investigators in their capacity as Investigators, and CSIR / CBT will not have the right to dictate or influence the content of any written documents (papers or articles) by the Investigators except to the extent that direct issues of confidentiality are concerned. However the papers articles or publications arising out of this study shall be co-authored with CBT scientists / PI Genomics program CBT, if he wishes to be, based on the intellectual input given by CBT for the this study [*sic*].

5. The copyrights of any interview materials or transcripts will reside with the Investigators only.

6. In case the study / research program leads to new knowledge, and is used by investigators or any organisation for commercial gains, then the commercial gains shall be shared between CSIR / CBT and investigators in proportion to intellectual input of each party.

7. CSIR / CBT will not be held responsible for the content of the Investigators' research findings, even if it pertains to CSIR / CBT or to any other individuals / groups / organisations about which the Investigators might write.

8. Investigators shall not file any application for seeking intellectual property rights in its own name or in the name of its associates or any other person on matters relating to the studies

wherein information about CSIR / CBT is involved without seeking written approval of Director – CBT.

9. Investigators shall not use the information parted by CSIR / CBT in the study for purpose other than specified in preamble and clause 1.

10. This agreement is valid independent of any other agreements that any of the Investigators might choose to sign with CSIR / CBT for purposes other than that of this research project.

ARBITRATION

In the event of any dispute or difference between the parties hereto, such disputes or differences shall be resolved amicably by mutual consultation. If such resolution is not possible, the unresolved dispute or difference shall be referred to the arbitration of two arbitrators, one appointed by each party and an umpire appointed by two arbitrators. The three will constitute the Arbitral Tribunal, which shall hold its proceedings in Delhi and in accordance with Indian arbitration act, 1996.

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