

Commercializing University Biomedical Ideas: Problems and Opportunities

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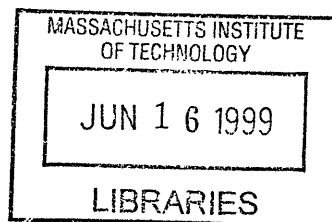
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ABSTRACT

The level of entrepreneurship and commercialization of inventions at universities in the United States varies widely. This study attempts to uncover the factors that may explain the differences in the attitude toward entrepreneurship and commercialization found at academic institutions. To this end nineteen interviews with faculty researchers, inventors, entrepreneurs, venture capitalists, technology transfer officers, and others were conducted. The different perceptions toward entrepreneurship and commercialization at the Massachusetts Institute of Technology, Harvard University, and Harvard Medical School and its associated research hospitals were examined with particular care.

Several factors that are significant in promoting entrepreneurship and interest in the commercialization of ideas were identified. Although these factors may account for the observed differences, no one factor was singled out as being the most important. These factors include the presence of mentors and role models, the composition of the institution's intellectual property, cultural differences, the conflict of interest policy, a critical mass of people, the technology transfer process, and the availability of university venture funds. Many of those interviewed believed that the nature of intellectual property and accessibility to mentors and role models by the researchers and inventors were probably the most significant of all factors for enhancing entrepreneurship.

Thesis Supervisor: Edward B. Roberts

Title: David Sarnoff Professor of Management

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Chapter 1: Introduction

Technology licensing and the creation of start-up companies are attractive to universities because these activities not only disseminate beneficial knowledge for public use, but also can enhance the universities' reputation, increase regional economic development and, in some cases, can be quite profitable to the school. The passage of the Bayh-Dole Act of 1980 [Public Law 96-517] was followed by a significant increase in university licensing and intellectual property programs. However, the level of entrepreneurship and commercialization of inventions at universities in the United States varies. This study attempts to understand the factors that may explain the differences in the perceived attitude toward entrepreneurship and commercialization at academic institutions by examining two universities that conduct biomedical research in the Metropolitan Boston Area. One advantage in comparing neighboring institutions is that the influence of regional differences is minimized.

Throughout the world, the Massachusetts Institute of Technology (MIT), Harvard University, and the Harvard Medical School and its associated hospitals are regarded as research leaders. MIT is also looked upon as being entrepreneurial and, indeed, has been responsible for the creation of a significant number of spin-off companies. In contrast, at Harvard and, in particular, at the Medical School Campus, the attitude of the faculty and staff is not generally oriented toward entrepreneurship. This study examines MIT, Harvard University, and Harvard Medical School and its associated research hospitals and, to a lesser extent, Boston University by means of a series of interviews. Furthermore, this study identifies and defines the factors that are most significant in

promoting an atmosphere of entrepreneurship and interest in the commercialization of ideas.

Chapter 2: Background Information

As a member of the Faculty of Harvard Medical School, in Boston, Massachusetts, I experienced firsthand the frustration endured by me and my colleagues who are interested in working with industry to build upon ideas and other inventions originating from our research. There are few colleagues available whom I can ask about the process of bringing inventions to the market place, either through licensing or through the process of forming a start-up company. Publication is considered the preferred route of knowledge dissemination at Harvard Medical School. In contrast to the situation at the medical school, the Massachusetts Institute of Technology (MIT) fosters an environment in which entrepreneurship is not only accepted, but is encouraged. Like MIT, the amount of intellectual property at Harvard University and especially at Harvard Medical School and its affiliated teaching hospitals is substantial. The study described herein examines the different attitudes at these institutions toward entrepreneurship and the commercialization of ideas in order to discover the factors that may explain these differences.

To appreciate the culture surrounding entrepreneurship at MIT, the next section of this chapter briefly describes the history of MIT and its relations with industry.

MIT and Entrepreneurship

William Barton Rogers founded MIT in 1861; his purpose was to create an institution to “respect the dignity of useful work.” MIT developed close ties with industry from its inception and this relationship is perpetuated today by the MIT Industrial Liaison

Program. During the Second World War major technological effort at MIT was directed toward the development of useful instrumentation and other materials to win the war. Following the end of the war, MIT president Karl Taylor Compton helped create American Research and Development (ARD), the first institutional venture capital fund. The eventual head of this fund was the famed General Georges Doriot, Professor of Industrial Management at Harvard Business School. In addition, Compton and his successor as president of MIT, James R. Killian, were proponents of faculty maintenance of close ties with industry and they also encouraged entrepreneurial activity. Of note, it is common for MIT faculty to consult outside of MIT about one day a week and for some members to form their own company. Although in some instances issues of conflict of interest may arise, it has been rare for MIT faculty who have founded companies to resign from their MIT positions.

It is noteworthy that the dominant pattern of the technology companies in the Greater Boston-Route 128 region is derived from MIT laboratories and departments while the proliferation of new technology companies in “Silicon Valley” is mostly the result of multiple spin-offs of existing companies.¹ Furthermore, despite the strong entrepreneurial culture in the Boston area, it was not until the biotechnological revolution that Harvard University began to play a role in the entrepreneurial arena.² In 1989 Louis published a survey that reported that the Harvard life sciences faculty ranked tenth, with 26% of the members holding “equity in a company whose products or services are based

¹ Roberts EB. *Entrepreneurship in High Technology: Lessons from MIT and Beyond*. New York: Oxford University Press: 1991:35.

² *Ibid.*, 36.

on their own research, ” compared to the MIT life sciences faculty which ranked first with 44% holding equity.³

Technology Transfer

History

In 1980 the Bayh-Dole Act [Public Law 96-517] changed the relationship of industry to universities, not-for-profit corporations (such as research hospitals), and government sponsored research laboratories. Passage of the act did two things: first, it allowed these institutions and other recipients of government sponsored research (such as small businesses) to commercialize their inventions. Second, the act allowed these institutions to offer exclusive license of their technology with hope of diffusing discoveries to the public that indirectly funds the research through tax dollars. Supporters of the Bayh-Dole Act believed that unless universities were given the power to exclusively license patentable inventions, many of the findings of federally-funded research would never be made available to industry or considered for commercialization. This is important because university research is the primary source of basic research discoveries in the United States and is a major source of competitive strength in world markets. In this connection, it should be pointed out that the National Science Foundation reported in

³ Louis KS. Blumenthal D, Gluck ME, Stato MA. Entrepreneurship in Academe: An Exploration of Behaviors Among Life Scientists. *Administrative Science Quarterly*, March 1989;34:127.

March 1997 that three-quarters of all patent applications in the United States were the result of publicly-funded research.⁴

The passage of the Bayh-Dole Act was followed by a significant increase in university licensing and intellectual property programs. For example, a recent survey of 131 universities by the Association of University Technology Managers (AUTM) found that the number of inventions disclosed in fiscal year 1996 increased by 9.3% relative to 1995.⁵ Licensing income increased over the same period by 22.1% and totaled \$365.2 million. According to its 1997 university survey, AUTM found that 87% of all license revenues were from the area of life science.⁶

Invention Characteristics

Jensen and Thursby examined the stage of development of licensed inventions in a survey of 135 university technology managers (see Table 1).⁷ Only 12% of the licenses were for discoveries that had immediate practical or commercial use and over 75% were no more than a proof of concept (i.e., no prototype or lab scale only).

⁴ Rodin J. Federal Research Facility Needs: Judith Rodin. Congressional Testimony before the Senate Subcommittee on Science on Science, Technology, and Space of the Senate Committee on Commerce, Science, and Transportation. April 28, 1998

⁵ Technology Transfer-Administration of the Bayh-Dole Act by Research Universities. *United States General Accounting Office Report B-275266*, May 7, 1998

⁶ Massing DE (ed.). *Association of University Technology Managers Licensing Survey: Fiscal Year 1997*. Norwalk, CT: Association of University Technology Managers; 1998:2.

⁷ Jensen R, Thursby M. Proofs and Prototypes for Sale: The Tale of University Licensing. *NBER Working Paper #6698*, 1998:5.

Table 1⁸	
Stage of Development of licensed inventions which were *	Weighted Mean %
Proof of concept but no prototype	48
Prototype available but only lab scale	29
Some animal data available	25
Some clinical data available	5
Manufacturing feasibility known	8
Inventor cooperation required	71
Ready for practical commercial use	12

*Percentages need not sum to 100.

Most licensed technologies are, therefore, at a very early stage and require considerable development to become a marketable product. Inventor cooperation is generally required during the development and commercialization process in addition to a significant investment of money and time by the licensee. There is no guarantee of success or commercial viability and the risks for the licensee increase with earlier and more basic technologies.⁹ In addition, early stage discoveries also require greater intellectual property protection.

Reagent and biological materials (e.g., monoclonal antibodies and cell lines) as well as software make up the majority of inventions that have immediate commercial use and they are generally licensed for a fixed fee.¹⁰

⁸ Table 1 is modified from Table 1 in Jensen R, Thursby M. Proofs and Prototypes for Sale: The Tale of University Licensing. *NBER Working Paper #6698*, 1998.

⁹ Nelsen L. Identifying, Evaluating and Reporting Innovative Research Developments at the University. In Peterson GR (ed.) *Understanding Biotechnology Law: Protection, Licensing, and Intellectual Property Policies*. New York: Marcel Dekker; 1993:25.

¹⁰ Jensen, *op. cit.*, 5.

Licensing and Patent Statistics

This section presents some of the statistics concerning technology licensing at MIT, Harvard University, Harvard Medical School and its affiliated hospitals, and Boston University. Table 2 shows the level of sponsored research at these institutions for fiscal year 1997. Although the total amount of support for sponsored research at MIT is close to that for the Harvard Medical Community, it should be noted that approximately half of \$714 million awarded included support for Lincoln Laboratory (\$331 million) and for Whitehead Institute (\$18 million). Of particular interest is the significant absolute dollar amount of industry research support awarded to the Harvard Medical Community (\$104 million) compared to MIT (\$67 million) and Boston University (\$10 million). However, it should be emphasized that all of the \$67 million awarded to MIT by industry was exclusively for use by the school and excluded Lincoln Laboratory and Whitehead Institute. This amount of industrial support represents 18% ($\$67\text{MM}/\365MM) of the total on-campus research expenditures and is higher than Harvard Medical Community at 14% ($\$104\text{MM}/\745MM) and Boston University at 8% ($\$10\text{MM}/\132MM).

Table 2: Total Sponsored Research Expenditures FY1997¹¹			
(All numbers are in million \$)			
INSTITUTION	TOTAL	Federal Government Sources	Industrial Sources
Harvard University	\$367	\$265	\$14
Harvard Medical School ¹²	122	97	4
Beth Israel Deaconess Hospital	89	58	15
Brigham & Women's Hospital	154	109	22
Dana-Farber Cancer Institute	89	76	14
Massachusetts General Hospital	212	129	40
The Children's Hospital	79	56	9
Harvard Medical Community(TOTAL) [†]	745	525	104
MIT	714 [‡]	620 [§]	67
Boston University (*FY1998 Data) ¹³	132*	97*	10*

[†] This total is the sum of the support received by Harvard Medical School and its associated hospitals as shown above.

[‡] Approximately half of this amount went to support Lincoln Laboratory (\$331 million) and Whitehead Institute (\$18 million).

[§] MIT on-campus federal government funds is \$271 million.

Table 3 shows the number of invention disclosures, patents and licenses issued for fiscal year 1997. Here again, there is a significant number of disclosures and new patents at both MIT and the Harvard Medical Community. Although there were more invention disclosures at the Harvard Medical Community than at MIT, the number of patents filed and issued to both is approximately equal. The number of licenses and options executed at the Harvard Medical Community may be greater than MIT because of the significant number of biological materials, such as cell lines and monoclonal antibodies, that are non-exclusively licensed.

¹¹ Massing, *op. cit.*, 145.

¹² *Harvard University Office for Sponsored Research OSR FY 1998 Annual Financial Report*. Cambridge MA: Harvard University; 1997.

¹³ Ashley Stevens. Boston University Technology Transfer Office. Personal Communication, May 1999.

Table 3: Disclosures, Patents, and Licensing for FY 1997¹⁴

INSTITUTION	Invention Disclosures Received	New U.S. Patent Applications Filed	Licenses & Options Executed	License & Options Yielding License Income	U.S. Patents Issued
Harvard University	119	61	67	232	39
Harvard Medical School ¹⁵	56	22	41		26
Beth Israel Deaconess Hospital	65	36	53	4	10
Brigham & Women's Hospital	86	52	19	50	20
Dana-Farber Cancer Institute	54	34	23	47	20
Massachusetts General Hospital	123	61	34	43	42
The Children's Hospital	68	21	16	26	18
Harvard Medical Community(TOTAL) [†]	452	226	186		136
MIT	360	200	75	255	134
Boston University (*FY1998 Data) ¹⁶	63*	26*	17*	15*	28*

[†] This total is the sum of the values for Harvard Medical School and its associated hospitals as shown above.

Table 4 shows the gross license income received by the various institutions in fiscal year 1997. Although MIT does not have a Medical School it received income amounting to \$14.8 million from technology related to the life sciences as compared to \$19.7 million received by the Harvard Medical Community. Table 5 shows the number of start-up companies created in fiscal year 1997 and 1998. MIT had almost the same number of start-up companies in the life sciences as the Harvard Medical Community. Boston University was responsible for 3 start-up companies in fiscal year 1998, which is significant, because their research budget is only one-fifth to one-sixth that of the Harvard Medical Community which was responsible for 7 start-up companies.

¹⁴ Massing, *op. cit.*, 90, 108, 126, 129, 132, 146, 150, 154-156

¹⁵ *Harvard Technology Licensing Fiscal Year 1998 Annual Report to the Committee on Patents and Copyrights*. Cambridge, MA: Harvard University; 1998:13.

¹⁶ Stevens, *op. cit.*

(All numbers are in million \$) INSTITUTION	TOTAL	Life Science	Physical Science
Harvard University	16.5 [‡]	15.6 [‡]	0.8
Harvard Medical School	9.3	9.3	0
Beth Israel Deaconess Hospital	0.3	0.3	0
Brigham & Women's Hospital	2.7	2.7	0
Dana-Farber Cancer Institute	3.2	3.2	0
Massachusetts General Hospital	2.6	2.6	0
The Children's Hospital	1.6	1.6	0
Harvard Medical Community(TOTAL) [†]	19.7	19.7	0
MIT	21.2	14.8	6.3
Boston University (*data not available)	N/A*	N/A*	N/A*

[†] This total is the sum of the gross license income by Harvard Medical School and its associated hospitals as shown above.

[‡] \$5.56 million of income was part of a patent enforcement settlement. The adjusted FY 1997 total license income is \$10.85 million.¹⁸

INSTITUTION	FY 1997		FY 1998	
	Total	Life Sciences	Total	Life Sciences
Harvard University	1	0	0	0
Harvard Medical School	0	0	0	0
Beth Israel Deaconess Hospital	0	0	1	1
Brigham & Women's Hospital	2	2	1	1
Dana-Farber Cancer Institute	0	0	0	0
Massachusetts General Hospital	3	3	3	3
The Children's Hospital	2	2	2	2
Harvard Medical Community(TOTAL) [†]	7	7	7	7
MIT	17	5	16	7
Boston University (*FY1998 Data) ²⁰			3*	

[†] This total is the sum of the start-up companies at Harvard Medical School and its associated hospitals as shown above.

[‡] Start-up companies formed using technology licensed from the institutions shown.

¹⁷ Messing, *op. cit.*, 113, 151.

¹⁸ *Harvard Technology Licensing Fiscal Year 1998 Annual Report to the Committee on Patents and Copyrights*. Cambridge, MA: Harvard University; 1998:3.

¹⁹ Messing, *op. cit.*, 135, 157.

²⁰ Stevens, *op. cit.*

Finally, Table 6 shows the number of licenses executed with equity: 6 at Boston University, 8 at MIT, and 4 at the Harvard Medical Community.

Table 6: Licenses Executed with Equity FY1997²¹	
INSTITUTION	Licenses executed with equity
Harvard University	2
Harvard Medical School	0
Beth Israel Deaconess Hospital	0
Brigham & Women's Hospital	1
Dana-Farber Cancer Institute	0
Massachusetts General Hospital	1
The Children's Hospital	2
Harvard Medical Community(TOTAL) [†]	4
MIT	8
Boston University (*FY1998 Data) ²²	6*

[†] This total is the sum of the licenses executed with equity at Harvard Medical School and its associated hospitals as shown above.

²¹ Massing, *op. cit.*, 138, 158.

²² Stevens, *op cit.*

Chapter 3: Methods

Introduction

In order to understand the difference in the perceived attitude toward entrepreneurship and commercialization found at MIT and at the Harvard Medical School and its associated research hospitals, a series of interviews was conducted. Another aim of this study was to identify factors that may account for these differences which, in turn, might suggest ways to increase the opportunities for universities to participate in commercializing ideas and to engage to a larger extent in entrepreneurship.

Interview Methodology

The method used to gather data for this study was to interview university faculty researchers, inventors, entrepreneurs, venture capitalists, attorneys, university and research hospital technology transfer officers and research administrators. All 19 interviews were face-to-face with one exception and were done without the use of any electronic recording device in order to maintain a relaxed atmosphere. Interview sessions lasted about 60 minutes.

Some candidates for interviews were selected on the basis of recommendations by Dr. Edward B. Roberts (David Sarnoff Professor of Management and Chairman of the Entrepreneurship Center, MIT Sloan School of Management) and the early interviewees themselves. The final selection of those interviewed was based on this author's

estimation of individuals he felt to be especially familiar with entrepreneurship and commercialization of university inventions.

A short summary of each interview presented in Chapter 4 is based on this author's handwritten notes taken during the meeting; hence, these synopses can be considered as reflecting my perception of the opinions expressed by the interviewees.

Occupation of Interviewees

In order to preserve the anonymity of the interviewees their names and affiliations are not stated in the interview. A collective list of names and titles of those interviewed is found in the Appendix.

Nineteen interviews were conducted. The interviewees included six university researchers, who are also inventors or entrepreneurs, five of whom have been or are associated with both MIT and Harvard University. A total of six technology transfer officers from MIT, Harvard University, Harvard Medical School and its associated research hospitals, and Boston University were interviewed. Three senior-level managers of industrially sponsored research at Harvard research hospitals, who are also involved in the management of intellectual property, were interviewed. Three venture capitalists from the Boston area specializing in medicine and healthcare were included. Also, an attorney, who was an expert in patent law and invention licensing, was interviewed.

Interview Questions

Each interview began with a description of the study's goal. All the interviewees were of the opinion that there was a difference in the amount of interest shown for commercialization of ideas and entrepreneurship at the Harvard Medical Community as compared to MIT. I then put forward an open-ended question such as: "What in your view are the reasons for the differences between MIT and the Harvard Medical Community in the areas of entrepreneurship, commercialization of ideas, and the creation of start-up companies." The interviewees then gave their opinions freely without my guidance. When they completed their comments, I would bring up the general topics listed below if they were not already included in their initial discussion; not all the interviewees were asked to elaborate about every topic. In addition to these topics if other pertinent and interesting subjects were brought up by the interviewee, such as "differences in culture" or the role of the technology transfer offices at the institutions, at my discretion, I would ask them to elaborate on them.

Interview Topics:

1. The influence of the university conflict of interest policy.
2. The effect of the nature of the intellectual property, i.e., the type and stage of development.
3. Importance of having role models and mentors at academic institutions.
4. The choice of licensing versus creation of a start-up company.

5. Issues surrounding inventors having company equity.
6. The value of internal venture funding: the efficacy of the Boston University Community Technology Fund and Medical Science Partners.
7. Methods to increase awareness of commercialization of ideas and entrepreneurship.

Chapter 4: Interviews

Introduction

This section is a short summary of interviews with inventors, entrepreneurs, venture capitalists, and university and research hospital technology transfer officers and research administrators. All the interviews were face-to-face with one noted exception and done without the use of any electronic recording device. Each interview synopsis is based on this author's handwritten notes taken during the meeting and, therefore, reflects his perception of the opinions expressed by the individuals interviewed. Although great care was taken to ensure accuracy, the possibility of misinterpretation cannot be precluded. Furthermore, those interviewed did not review these synopses for accuracy or omission. In order to maintain the anonymity of these people their names and affiliations are not stated in the actual interviews. The names and titles of those interviewed is given in the Appendix.

The Harvard Medical Community discussed in this section refers to Harvard Medical School, Harvard Dental School, and the affiliated Harvard teaching and research hospitals.

In each case the interviewee was asked to express an opinion about his/her perception of the differences between MIT and the Harvard Medical Community in regard to entrepreneurship, commercialization of ideas, and the creation of start-up companies.



The generous assistance, cooperation, and insights of those interviewed in this study is sincerely appreciated by the author.

Interview Summaries:

University Researchers and Entrepreneurs

Interviewee A

This individual is an inventor and entrepreneur who has been on the faculty of both Harvard and MIT. He took great pains to describe in detail his perceived differences in attitude toward entrepreneurship and commercialization at MIT and at Harvard.

At MIT people start a company for the “joy” of starting a company. It is a team enterprise of cooperation and the money is a secondary motivation (“no one is greedy”). He generalized that at Harvard Medical School there appears to be “greed” and greater interest in the money. MIT is very transparent. At MIT one takes an idea, licenses it or builds a company and the inventor may take equity. He then refrains from further research in the area of the commercialized idea to avoid the possibility of conflict of interest. In contrast, at Harvard the inventor usually wants to continue to explore the same science in his laboratory that he has offered for commercialization and thus there is no clear separation of the business from the academic research.

There is no such thing as an idea that is too simple on which to base a business. Ideas are cheap, but trying to make a company out of an idea is always difficult. University Technology Transfer Offices dramatically overvalue ideas. This condition may arise

from the publicity surrounding the big licensing hits and the impression that it happens often, although in general this is not the case. “Bad ideas can be expensive to recover from,” thus it is important for the technology transfer office to hire people who can spot the most promising ideas. MIT has the highest level of sophistication in this regard.

MIT likes useful things, so when someone has a new idea they ask, “What is it good for?” At Harvard they ask, “Why is the idea interesting?” Although this is “profound” and reasonable, interesting ideas generally do not serve as a basis for a business. In addition, at Harvard more often the “science is chasing a problem.”

When the social structure of the institutions are considered, MIT has a flat structure and hierarchy is not important. Although all of Harvard University has a hierarchical system, the most dramatic example of class distinction is at Harvard Medical School where even physicians are categorized by their medical specialty. The hierarchical structure may hinder some forms of cooperation and collaboration at Harvard.

Some of the intellectual property in the Harvard Medical Community is process related and similar to what is created at the engineering schools at MIT. In addition, composition of matter inventions, which make the best patents, are found at both institutions. Intellectual property usually has the greatest value when it is somewhere between science and engineering. Patents for innovative processes are more complicated since many of the end results of the processes can be duplicated by procedures which circumvent the patented technology. Thus, the “paranoia” displayed by some members of the Harvard Medical Community causing them to conceal their work may be justified.

When a good invention or innovation is difficult to license, the creation of a start-up company may be necessary. In general, small companies are more receptive to new ideas than are larger organizations that prefer a developed product.

Individuals are recognized favorably at MIT for their entrepreneurial activities and industrial ties. Working with industry is respectable and a source of pride for the faculty. Clearly, there is a substantial group of faculty and others at MIT that can act as mentors for those interested in learning about commercialization and how to participate in the entrepreneurial process. At Harvard commercial activities are not usually talked about, instead discussion tends to focus on items associated with the traditional academic recognition system. Commercial activities and entrepreneurship are not openly discussed with graduate students at Harvard. One key question is, “Is activity in commercialization really a part of the academic function?” At MIT it is, while at Harvard it seldom appears to be.

The fragmentation at Harvard is very notable between the different Harvard Schools. At MIT, even though Sloan is at the other end of the campus, there are nevertheless people from the engineering, science and other departments present at the School of Management and vice-versa.

In summary, in the MIT culture the activity of forming companies is considered part of the creative enterprise. At the Harvard Faculty of Arts and Sciences, for instance, creating enterprises is not “bad, but it is outside” of the usual academic mission where ideas reign supreme. In contrast, at the Harvard Medical Community the culture should

be similar to that at MIT, but it may not necessarily be so because more cooperation is needed in the Medical School Community. MIT has a culture that leads to cooperation.

The value system at Harvard Faculty of Arts and Sciences is based on the creation of ideas and teaching. The idea itself is sufficient even if it has no application. By comparison, at MIT ideas are commonly used to solve societal problems. In the Harvard Medical Community the thrust is more restricted in that the cure of the patient is the primary goal. These are the key differences between these institutions.

Problem solving has little “charm” at Harvard while at MIT a simpler and better way is the goal. For example, when asked to make a better watch, at MIT they would use fewer parts, make it smaller or lighter, etc. In contrast, at Harvard their solution to making a better watch would be to find a new way to tell time. There are no metrics for measuring learning. Good scholarship is good scholarship and commercialization has a negative connotation at Harvard.

Interviewee B

This university inventor believes the difference between the level of innovation, entrepreneurship, and commercialization of ideas at MIT and at the Harvard Medical Community may be explained at least in part by the following reasons. First, in contrast to MIT, there is an inherent “mistrust” at Harvard associated with the conflict of interest policy. Furthermore, there is more mistrust at Harvard associated with doing things jointly with industry whereas at MIT there is great interest in such an association. The mistrust may not be unjustified given that the intellectual property at Harvard is more basic and at an earlier stage of development. Second, another difference between the two

institutions is that the technology licensing office at MIT is good at deal making. The second reason may follow directly from the first in that the issue of mistrust demands excellent technology transfer, which is readily available at MIT.

At MIT faculty are not discouraged from working with industry, but there is a definite line between academic pursuits (that must take first priority) and working with industry. In addition, at MIT investigators are given credit if their technology has an impact in the “real world.”

The investigators at the two institutions do not appear to be at all different. Thus, in the Harvard Medical Community there are scientists and clinicians while at MIT there are scientists and engineers.

Biological innovations have a long development time compared to other types of inventions though this does not explain the differences between Harvard and MIT. From an investment perspective, the biotechnology companies have done well if company valuations are used as a marker. It also takes more time to create value in a biotechnology company.

The nature of the intellectual property does not appear to be significantly different between the institutions. Moreover, a patent should describe a new principle rather than just a new device. Thus the invention of devices or drugs is not an important distinction when trying to characterize the differences between institutions. Creating value demands that “smaller ideas” need to be further along in development than “larger ideas.”

Unlike MIT the Harvard Medical Community is fragmented, but this is not a significant reason for the differences between them. However, the multiplicity of technology transfer offices in the Harvard Medical Community may render each individual office less effective than the one centralized technology transfer office at MIT.

The role of venture capital is important and fundamental to the process of forming start-up companies. Medical Science Partners probably has not had a significant influence because of the large number of venture capital firms in the Boston area.

A long-range solution for the Harvard Medical Community requires exposure to entrepreneur role models and a reduction in anxiety about the conflict of interest policy. In addition, inventions and start-up companies spun out of the Harvard Medical Community should be internally publicized more widely with emphasis on how they are being used to help patients and save lives. For instance, at MIT there are several ways that entrepreneurship, commercialization of ideas, and industrial collaboration are featured and these include, amongst others, the MIT \$50K business plan competition, the MIT Enterprise Forum, the Lemelson Award, and the Industrial Liaison Program. Finally, another solution for the Harvard Medical Community may be found in a collaborative effort between the Harvard Business School and the Medical School which should increase exposure to entrepreneurship and yield more role models.

Interviewee C

The interviewee is both an inventor and scientific advisor to several companies. He noted the following differences between MIT and the Harvard Medical Community:

- MIT is a “monolithic” and “federalist” institution compared to Harvard which is “fragmented” and “medieval” with separate regimes.
- MIT is designed to be pragmatic and strives to solve society’s problems.
- People are aware at MIT of the importance of protecting ideas and are focussed on finding the “short path” to commercialization.
- MIT is not a healthcare institution and the development time for many inventions is only about 18 months versus nine years at Harvard Medical School.

Another difference is that at MIT industrial connections can be important in advancing a faculty member’s academic position.

At the Harvard Medical Community the faculty is not as sophisticated in the commercial sense and it’s not part of the culture to think of one’s work in terms of translation into a saleable therapy. In addition, clinical Phase I, II, and III studies (required in medicine for commercial approval of new drugs or medical devices) carry a large price tag and have a long time frame. In the biological world the culture is “not about implementation” whereas in the clinical realm, although there may be lower barriers to innovation, the patient care gets in the way and issues of conflict of interest may also arise. The concept of conflict of interest has as its purpose protection of both patients and the institution. Although, in the final analysis, it does not stifle productivity it does “create an ambiance not to be entrepreneurial unless you have a fire in your belly.” Thus the message is do not explore entrepreneurship.

At Harvard Medical Community there is no formal mechanism for people to gain experience with companies. Furthermore, very few people know that they may consider commercialization. “Who can one go to and not worry about being criticized” if one is interested in learning about the commercialization process. One potential solution is to establish a joint office of entrepreneurship combining Harvard Business School and Harvard Medical School. Another is to establish a joint Harvard Business School, Medical School, and also School of Public Health Program which would offer a 6- to 12-month postgraduate curriculum on entrepreneurship.

Medical Science Partners has not caught hold because the need to produce a return on investment got in the way of its original mission to stimulate commercialization. In its early years it did form some companies, but currently it has “no impact on my life.”

Working with industry and with venture capitalists is worthwhile. The networking is beneficial as is the participation on the boards of several companies. Involvement with industry has helped focus academic research on the most interesting problems. Overall, working with industry is helpful and probably one in two or one in three assistant professors will find that it is a new and valuable knowledge base for them.

The nature of intellectual property is not a major factor in commercialization. Although in the areas of biology and medicine the stage of development of the idea or invention and the time when a profit will be made are important factors. With the long time frame for the development of most biological inventions, it is more difficult to raise money to support commercial efforts, since many venture capitalists and investors would like to

invest over a shorter time horizon. Accordingly, it is more difficult to raise money for funding these ventures.

Interviewee D

The interviewee is a university inventor and entrepreneur. MIT provides better support for entrepreneurs than the Harvard Medical Community and the former has a very efficient technology transfer office. MIT is also “monolithic.” A “critical mass” composed of people and resources is found at MIT whereas at Harvard and the research hospitals this feature is absent owing to competition and fragmentation.

Interviewee E

This is an entrepreneur/inventor at a research hospital who feels that most investigators consider publishing as the main avenue for establishing priority and disseminating their findings. However, commercializing is another means of knowledge dissemination and along with publication is actively pursued by his department. Commercialization is accomplished through licensing technology to another company or through the formation of a start-up company. The advantages of licensing are that it allows the transfer process to proceed quickly and it has less risk. Partnering with an established company improves the ability to prototype, engineer, have access to equipment, and co-invest rapidly. In addition, the licensing process transfers the commercial responsibilities to the licensee and allows the inventor quickly to get back to his lab, something he generally wants to do.

Many investigators would like to have one of their ideas serve as the basis for founding a company. For those inventors who have the desire to build a company, success is best assured when they are personally involved on a day-to-day basis. Substantial amounts of money can be made by this route but, of course, it requires a large expenditure of time. Those who are able to accomplish this attain significant recognition among their peers, much like “movie stars.”

Members of the department have many opportunities to learn the process of commercialization and the technology transfer office is there regularly to discuss commercialization issues. For instance, the protection of intellectual property is important if you are seeking an industrial partner. Faculty are, therefore, well versed in the kind of information that can be disclosed at scientific meetings and through publication prior to obtaining a patent for an invention. As a result it is not difficult to protect the intellectual property through a future patent. Also, now that members of the department are familiar with the procedure, disclosures of new technology are made sooner in order not to delay publication. Finally, after an idea is patented the investigators are typically the ones to go out and market the invention to industry.

Some industry-sponsored research allow the sponsor to review a manuscript prior to publication to determine whether there are any inventions that may need patent protection by the research institution prior to publication. This offers only a minimal delay to publication; abstracts are reviewed within 10 days and final manuscript papers within 30 days.

The idea of a collaboration between the Harvard Medical Community and the Harvard Business School to sponsor joint activities to foster entrepreneurship is promising, although it will take time to develop into something more than a superficial association between the schools.

The potential for conflict of interest is a frequent topic of discussion at meetings, but disclosure and surveillance can assuage this anxiety. People tend to assume one of two extremes when it comes to their career, either they want to protect the institution at all cost or to make things happen at all cost.

This investigator says he prefers to be in the lab and does not have the time to participate on company boards. This preference is based solely on practical considerations and not on “moral grounds.” Some people fear that working with industry will tempt the best and the brightest to leave academia, but there is no evidence that this is a common occurrence. Several faculty in his department do participate on the scientific advisory boards of start-up companies. Most investigators enjoy their partnership with industry and look for more areas in which to continue this kind of association.

Interviewee F

The interviewee is an inventor whose “radical” new idea is the basis of a start-up company. After his idea was patented it was determined that a licensing agreement with a pharmaceutical company would not allow the inventor, the institution, and the pharmaceutical industry to realize the full potential of the invention. Accordingly, the technology licensing office recommended creating a start-up company and approached a venture capitalist who committed \$7 million to the company. The institution received a

royalty payment and equity for the use of the patent. The vice president of science at another firm and friend of the inventor was instrumental in “keeping the ball rolling” to get the company formed and was the spin-off company’s first employee. Since the laboratory was well funded, equity for the inventor and colleagues was taken in lieu of company sponsorship of the ongoing laboratory research. The company was able to reserve a significant position of equity for the future CEO and company employees.

The conflict of interest policy generated no difficulties when the new company was formed. The inventor became a non-voting member of the board of directors and this arrangement proved satisfactory to his institution’s academic department.

We discussed the differences concerning commercialization at universities such as MIT and Harvard and he noted that MIT has the advantage of a history of solving problems in physics and chemistry. MIT has a history of over 50 years of collaboration with industry, directed toward making better products and as a result has many industrial contacts. At Harvard Medical School and the Harvard hospitals there is a significant amount of support from the National Institutes of Health and industrial interactions are not considered necessary, especially since basic research is emphasized and product development plays a minor role. He feels that, “basic science rarely has any use industrially.”

Venture capitalists have varying relationships with academic institutions. At MIT the relationship is good and smooth in contrast to the situation at the Harvard Medical Community. At the Harvard institutions the tendency is to obtain patents, but the inventions may not be the types that companies will choose to bring to market. In

addition, the licensing offices do not concentrate on marketing the inventions after the patents are obtained. This situation does not hold at MIT.

He does not believe in seed funding, especially at levels of less than \$100,000, and he does not favor technology incubators. Internal institutional seed funds are vulnerable to internal “politics.” Alternatively, it is better to use investment firms to provide appropriate capital initially and then plan on a second round of financing in the future.

Attorneys

Interviewee G

The interviewee is both an entrepreneur and an attorney, who has worked with several technology transfer and licensing offices in the Harvard Medical Community and at MIT. In comparison to the Harvard Medical Community, MIT is more open, less rigid, and less bureaucratic. MIT is a “cauldron of ideas” and technology licensing is both centralized and the focal point for ideas, in contrast to the fragmented technology transfer at Harvard University and the Harvard Medical Community. The surfacing of ideas is the same at both institutions, but coordination is better at MIT. The dispersion of the buildings at Harvard may also play a small negative role by reducing interaction and the potential for collaboration.

Licensing at MIT is a straightforward process compared to the drawn-out procedure typically found in the Harvard Medical Community. At MIT emphasis is on business issues while at Harvard it tends to be the legal aspects surrounding the licensing deal. It is noteworthy that at some of the Harvard Medical Community institutions sorting out the

rights to licenses involving industry-sponsored research is very difficult. Lastly, the technology transfer office at MIT strongly encourages inventors to work with them to “push ideas out the door.”

The composition of the intellectual property is important to the dynamics of how a company is formed. For instance, inventions in the area of information technology have fewer barriers to entry, cost less, and are further advanced than biotechnology when it comes to creating a product. Biotechnology, however, is more fundamental, has a more sustainable position, and has the advantage of a longer time frame of eight to ten years from concept to market, which gives the company management time to weave together the story and to work with investors. On the other hand, in the case of information technology there is no incubation period and a relatively short time frame; this situation does not allow recovery from mistakes. It is interesting to note that inventors in the field of information technology generally approach the venture capitalists whereas the venture capitalists go to the universities to seek out inventors working in the field of biotechnology.

Venture Capitalists

Interviewee H

This venture capitalist feels that leadership factors are most important for successful entrepreneurship and start-up ventures. First, he feels that it is essential to have role models and they are typically found at MIT, Stanford, and Berkeley. These mentors are part of an ongoing system that creates more mentors who will guide future generations.

Second, the most important role of the technology transfer office is to facilitate the connection between the inventor and the entrepreneur. It is noteworthy that at MIT and Boston University the technology transfer people are exceptionally adept at doing this. For instance, at MIT besides the technology licensing office additional methods to bring inventors and entrepreneurs together include the \$50K business plan competition and the MIT Enterprise Forum. The licensing function of the technology transfer offices is seen as a less critical factor. Of note, he suggests that the Harvard Medical Community needed to create a similar network.

An entrepreneur should be a problem solver who can create value in a company by combining technology, business, and finance.

Conflict of interest is not an issue, but the “psychology” surrounding conflict of interest at Harvard needs to change. He suggests inviting venture capitalists, inventors, entrepreneurs, and others to “put on a fair” to establish contacts. Companies that have spun out of technology from the Harvard Medical Community should be invited to give seminars so faculty appreciate the concept of entrepreneurship. Furthermore, role models are very effective in demonstrating to faculty that it is “cool to invent things” with commercial potential. On the other hand, not everyone will be interested in starting a company even though commercializing inventions is good for the inventor, the patient, and the institution.

He does not believe that patient care prevents physicians from becoming entrepreneurs; he feels that busy people are good at getting things done.

Intellectual property procedures at MIT and Harvard are not significantly different and are not a major reason for the differences in entrepreneurial interest. Nevertheless, innovative procedures and treatment protocols are generally not a foundation that supports a start-up company.

He does not believe that an internal fund to develop inventions by supplying seed money in the \$25,000-\$50,000 range is needed. He suggests that better use of the existing resources be made and there should be more collaboration with the business school, business plan competitions like the MIT \$50K contest, arranging for an entrepreneurship seminar series, and networking. He suggests that leasing office or laboratory space be considered by early stage companies so that they can develop their inventions. This procedure is followed at Boston University and it can help remind others on the campus about potential commercialization.

He regards as positive a model like the Community Technology Fund at Boston University which he believes has done well in creating university spin-off companies.

In the majority of cases, his venture capital firm learns about university inventions directly from the professors themselves.

Interviewee I

This venture capitalist noted that MIT is unusual. MIT started as a trade school teaching practical things. It has a history of spinning off start-up companies going back a “long way.” Entrepreneurship has been at MIT for the past 50 years, since the end of World War II, beginning with the work of General Georges Doriot. In addition to publishing

and other related academic pursuits, creating inventions is an important dimension of a professor's career. At MIT entrepreneurship is promoted because it brings respect, authority, and recognition.

Harvard research scientists learn, observe, and do. At Harvard Medical School there are groups translating research into new companies. This is less common at the Harvard research hospitals.

The infrastructure built around medical innovation is more complicated than that around other areas. It involves government regulatory bodies and, therefore, it is not as easy for a medical researcher to be an innovator. The training for a researcher is different from that of the innovator. For example, in Germany universities and industry only recently have joined forces.

The innovations need to be sufficiently radical to open a new field. Large companies tend to stifle innovation. In general, "smart people see it and say I can get a product out of it." The product must have an impact, or it will not sell. Timing is also important for innovations as seen in the history of the facsimile machine.

Internal venture capital, like that available at Boston University, is useful for ideas that are not ripe enough to attract external venture capitalists. In addition, it teaches people to see how to build companies.

Interviewee J

This interview was with a venture capitalist who felt "cultural differences" are a major reason for the difference in the levels of entrepreneurship at MIT and the Harvard

Medical Community. Entrepreneurship is highly encouraged in MIT's doctoral programs. Research done in the Harvard Medical Community is very early stage and is less likely to become the foundation on which to build a company.

The technology transfer offices are under-funded at most of the Harvard Research Hospitals especially in comparison to MIT, which serves as the "premier model of technology transfer." Since it is not possible to determine in advance which inventions are going to be the most valuable, an important mission of the MIT Technology Transfer Office has been to get the technology into the world beyond MIT.

In order to increase technology transfer and entrepreneurship in the Harvard Medical Community the interviewee proposed increasing the budget and staff of the Technology Transfer Offices which should also form a more solid network of relationships with department chairmen and entrepreneurs. It is his impression that there is an overabundance of attorneys in many of their transfer offices. A supra-organization to enable the technology transfer offices in the Harvard Medical Community to work more closely with each other is not a viable solution because of the long-standing distrust between the Medical School and the Hospitals.

The conflict of interest policy at Harvard, essentially identical to MIT's, has not caused significant difficulties in his opinion. An example of the "disincentives" to entrepreneurship at one Harvard research hospital is the requirement that prevents inventors from holding equity stock in their name as payment for inventions they created at and licensed from that hospital. The hospital holds the stock for the inventor until it is liquidated.

Internal venturing at universities can be worthwhile, but the venture group must be independent of the university and its personnel should be compensated similarly to those in the venture capital community at large. The internal venture group should not have the right of first refusal to fund technology arising from the university.

Managers of Industry-Sponsored Research

Interviewee K

This interview was with a research manager who feels the major reason for the different degree of entrepreneurship at MIT and the Harvard Medical Community is that Harvard is not a nurturing environment for this activity and that there are few mentors available to offer guidance. Some hospital departments do have industry associations and provide a nurturing environment complete with mentors, but this is the exception. Furthermore, at Harvard there are “cultural issues” stemming from the question of the appropriateness to one’s academic career of working with industry in strong contrast to the situation at MIT. Harvard enforces an “elitism” value system that makes it less attractive to work with industry and some characterize it as “dirty” to do so. However, at the Harvard research hospitals industry-sponsored research in the biomedical area is more readily accepted than at the Medical School. In fact, researchers from the hospitals have been known to move to industry and from industry back to the hospital on occasion. Clearly, this collaboration improves the transfer of ideas and knowledge.

Standards at Harvard are different from those at MIT. At Harvard the standard is publication, while at MIT building things is an accepted practice. He feels MIT is an

engineering school and its people think pragmatically. What makes Harvard what it is are the high standards and the significant prestige and pride of being from Harvard. This value system should not be changed.

The only difference between the Harvard and the MIT conflict of interest rules is the clinical trials section found in the Harvard rules. The other sections are more conservative at MIT and aim to protect students from being diverted into research work that may be of benefit to the industry sponsor. Of note, at MIT there is a “decoupling of culture with rules.” At Harvard there is a high degree of misunderstanding about the conflict of interest rules. Consulting work is, however, relatively well accepted at Harvard.

In addition to having marketing know-how and experience working with inventors to form start-up companies, the Technology Transfer Office at MIT has superb skills that have endured for decades. Boston University also has competency working with start-up companies. Entrepreneurs and individuals directing companies are respected at MIT. In general, the majority of scientists involved in basic research, including non-clinician physicians, are more interested in remaining in the laboratory than in working to start a company. On occasion in the Harvard Medical Community, a department chairperson or a peer can get in the way of building a company around an appropriate idea.

Most technology transfer offices do not have the resources to do active marketing of licenses. One of the Harvard hospitals recently hired a marketing manager to help get inventions licensed. Venture capitalists and entrepreneurs rarely examine unlicensed patents to find technology to license and market because if a technology transfer officer

determines that an invention is potentially valuable he would actively seek a licensee and not depend on having a venture capitalist or entrepreneur in search of inventions approach him.

One route to licenses for our ideas and inventions is through direct scientist to scientist communication. Many new products do not arise from industrial research and development but rather originate from the outside. Scientists from the large pharmaceutical companies and university researchers attend scientific meetings and at these events the direct one-to-one communication may eventually lead to licensing agreements.

Medical Science Partners is looked upon as any other venture capital fund. They do not fund high-risk ventures such as “proof of concept.” The deals they are attracted to are the same ones that will also attract other venture capital firms. Venture capital firms, in the opinion of the interviewee, do not respond as well when approached by the Harvard Medical Community as they do by MIT. MIT knows when and which venture capital firm to contact.

Medical device innovations are generally improvements of existing devices rather than examples of a radical new technology. It is, therefore, not uncommon for surgeons and other clinicians who are pragmatic to work directly with manufacturing companies. It is unlikely that the idea will have as profound an effect as the creation of a new molecule, which can often be revolutionary. Many of the technologies that can be licensed, like laser treatments, have a relatively quick cycle time. The nature of the intellectual property in the Harvard Medical Community is typically biological and healthcare related

with a relatively long development time of up to 10 years. However, the Biology Department at MIT has similar types of intellectual property that are by definition early stage. Moreover, at MIT there are multiple fields of investigation, some with significantly shorter development cycles.

Undisclosed intellectual property generally results from the inventor's lack of awareness of the value of the idea rather than to his lack of knowledge of where to go to disclose the invention. There probably is a significant amount of undisclosed intellectual property.

The technology transfer office cannot inspect each lab for potential commercial inventions. However, the climate of awareness at MIT is greater than that in the Harvard Medical Community. For instance, at MIT if someone licenses a revolutionary invention or is part of a start-up company, others in the MIT community are very likely to hear about it. In addition, grants from industry such as those from a pharmaceutical company are beneficial because they often provide unrestricted funds to the university. Thus, the attention generated by working with companies signals to others the potential benefits of collaborating with industry.

Lastly, it is rare to lose patent rights by publicly speaking or publishing data before a patent is actually obtained, provided disclosure has been made to the technology transfer office.

Interviewee L

A medical research and licensing manager who was interviewed by telephone made the following observations:

- The primary difference between MIT and the Harvard Medical Community is that money that comes from industry is treated as “suspect” by the latter. At the Medical School there is disapproval of anything that may contaminate the “purity of the research.”
- The conflict of interest rules in the Harvard Medical Community have a “dampening effect” and a negative aura associated with them that tend to discourage collaborating with industry.
- Relationships with venture capitalists are excellent and are therefore not a limiting factor in creating start-up companies in the Harvard Medical Community and at MIT.
- Medical Science Partners has not had a significant effect.

Interviewee M

This interview was with a medical research manager who feels the main reason for the differences between MIT and the Harvard Medical Community and Harvard University itself is the fragmentation existing in these latter two places. Furthermore, at MIT the strong tradition in the areas of electronics and engineering has generated a history of industrial collaboration. At MIT there are no patient-care issues and the “mind-set” at MIT is different.

His organization is considering establishing an internal venture fund to provide seed capital to fund the development of ideas that are not typically funded by the National Institutes of Health because they are too premature to be supported by the venture capital community.

Furthermore, the interviewee notes that the technology transfer office has to educate the faculty that they “do not own the technology” and, therefore, that they should not pursue the technology transfer on their own.

Conflict of interest was not a major issue in the case of a recent start-up at his institution. If the hospital has a stake in the company and a clinical study is required, the rules prohibit the study at the medical center. In this instance, the inventor’s laboratory was well funded and he did not need additional funds to support his laboratory. The inventor and other laboratory colleagues received an equity stake in the new company. The institution received some royalty compensation and an equity share. There was concern initially by the hospital board of trustees about favoring equity rather than royalties alone. The interviewee noted that it is fine “for a not-for-profit to have equity in a profit-making entity.” The equity in the new company is used to incentivize the inventor to buy into the new venture and ensures that the investigator’s “brainpower” will be there. The hospital requested that the inventor/founder be a non-voting member on the board of directors of the new company and a member of the scientific advisory board. Technology transfer officers are not allowed on the company board of directors.

Officers of Technology Transfer

Interviewee N

This interview was with a technology transfer professional who feels that the Harvard Medical Community is “fragmented,” with its pieces somewhat “divorced” from one another. The conflict of interest policy at Harvard is almost the same as that at MIT and

is not the reason for the differences in the level of start-up companies and commercialization seen at the two institutions. The conflict of interest regulations at Harvard are somewhat of an impediment to innovation and entrepreneurship. However, as far as start-up companies are concerned one rarely runs into problems of conflict of interest arising from stock ownership since such companies when first established do not issue stock that is publicly traded.

The “culture” of the two institutions is different. MIT is primarily in the education business while the medical center is in the patient-care business. When dealing with patients there is a limited market for the technology that can be used to form start-up companies. MIT is also “entrepreneurial” and people are educated to become successful business people who can, in turn, become mentors for future entrepreneurs.

The individuals at both institutions teach, carry out research, write grant proposals, and perform administrative activities. However, at the medical centers there is the additional activity of patient care. Therefore, less time remains to pursue a start-up company and other entrepreneurial interests. As a result, some inventors involved in patient care may opt to be a scientific advisor on a company board.

The quantity of intellectual property in the Harvard Medical Community is actually quite significant in light of the approximately \$1 billion in grant awards received from National Institutes of Health and the 100-200 new inventions that the Community patents each year. The recent publicity surrounding the formation of a start-up company at one institution prompted eight to ten other investigators to declare that they too wanted to start a company based on their inventions. A start-up company may be the preferred way

to get the invention out as compared to licensing. However, where possible a licensing scheme is usually best and can increase the chance of bringing the invention to market.

A technology development fund is being considered which would award support in the \$50,000 to \$75,000 range for inventions that are too premature for venture capital funding and which are not typically funded by the National Institutes of Health.

Unfortunately, internal venture funds are often subject to institutional politics.

The majority of disclosures at this particular interviewee's institution are for molecular biology-related intellectual property and only 12 or so are by clinicians such as surgeons, urologists, radiologists, obstetricians and gynecologists, etc. for medical devices. The latter are straight licensing opportunities.

Interviewee O

This interview was with a technology transfer officer. The Harvard Medical Community and MIT were compared.

The conflict of interest policy is almost the same at Harvard and MIT, although the common perception is that they are different. Harvard utilizes a conflict of interest committee to clarify certain issues involving conflict of interest, such a committee is rarely used at MIT.

The number of ideas that can support a new company is small. At MIT there is a "predisposition" to start a new company, while at Harvard the majority of inventors have no desire to start a company. Furthermore, the faculty at Harvard generally does not want to spend years immersed in building a start-up company that will take them away

for their academic research. The preferred route in most cases is to license the technology thereby enabling the faculty member to return to academic research.

Although there are differences in the type of intellectual property at MIT and Harvard University there are also similarities. The nature of the intellectual property is only part of the explanation for the differences in commercialization and entrepreneurship found at these institutions. Interestingly, the end result of what comes out of the Harvard Medical School is closer to that at MIT than to that from the Harvard Faculty of Arts and Sciences.

Intellectual property may not be disclosed by an inventor because he may not appreciate the commercial value of his invention. Sometimes a more entrepreneurial associate of the inventor may recognize the value and recommend that a disclosure be made.

There are, to be sure, “pockets” of entrepreneurs in several departments at Harvard University and the Harvard Medical Community. These people now serve as role models and in time they may effect a change at Harvard as others begin to appreciate that it is possible to balance traditional academic pursuits with entrepreneurship. More people are interested in entrepreneurship now than was the case 10 or 15 years ago. There are more opportunities and more faculty members continue to realize they can pursue both academic research and entrepreneurial goals.

Medical Science Partners was conceived at Harvard Medical School about 1985. Its purpose was to bring together a group of limited partners who would create a fund to support development research which would fill the gap between an idea and its prototype.

The ultimate aim was to increase the level of commercialization in the Harvard Medical Community and to return a profit to Harvard University.

The enormous research budgets of the Medical School and the various Harvard research and teaching hospitals preclude the possibility of creating one supra-organization to handle all the technology transfer for the entire Harvard Medical Community. Each member believes that its own large research budget bestows upon it the right to control technology transfer.

Interviewee P

This interview was with a technology transfer officer who noted the following:

- The conflict of interest policy at Harvard is a very sensitive detector of potential conflicts.
- Entrepreneur role models are not found easily in the Harvard Medical Community in contrast to the situation at MIT.
- There probably is a significant amount of intellectual property that has not been disclosed to the technology transfer office.
- A program has been established to demonstrate to faculty members the process of new venture creation.

Technology transfer should be designed as a “short-lived process” i.e., the transfer office does its job quickly and the entrepreneur then steps in. However at Harvard it is a ‘long-term’ commitment. Few licenses are like Stanford University’s “big hit” (Cohen-Boyer

DNA cloning invention). All universities underfund technology transfer offices. One useful benchmark measure is the number of full time technology transfer employees per million dollars of sponsored research.

Finally, cultural issues are significant in that institutions “need to do it their way.” Harvard is careful to guard its good name, especially when working with industry.

Interviewee Q

This person is a technology licensing official who noted that the nature of the intellectual property affects the likelihood that it can be used as the basis to create a start-up company. Early stage research is less likely to be used as a foundation for a start-up company. In addition, in order to consider a start-up company as an alternative to licensing the technology transfer official must be truly adept at creating start-up companies and actively seek out technologies that are able to stand on their own.

Interviewee R

This technology transfer official feels that some of the frustration associated with entrepreneurship at the Harvard Medical Community is the result of the “fragmented culture.” There are competing forces between the hospitals and the medical school but, in the final analysis, the policies of the hospital will be followed. Each technology transfer office evolved differently in the Harvard Medical Community resulting in the creation of different cultures ranging from entrepreneurial to legal in character. Furthermore, some of the technology offices are strongly oriented toward administering industrial support for research with the licensing function being of secondary importance.

Both Harvard and MIT supply technology to the world. Some notable differences between the institutions are: At Harvard the importance of school structure is strong while at MIT it is weak. MIT has a more top down organizational structure than Harvard and there is more networking and less competition between people at the former.

Entrepreneurship at MIT is done on the inventors' own time and is not the primary product of their work, but rather is a by-product of it. Moreover, licensing and creation of start-up companies are not part of the academic reward system at MIT.

The interviewee suggested that the Harvard Medical Community set up an supra-organization to help grow a more entrepreneurial culture and that activities include events like the MIT Enterprise Forum, a business plan competition, and professors teaching each other about entrepreneurship. It was further suggested that an academic track be set up at Harvard Medical School for physicians interested in entrepreneurship which allows for reduced patient care and fewer academic responsibilities. These individuals could participate in seminars and other events which would, in turn, teach the process of commercialization and entrepreneurship to other members of the Harvard Medical Community.

Medical Science Partners' original mission was to fund the development of technology arising within the Harvard Medical School complex that was insufficiently developed to win other support. Harvard University participated as a limited partner and the fund raised significant capital, but several issues arose including problems with conflict of interest. Subsequently, the fund's mission changed and it is now required that at least one person at the company be affiliated with Harvard Medical School in order for the

company to be eligible for funding from Medical Science Partners. The fund has had almost no significant impact in the Harvard Medical Community.

In order for internal venturing to have an impact, significantly large awards well above the \$25,000 to \$50,000 range must be made. Internal venture funds are vulnerable to institutional politics when a choice has to be made about which projects should receive support. Furthermore, students are at some risk of exploitation and may be transferred from their academic research to commercial development. Finally, the presence of an internal venture fund may hurt relationships with the venture capitalists if it is believed that the venture capitalists have “second pick” of inventions.

Interviewee S

This technology transfer officer feels that the MIT conflict of interest policy is very clearly stated and uniformly applied. There are very few situations requiring clarification or need for interpretation.

There is fragmentation within the Harvard Medical Community since the Harvard Hospitals and the Medical School are each independent corporations with their own staff and income stream. In addition, the Harvard Medical School Technology Licensing Office is separated from the main Harvard University Technology Licensing Office and yet the latter has final signing authority for all University deals, even when a deal is negotiated by the Medical School Office. A meeting to organize all the Harvard Medical Community affiliates is being considered to discuss marketing and other common issues.

A technology transfer office deals with two worlds, the faculty and the corporate. On the faculty dimension it may be beneficial to do short presentations about the technology transfer process on a recurring basis. For example, a two-day seminar for investigators similar to Stanford's "licensing 101" should be considered. Frequently, the technology transfer office makes relatively small amounts of money (but its existence is justified on the basis of the good it does for the university and the public).

If the technology of an invention is able to stand on its own there is a preference to create a start-up company rather than license the technology. However, for a start-up to be considered the inventor must be willing, at a minimum, to be scientific advisor.

Although the inventor does not need to be a line officer in the new company or take a leave of absence, starting a new company will nevertheless require a great deal of the inventor's time. One caution is not to tie up technology by forming a start-up company if a straight licensing arrangement will work.

Chapter 5: Results and Analysis

Introduction

There is no single reason one institution is more entrepreneurial and more involved with commercializing ideas than another. I found this to be true in the course of investigating the differences between MIT and the Harvard Medical Community. This chapter is a compilation and analysis of the discussions with interviewees and is organized according to the topics shown in Chapter 3. Interviewees were not asked to rank the order of importance of the reasons that may explain the differences between the Harvard Medical Community and MIT although some did so as a matter of course during the interview.

An alternative approach to this study would have been to propose one or more possible hypotheses to explain the differences between the institutions and use the interviews to test each hypothesis. However, given the limited resources and small sample size available, this investigative method was not chosen and instead the method described in Chapter 3 was followed.

For each topic there is an introduction with background information followed by an account of the more pertinent comments and opinions expressed by the interviewees. A discussion of the findings follows. No attempt was made to organize the topics in any particular order for this report. In Chapter 6, Summary and Recommendations, this author's opinion about the relative importance of each topic is given.

As noted previously, the Harvard Medical Community mentioned in this report embraces Harvard Medical School, Harvard Dental School, and the affiliated Harvard teaching and research hospitals.

Conflict of Interest

Conflict of interest is an important and serious issue in academe, medicine, government agencies, and other organizations. Harvard Medical School has a broad definition of conflict of interest as shown below:

“A faculty member (full- or part-time) is considered to have a conflict of interest when he, any of his family, or any associated entity possesses a financial interest in an activity which involves his responsibilities as a member of the Faculty of Medicine. Included in these responsibilities are all activities in which the faculty member is engaged in the areas of teaching, research, patient care and administration.”²³

Faculty members of Harvard Medical School and Harvard School of Dental Medicine are required to follow the *Faculty Policies on Integrity in Science*.²⁴ The policies include sections concerning conflicts of interest and commitment. Scientists and physicians at the teaching and research hospitals associated with Harvard Medical School most often have faculty appointments at this institution. In order to uncover situations that may give

²³ *Faculty Policies on Integrity in Science*. Faculty of Medicine, Harvard University. Boston, MA: Harvard University; November 1997:13.

²⁴ *Ibid.*, 1-19.

rise to a conflict of interest, once a year Harvard Medical School requires faculty to disclose financial interests that they or their families have. Except for the section that covers clinical trials involving patients, the conflict of interest policy at Harvard is not significantly different from that at MIT.

A faculty member with a financial interest in a company that manufactures products or renders services that are derived from his own research through a licensing agreement must adhere to the following:

- the faculty member cannot receive direct or indirect research support from the company to support activities at the university
- students cannot be used to carry out research and development projects for the company

The Policy also covers industry-sponsored research and states that faculty must be allowed to publish or communicate their research findings freely. The policy at Harvard suggests guidelines about advance manuscript review by sponsors before submission for publication so that optimal protection of intellectual property can be achieved. The delay for this process is typically 30 days, but not more than 60 days. As implied above, a faculty member receiving industrial sponsorship for laboratory research cannot have a financial interest in the sponsoring company. The Harvard Medical School Policy also has guidelines concerning conflicts of commitment, according to which no more than 20% of full-time professional effort may be directed to outside work. MIT has a similar policy on conflict of commitment.

Findings

Fourteen of the nineteen people interviewed commented on the conflict of interest policy at Harvard Medical School and most agreed it was similar to MIT's policy. Nine of the fourteen pointed out that in the Harvard Medical Community there was an "aura," "psychology," "dampening effect," or "inherent mistrust" associated with the Harvard University policy. Interestingly, of the five entrepreneurs who discussed conflict of interest four agreed that an aura of mistrust existed. Interviewee C stated the conflict of interest policy does not stifle productivity, but it does "create an ambiance not to be entrepreneurial unless you have a fire in your belly." Several felt that at Harvard there was misunderstanding about the conflict of interest rules and one interviewee said it was a very sensitive detector of potential conflicts.

At Harvard the inventor often wants to continue to explore the same science in his laboratory that he has offered for commercialization. In these situations clarification by Harvard University may be required to avoid a potential conflict of interest. Interviewee S declared the conflict of interest policy at MIT was clearly stated and uniformly applied, with few situations requiring clarification.

In summary, all the interviewees who had first-hand experience with technology transfer and/or the commercialization process believed that the MIT and Harvard University rules on conflict of interest are similar. It is this author's opinion that the faculty as a whole may actually not be aware of this. Furthermore, half of all those interviewed stated there was a feeling of misunderstanding and mistrust associated with the conflict of interest policy at Harvard which sent a message to faculty that working with industry was itself a

conflict of interest. In spite of this, one interviewee felt that consulting was relatively well accepted at Harvard University.

Discussion

Disclosure is an important tool in helping to discover potential conflicts of interest. The conflict of interest policy at Harvard, although not in itself the major cause for the differences in the levels of entrepreneurship and commercialization found at MIT and Harvard Medical School, does appear to play some role. The Harvard conflict of interest rules, as previously noted, are similar to those in effect at MIT, yet the impression at Harvard was that industrial collaboration involving money is “bad” and gives rise to a conflict of interest. Interviewee C, an inventor and entrepreneur, noted that this policy suggests that one should not explore entrepreneurship at Harvard. This perception surrounding the conflict of interest policy may, in practice, be secondary in importance to historical or cultural influences at Harvard. Interviewee K pointed out that at MIT there is a “decoupling of culture from the rules” while at Harvard the culture and the rules may be more tightly bound together.

The process of disclosure at Harvard of one’s involvement with outside interests may in itself also reinforce the general sense of mistrust. The conflict of interest rules at Harvard are part of a pamphlet entitled *Faculty Policies on Integrity in Science*. According to this pamphlet, each year the faculty must disclose their personal financial situation and other potential conflicts of interest. The very title on the pamphlet may cause a feeling of anxiety on the part of the faculty member. Hence, it is perhaps not surprising in light of

the foregoing that recently a committee has been formed at Harvard Medical School to reevaluate its conflict of interest policy.

In summary, the issue of conflict of interest is one of several factors involved in the differences seen in entrepreneurship and commercialization at MIT and the Harvard Medical Community. The conflict of interest issue, which appears to be so significant at Harvard University and the Harvard Medical Community, is apparently less of an impediment to entrepreneurship and commercialization at other institutions.

Composition of the Intellectual Property

Commercializing technology is the process of bringing to market the results of experimental studies and research. A research institution is a source of technology or intellectual property. The intellectual property typically licensed from universities includes copyrights, patents, cell lines and other biological property, software code (copyrighted or patented), semiconductor chip maskworks, drawings, trademarks, and know-how. However, it is the nature of the intellectual property which actually determines whether the institution can engage successfully in entrepreneurship and the commercialization of ideas. This is because some types of technology are more desirable to a licensee, or are more easily protected by patents and copyrights preventing challenges by competitors, or are more amenable for use as a basis for a start-up company.

Levin reported the effectiveness of patents in protecting a discovery is very nonuniform across the 130 industries he examined.²⁵ Patents were regarded as most effective in industries with chemical-based technologies such as found in the pharmaceutical industry, moderately effective for industries dealing with relatively simple mechanical devices, and least effective for most of the other industries he studied. In addition, process patents, according to Levin, were less effective than new product patents in most industries. Thus, a patent better protects a molecule, compound, pharmaceutical agent, or biological material than a medical device, which itself is frequently better protected than other types of inventions. Process oriented inventions, like some intended for use in clinical medicine and in engineering, are not well protected by patents and copyrights.

The type of intellectual property and its stage of development must be considered when assessing its commercial potential. In a recent study of university technology transfer, Jensen and Thursby found that only 12% of licenses were for discoveries that were ready for practical or commercial use, implying that most licensees would usually have to invest significant development time and money before bringing the product to market.²⁶ Intellectual properties derived from life sciences tend to be very early stage and far removed from the final product used by the consumer. Thus, it can be seen for early stage inventions with a long development time, such as those found in biotechnology, the financial aspect is rather perilous since it is very difficult to predict whether the technology will actually work and have worthwhile commercial potential.

²⁵ Levin RC. A New Look at the Patent System. *American Economic Review*, May 1986;76(2):199-202.

²⁶ Jensen R, Thursby M. Proofs and Prototypes for Sale: The Tale of University Licensing. *NBER Working Paper #6698*, 1998.

The role of industrial sponsorship of research also needs to be considered when examining the commercialization of an institution's intellectual property. Industrial sponsorship may affect the theme of the laboratory research and thus the type of intellectual property to be made available for licensing or for use as a basis for a start-up company.

Findings

The characteristics of intellectual property were discussed with 12 of the interviewees with ten of them specifically commenting on the differences between MIT and Harvard. All agreed that the research institution can be a source of intellectual property and that the nature of the intellectual property is what determines whether the institution can engage successfully in entrepreneurship and commercialization of ideas. However, six of ten specifically said they believed that the nature of the intellectual property was not the reason for the differences in commercialization seen at the Harvard Medical Community and MIT because it was essentially similar in nature at both places. Interviewee A was of the opinion that some of the intellectual property in the Harvard Medical Community is process related and, therefore, in that respect "not unlike what is created at the engineering schools at MIT." Two of the three interviewees felt that intellectual property does play a role in enhancing entrepreneurship at MIT as compared to the Harvard Medical Community. They further noted that the majority of the research at their institutions was early stage and less likely to be used as the foundation for a start-up company. It is noteworthy that the occupation of the interviewees had very little effect, if any, on their feeling about the role of intellectual property.

Seven subjects said the biological sciences are typically at an early stage when commercialization is considered and, therefore, require a relatively long time frame for development as compared to other types of intellectual property. On the other hand, four interviewees reported that an advantage of the biological sciences was that inventions originating from this field are usually more patentable and, therefore, have a more sustainable position in the marketplace compared to other types of intellectual property. Moreover, in spite of the longer development time needed for biological innovations, the protection afforded by patents offers the potential for significant value creation compared to other types of inventions. Interviewee C pointed out that some biological and life science inventions require clinical trials in order to obtain government approval to bring them to market. Clearly, these inventions may not only have an especially long time frame, but also the additional disadvantage of a large price tag.

Discussion

Jensen and Thursby report that a significant portion of invention disclosures are based on research carried out in schools of science, engineering, medicine, and nursing.²⁷

Although MIT does not have a medical school, 45% of the total of its active licenses and options are in the life sciences.²⁸ This finding is consistent with the opinion of the majority of interviewees who discussed the subject of intellectual property. It was their

²⁷ *Ibid.*, 5.

²⁸ Massing DE (ed.). *Association of University Technology Managers Licensing Survey: Fiscal Year 1997*. Norwalk, CT: Association of University Technology Managers; 1998:100.

view that the nature of intellectual property at the Harvard Medical Community and at MIT is quite similar. Therefore, while the nature of intellectual property may be an important factor in determining whether an institution can engage successfully in entrepreneurship and commercialization of ideas, in the case of these two institutions it was not believed to be a major factor responsible for the observed differences. On the other hand, the nature of the intellectual property may play a major role at other research universities in determining their involvement with entrepreneurship and commercialization of ideas. This finding is important relative to the other topics discussed in this chapter because the kind of intellectual property originating from an institution is a reflection of the university's mission and cannot be easily changed. In contrast, most of the other topics dealt with in this report such as, conflict of interest and mentoring, are part of the supporting infrastructure and are more easily modified.

Inventions derived from research in the life sciences and related areas are often at an early stage and require long development times compared to many other types of intellectual property such as software, information technology, or mechanical devices. For instance, innovations involving medical devices are generally improvements of existing instrumentation and usually can be brought to market in a relatively short time; they are seldom examples of radical new technology. It is therefore, not uncommon for surgeons and other clinicians, who are of a practical bent, to work directly with manufacturing companies. In general, it is unlikely that inventions such as mechanical devices will have as profound an effect on society as the creation of a new molecule, which can often not only be revolutionary, and of broad benefit, but can be also more

easily protected by a patent. Interestingly, out of a total of 33 start-up companies originating from MIT technology in the years 1997 and in 1998, 12 were in the area of life sciences. In the same two-year period a total of 14 start-up companies, based on technology from the Harvard Medical Community, were founded.

In summary, the nature of the intellectual property at a university is a key factor in determining whether the institution can engage successfully in entrepreneurship and commercialization of ideas. Institutions that engage in research in the fields of science, medicine, and engineering typically have more invention disclosures than those that do research in other areas. In addition, inventions that yield new products are more likely to be significant for the purposes of commercialization than those that give rise to new processes.

Fragmentation

The multiple schools and teaching hospitals that comprise Harvard University and the Harvard Medical Community were the subject of discussion by many of the interviewees. Several felt there was “fragmentation” in the Medical School Community and that this accounts for the different levels of entrepreneurship and commercialization of ideas seen at the Harvard Medical Community and MIT.

Harvard University in Cambridge, Massachusetts is a decentralized organization of nine faculties overseeing its 12 schools and colleges. Both Harvard Medical School and its School of Dental Medicine are located on one campus adjacent to the School of Public Health in Boston, Massachusetts. The Harvard Graduate School of Business

Administration is located in another venue in Boston across the Charles River from the main campus in Cambridge. The physical separation of the schools and faculties of Harvard University clearly limits interactions among the faculty and staff of the different schools. For example, the Medical School has its own technology transfer office and is separate from the Office of Technology and Trademark Licensing located on the main campus of the University in Cambridge.

The Medical School Campus encompasses three major teaching hospitals (Beth Israel Deaconess Hospital, Brigham and Women's Hospital, and The Children's Hospital) as well as Dana-Farber Cancer Institute and the Joslin Diabetes Center all of which are located adjacent to each other. The Massachusetts General Hospital, a major component of the Medical School Community, is located in a different section of Boston. All are separate organizational and financial entities and each supports its own technology transfer office. In contrast, Boston University School Of Medicine and its teaching hospital are not only adjacent to each other, but share the same technology transfer office that serves all of Boston University. Thus, Harvard University and the Harvard Medical Community are fragmented physically, organizationally, and financially.

Findings

"Fragmentation" of the Harvard Medical Community was noted by 9 of the 19 interviewees. In spite of the fact that none felt that fragmentation was a major factor affecting the level of commercialization at Harvard University and the Harvard Medical Community, almost all agreed that fragmentation was a negative influence. Two interviewees felt that the existence of multiple entities lead to the investigators being

confronted with competing forces. Two others felt that cooperation and coordination was poor among the hospitals and the medical school. The dispersion of the buildings at Harvard was believed by Interviewee G to play a small negative role by reducing interaction and potential collaboration. Interviewee A emphasized that at MIT, even though Sloan is at the far end of the campus, there are nevertheless faculty members from the engineering, science and other schools to be found at the School of Management and vice-versa.

Discussion

Although fragmentation may not be a major cause of reduced amounts of entrepreneurship at Harvard University and the Harvard Medical Community it was the general consensus of the interviewees that a critical mass of people and resources are desirable in order to develop a system to support inventors and others interested in entrepreneurship and the commercialization of ideas. The competing forces at Harvard University, the Medical School, and the hospitals may also create an atmosphere that decreases possibly important interactions that might under different circumstances lead to collaboration among the faculty and staff of the different disciplines. In addition, the multitude of separate and smaller technology transfer offices in the Harvard Medical Community does not allow each office to develop the diversity of skills that is found in a centralized setting such as that at the Technology Licensing Office which supports the entire MIT community.

Mentorship and Role models

In order to facilitate the transfer of inventions and ideas from the university to the commercial sector a supportive environment is beneficial. Role models and mentors are a part of such an environment and can assist those interested in entrepreneurship and in the commercialization of ideas.^{29,30} This section examines the opinions and views of the interviewees about the importance of role models and mentors.

Findings

Ten of the interviewees were of the opinion that mentors and role models are an important means for providing guidance and instruction to those interested in learning about entrepreneurship and the process of commercialization of ideas. On the other hand, even though at Harvard and the Harvard Medical Community role models were less available than at MIT some groups were more entrepreneurial than others and, accordingly, those associated with had more opportunities to learn the know-how. Interviewee C stated that few people at the Harvard Medical Community realize they may consider commercialization. Several interviewees felt that inventions and start-up companies spun out of Harvard Medical Community should be publicized more widely internally with emphasis on how they are being used to help patients and save lives.

²⁹ Smilor RW, Gibson DV, Dietrich GB. University Spin-Out Companies: Technology Start-Ups from UT-Austin. *Journal of Business Venturing*, 1990;5:63-76.

³⁰ Morrison JD, Wetzel WE. A Supportive Environment for Faculty Spin-Off Companies. In Brett AM, Gibson DV, Smilor RW, eds. *University Spin-off Companies: Economic Development, Faculty Entrepreneurs, and Technology Transfer*. Savage, MD: Rowman & Littlefield; 1991:123.

Discussion

One of the most significant differences noted by the interviewees was the abundance of role models and mentors familiar with entrepreneurship and the commercialization process that was available at MIT as compared to the Harvard Medical Community.

They felt that the presence of role models was to some extent responsible for the amount of entrepreneurship and commercialization found at academic institutions. In addition, once mentoring is established, the mentors become part of an ongoing system that creates new mentors who will, in turn, guide future generations of workers.

Those interested in commercialization of ideas benefit by having faculty, staff, and others available to discuss entrepreneurship and the commercialization process. In some cases this association can not only encourage the inventor, but may also make the difference between success and failure in the commercialization process. Mentors can also help those interested in creating a start-up company by giving advice and by enabling them to develop a network of contacts. A critical mass of like-minded people interested in commercialization creates a momentum to move forward in this direction and this should be encouraged if a university is interested in developing more commercial interests and opportunities among its faculty.

Cultural Differences

The history of entrepreneurship at MIT was briefly described in Chapter 2. From its earliest days MIT has interacted strongly with industry. Thus, the culture at MIT has, no doubt, been molded by its long involvement with commercialization and

entrepreneurship. The cultural value that MIT derives from this relationship is, by no means, available at all universities and is relatively weak at Harvard University. To be sure, some people feel that exposure to industry may be a threat to intellectual freedom and can result in changes in the values of academe. The interviewees' opinions about the influence of industrial collaboration and commercialization on the culture at MIT and at the Harvard Medical Community are discussed below.

Findings

The cultural differences between MIT, Harvard University, and the Harvard Medical Community was the most commonly discussed topic, and was the subject of the views of 16 of the 19 interviewees. Interviewee A's remarks were particularly insightful noting that in the MIT culture the activity of creating enterprises is considered part of the creative process, whereas at Harvard creating enterprises is not "bad, but it is outside" of the usual academic mission where ideas reign supreme.

Six interviewees, of whom four were entrepreneurs and inventors, stated MIT's cultural history of being a pragmatically oriented institution founded to solve societal problems, is the basis of the school's continuing interest in commercialization. Five of those interviewed remarked about the organizational structure of MIT, describing it as "monolithic," "less rigid," and with "a flat social structure where hierarchy is not important," in contrast to what is seen at Harvard University and the Harvard Medical Community. Some added that this structure and the absence of organizational, physical, and financial "fragmentation" described previously in this chapter, contributed to the cooperation between faculty, staff and others at MIT. Noteworthy were the comments of

two interviewees who said intellectual property in the Harvard Medical Community that is truly basic and at an early stage of development, is especially vulnerable to theft. This situation can be tempting to unscrupulous individuals and may be responsible for the “paranoia” displayed by some members of the community causing them to conceal their work and be less willing to cooperate with one another.

Two interviewees added that the faculty at Harvard generally does not want to spend years immersed in building a start-up company and prefers in most cases to license inventions thereby enabling them to return to academic research. Moreover, eight of the interviewees commented about the high level of awareness of entrepreneurship and commercialization of ideas at MIT in contrast to the Harvard Medical Community and how this, in itself, created even greater awareness through positive feedback. Interviewee C stated that few people realize they may consider commercialization at Harvard.

Attitudes about industry-sponsored research and industrial collaboration were also discussed by seven of the interviewees. Four comments were similar to that of Interviewee B, who said that there is more mistrust at Harvard associated with doing things jointly with industry whereas at MIT there is great interest in such an association. In this connection, the founding of Biogen, Cambridge, Massachusetts, merits brief comment. The company was founded by Professors Walter Gilbert of Harvard University and Philip Sharp of MIT. Professor Sharp has retained his position with Biogen and also continues to function as a faculty member at MIT. In contrast, Professor Gilbert, who has also retained his association with Biogen, but left Harvard University in the midst of great controversy about the company.

Five noted the importance of technology transfer as an avenue for the dissemination of research discoveries. Interviewee E stated that most investigators consider publishing as the main avenue for establishing priority and disseminating their findings. He went on to say commercializing is another means of knowledge dissemination and along with publication should be actively pursued. Furthermore, several of those interviewed expressed views similar to those of Interviewee A, who said individuals are recognized favorably at MIT for their entrepreneurial activities and industrial ties and working with industry is respectable and a source of great pride.

Discussion

Although cultural differences between MIT, Harvard University and the Harvard Medical Community were clearly visible, it was noted by some of those interviewed that the culture at MIT was more like that at the Harvard Medical Community than that at Harvard University. Thus, cultural differences can explain, at least in part, the variations in the character and extent of industrial collaboration and entrepreneurship seen at MIT and at the Harvard Medical Community. Although, the culture of an organization is not unlike its traditions in that neither is readily subject to change, several people suggested internal publicity about commercial successes may be beneficial in enhancing faculty interest in these areas at Harvard University and the Harvard Medical Community.

The role of patient care in the Harvard Medical Community and its mission for humanity was not felt to be a significant barrier to industrial relationships or entrepreneurship. In addition, none of the interviewees indicated that the investigators at the different institutions were better than or significantly different from each other. Thus, in the

Harvard Medical Community there are scientists and clinicians while at MIT there are scientists and engineers.

University Venture Funds

The transfer of new ideas from universities to the commercial sector can be done in a variety of ways. The creation of start-up companies based on licensed university technology is one method to facilitate technology transfer. The creation of start-up companies is attractive to universities because such companies enhance their reputation, sometimes assist with recruiting researchers interested in entrepreneurship, and if successful can be quite profitable, since the universities frequently take equity positions.³¹

This chapter examines support for the creation of spin-off companies through the use of university-associated venture funds, i.e., internal venture capital funds. These funds can have several aims, but generally, they help inventors turn premature technology into commercial enterprises that may then become attractive to other investors or mainstream venture capitalists. The need for university-associated venture funds may be greater for universities located in areas where traditional venture capital is less available or where established investors have little interest in small seed-round investments.

³¹ Salemi T. Medical Schools Forming Funds to Plug Seed Gap. *Venture Capital & Health Care*. Wellesley, MA: Asset Alternatives; March 1999;3(3):25.

The three most commonly used models to increase seed funding for potential spin-off companies are listed below:³²

- The university creates an independent fund that has access to the school's technology. This is the most common model and the school often invests in the fund. An example is ARCH Venture Partners of the University of Chicago.
- The university creates and manages its own fund using its own money, such as an endowment, that invests in the school's technology. This is currently being used at Vanderbilt University in Nashville.
- The third model seeks to affiliate with outside venture capital groups to commercialize university technologies. This route is now being followed at the University of Alabama-Birmingham to cite one example.

Another method used by universities to help new spin-off companies succeed is through business incubators and research science parks that share some of the risks associated with new business ventures. In general, a business incubator is a physical facility, located close to the university, that provides low rent and helpful support services. Participants can carry out proof of concept experiments, build prototypes, and have greater access to the expertise available at the university.

³² *Ibid.*

Harvard University and Boston University have university-associated venture funds: Medical Science Partners and the Community Technology Fund, respectively, that are briefly described below.

Medical Science Partners

Medical Science Partners (MSP) was established in 1988 by Harvard University and its aim is to “bridge the development gap between scientific research and industrial product development.” According to one interviewee, who is familiar with MSP, this firm’s specific goal was to enable “Harvard Medical School to transfer technology from the laboratory to the patient’s bedside.” Harvard has a 10% share in the general partnership of MSP through a wholly-owned subsidiary, ION Inc. Harvard avoids conflict of interest by not investing directly in MSP’s fund. MSP does not have first rights to Harvard technology. Approximately 85% of MSP’s investments are “Harvard-related,” a concept which is met by having at least one person from Harvard Medical School affiliated with the funded company in one capacity or another, e.g., advisor. Its two funds have raised a total of \$67 million and as of September 1998, have successfully started 25 companies of which 8 are public companies. MSP’s input also includes the selection of experienced business managers to head the new ventures.

Community Technology Fund

The Boston University Community Technology Fund (CTF) was started in 1975 to assist with technology transfer and also to function as a venture capital fund. The fund primarily invests in inventions from inside Boston University, but will occasionally invest in outside companies. In addition to screening the university’s intellectual

property it also has the task of forming limited partnerships with those that want to invest in the school's technology. In contrast to Medical Science Partners of Harvard Medical School, the money invested in CTF is exclusively from Boston University. They typically support early stage innovations and limit investments to the fields of healthcare/biotechnology and information technology because of the University's strength in these market sectors. They often will join with an external venture capital firm who will take the lead role in helping to assure that the technology merits investment. An important function of CTF is to provide business know-how and administrative personnel. They also help with networking in the business community. CTF typically invests between \$250,000 and \$750,000 as an initial investment, although it does award some smaller amounts of seed money to develop inventions that show promise of becoming the basis of start-up companies.

Findings

Thirteen of the interviewees discussed the value of university-associated venture capital funds. Two of them favored seed stage funding in the \$25,000-\$75,000 range for technology too premature to be supported by the venture capital community. Two others noted that this level of funding would not have a major impact on launching start-up companies. In addition, two interviewees were concerned about institutional politics influencing the choice of projects to be supported. Three interviewees commented positively on the Boston University Community Technology Fund, noting the competency of the fund's managers in working with start-up companies and in its ability to publicize on campus the potential value of commercialization. The role of Medical

Science Partners was discussed with five interviewees, all of whom felt that it had no significant impact in the Harvard Medical Community. Interviewee K looked upon MSP as he would any other venture capital fund and considered it to be attracted to the same deals and opportunities as other venture capital firms.

Discussion

Most of the interviewees felt that in the Boston area there is such facile access to mainstream venture capital that, in comparison, university venture funds do not contribute significantly in enlarging the sphere of entrepreneurship. This was particularly true of Medical Science Partners of Harvard Medical School. Interestingly, MIT has neither a university-associated seed fund nor an internal venture fund yet still manages to spin-off a significant number of new companies each year.

Established venture capital firms are growing in size and this growth has diminished the availability of seed and early stage capital. This state of affairs may increase interest by universities in establishing their own venture funds to fill this gap. In addition, a university-associated venture fund should prove especially attractive to universities in locations where there is less access to mainstream venture capital. However, it should be pointed out that where there is access to mainstream venture capital, university venture funds may help only that minority of potential company founders who are “at the margin.”

If a university is considering establishing an internal venture fund, first, and as pointed out by two interviewees, the fund should not have the right of first refusal to fund new technologies at the school, as this may hurt relationships with external venture capitalists,

who may well feel that they have “second pick” of inventions. Second, it is important that the university attract experienced people to run its venture fund if it genuinely wishes to improve the chances for success and to avoid mediocre results. Finally, university officials should be careful not to overestimate the value of intellectual property created on their campus and put too much money into a deal. In this regard it should be noted that the Boston University Community Technology Fund may owe its success to the fact that its investments are focused on those core areas wherein the university has great expertise. In addition, the managers of the Community Technology Fund have strong relationships with principle investigators and attempt to create positive internal publicity about entrepreneurship and commercial successes throughout the entire university.

Other Issues

Technology Transfer

Technology Transfer Offices

The topic of university and hospital technology transfer offices was discussed by 10 of the interviewees, all of whom agreed these offices are a genuine asset to their institutions. Seven singled out for praise the MIT Technology Licensing Office for the following reasons: the office encourages inventors to work with it to “push ideas out the door,” its operation is relatively transparent, and it is “good at deal making.” Two interviewees remarked that at MIT technology transfer was a relatively quick process as compared to other institutions. Of note, two interviewees said Boston University’s Technology Transfer Office was knowledgeable about creating and working with start-up companies

and had a good network for bringing people together. “Deal making” and connecting inventors with entrepreneurs and with venture capitalists was felt to be an important role of the technology transfer office according to three interviewees, who also believed these offices have succeeded in increasing the growth of entrepreneurship and commercialization of ideas at MIT and Boston University. Interviewee H said that in his opinion the licensing function of the technology transfer offices was a less important factor than that of bringing people together.

Finally, the subject of unrecognized intellectual property was discussed with two interviewees. Both felt that undisclosed intellectual property generally results from an inventor’s failure to appreciate the merit of an idea or invention rather than from his lack of knowledge of the procedure for disclosing an invention. The climate of awareness was believed by some interviewees to be greater at MIT than at Harvard University and the Harvard Medical Community; they felt this condition at these places can be remedied by simply increasing publicity about disclosures, patents, and licenses.

Licensing Versus Creation of a Start-up Company

The question of pursuing technology licensing versus creating a start-up company was discussed by five interviewees. Three interviewees, two of whom are associated with Harvard University and the third with the Harvard Medical Community, commented that the preferred route in most cases is to license the technology; this choice enables the faculty member to return to academic research quickly. Three people, also from, the same institutions, noted that if a potentially good invention is difficult to license, but holds promise of serving as a foundation for a start-up company, the creation of a start-up

company may be the better route to pursue. Interviewee Q said that in order to consider a start-up company as an alternative to licensing, the technology transfer official must be especially adept in creating such companies and have an eye for seeking out technologies that are able to stand on their own. He went on to point out that both MIT and Boston University were fortunate in having such talented technology transfer personnel.

Lastly, two interviewees felt that the Harvard Medical Community Technology Transfer Offices were understaffed especially when compared to MIT. They suggested that the staffs be enlarged so that more attention can be paid to creating start-up companies and marketing of intellectual property.

Equity

This subject was discussed with three interviewees, admittedly a relatively small sample of those taking part in the study, who felt that, in general, the question of company equity should no longer be worrisome for inventors or institutions experienced in the areas of entrepreneurship and commercialization. The current conflict of interest policies of the institutions were believed to be adequate for averting potential problems associated with equity.

In fiscal year 1997, the number of licenses executed for equity at Harvard University including the Medical School was two, at the Harvard teaching hospitals it was four, and at MIT it was eight.³³ Taking an equity position in a company in lieu of a royalty stream

³³ Massing, *op. cit.*, 138, 158.

is one way for institutions to assist new companies that may not have adequate cash to pay for licensing. From the licensee's point of view equity is advantageous because it provides an incentive to the inventor to support the new venture.

Company Boards

This topic was discussed briefly with five interviewees and all felt that for a start-up company to be successful the inventor must be willing, at a minimum, to come on board as a scientific advisor. Interviewee C reported that his membership on the boards of several companies has proven very fruitful for him. He found that working with industry and with venture capitalists is a worthwhile experience and that the networking that resulted was especially beneficial. Furthermore, involvement with industry has been helpful in enabling him to focus his academic research on some unusually fascinating and rewarding problems.

Chapter 6: Summary and Recommendations

Summary

A series of interviews was conducted in order to identify factors that may account for the perceived differences in attitudes toward entrepreneurship and commercialization found at MIT and at Harvard Medical School and its associated research hospitals. This study was expected to suggest ways to increase future opportunities for these and other institutions to participate in these kinds of commercial enterprises. Nineteen interviewees participated in this endeavor; they identified several factors that may account for the observed differences. However, no one factor was singled out as the most important. Several of these factors are summarized below; it will be noted that some of them are interrelated.

1. The nature of the intellectual property found at an institution plays a vital role in determining whether the institution can engage successfully in entrepreneurship and the commercialization of ideas. Some types of technology are particularly attractive to a licensee; especially those that are more easily protected by patents and copyrights, and are more amenable for use as a basis for a start-up company. The intellectual property originating from an institution is a reflection of the university's mission and cannot be easily changed.
2. The presence of mentors and role models can have a big effect on the quantity and quality of entrepreneurship and commercialization found at academic institutions

and is perhaps the most important factor of all those described in this report. In addition, once mentoring is established at an institution, the mentors may become part of a self-perpetuating system that creates new mentors who will, in turn, guide future generations of workers. Mentors most commonly help those interested in commercialization of ideas or in creating a start-up company by offering them advice and by enabling them to develop a network of contacts.

3. Cultural differences can explain some of the variations in the character and extent of industrial collaboration and entrepreneurship seen at MIT and the Harvard Medical Community. Clearly, an institution's history and traditions play a role in molding its culture, as demonstrated in the case of MIT which has a long-standing involvement with commercialization. The culture of an organization is not unlike its traditions in that neither is readily subject to quick change in this regard and several interviewees pointed out that internal publicity about commercial success may be beneficial in enhancing faculty interest. The culture of an institution also may affect its attitude toward the concept of conflict of interest which itself can be influenced by the institution's traditions.
4. The issue of conflict of interest which appears to be quite significant at Harvard University and the Harvard Medical Community, is apparently less of an impediment to entrepreneurship and commercialization at other institutions. The "dampening effect" created by the conflict of interest policy at Harvard is most likely related to the tight coupling of the Harvard culture and these rules.

5. A critical mass of people and adequate resources is desirable in order to develop a system that supports inventors and others interested in entrepreneurship and the commercialization of ideas. The competing forces at Harvard University, its Medical School, and the hospitals create an atmosphere that decreases potentially important interactions that under different circumstances might lead to collaboration among the faculty and staff even across different disciplines.
6. Ideally, technology transfer should be a relatively quick process that encourages inventors to assist in getting their ideas out of the institution. Furthermore, to support the creation of start-up companies, it is important that technology transfer offices bring together inventors, entrepreneurs, and investors (venture capitalists).
7. Although university venture funds do not contribute significantly to enlarging the sphere of entrepreneurship they can prove especially attractive to universities located in areas where there is reduced access to mainstream venture capital. Nonetheless, university venture funds can benefit an institution by increasing awareness of entrepreneurship and the process of creating start-up companies.

Study Limitations

Some limitations of this study are that it does not examine industry-sponsored research or other techniques of technology transfer such as consulting. The main thrust of this study has been directed toward the factors that influence peoples' interest in technology licensing and the creation of start-up companies. This study which is based on information obtained from 19 interviews is limited by its small sample size which reduces the opportunity to do meaningful subgroup analysis of the interviewee responses

according to occupation. Other limitations include possible bias in the selection of interviewees and the variation in the set of questions used in the interviews.

Conclusion

The nature of an institution's intellectual property is a reflection of its culture, traditions, history, and mission. These qualities which define the institution are rather resistant to change. However, by increasing awareness of entrepreneurship and commercial success through role models and positive internal publicity, the institution may be change for the better the attitude of its researchers and workers toward entrepreneurship and commercializing of ideas. Accessibility to mentors and role models and the availability of activities which enable researchers to learn about entrepreneurship and commercialization were considered by some interviewees to be the most significant factors for increasing awareness and knowledge of these processes. In this regard, the presence of a transfer office that facilitates the bringing together of inventors and entrepreneurs is especially helpful. An outstanding collection of talent and activities directed toward collaboration and cooperation is clearly operating at MIT and successfully perpetuates interest in commercialization and entrepreneurship.

General Recommendations

1. Increase the availability of mentors and role models who are familiar with entrepreneurship and have experience in working with industry.

2. Increase awareness and acceptance of entrepreneurship and commercialization as an alternative avenue for knowledge dissemination thereby complementing traditional publication.

Two examples of successful programs that increase awareness of entrepreneurship at MIT are the \$50K Business Plan Competition, open to university students and researchers, and the MIT Enterprise Forum, organized and run by MIT alumni. These programs not only provide information about the process of commercialization and entrepreneurship, but they also offer a network which succeeds in facilitating cooperation between people from both inside and outside the institution. In addition, both programs have the incidental advantage of introducing individuals interested in entrepreneurship to one another and also to possible mentors and role models.

3. Technology transfer should be a quick process that facilitates the bringing together of inventors, entrepreneurs, and investors. In order to increase the degree of awareness of commercialization, the technology transfer office should routinely prompt each faculty member to disclose any potential inventions rather than depend on the investigator himself to voluntarily visit the technology transfer office.
4. The institution's conflict of interest policy should be clearly written and be non-intimidating.
5. Increase the availability of university venture funds at institutions located in places remote from mainstream venture capital.

Specific Recommendations

Considerations as they pertain to Harvard University and the Harvard Medical Community follow; under certain circumstances they may be also applicable to other institutions.

- Increase collaboration between Harvard Business School, the Harvard Medical Community, and other Harvard University schools. For example, this can be done on a small scale by publicizing the annual Harvard Business School Business Plan Competition and opening it up to all of Harvard University.
- Establish a general university entrepreneurship program encompassing all of Harvard. Its goal would be achieved, at least in part, by sponsoring activities which enhance cooperation and collaboration between the different schools and hospitals. One example of the type of program advocated here is the Entrepreneurship Center at MIT.
- Create an additional academic track at Harvard Medical School for physicians interested in entrepreneurship as suggested by Interviewee R, which would allow reduced patient care and fewer academic responsibilities. These individuals would participate in seminars and other events which would, in turn, teach the process of commercialization and entrepreneurship to other members of the Harvard Medical Community. A similar arrangement that embodies some of the features recommended here, although not an official track in itself, is available in the Health Care Entrepreneurship Program at Boston University. This program provides

students and academic fellows interested in entrepreneurship with an opportunity for hands-on experience.

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Appendix: Interviewee List

The author sincerely appreciates the generous assistance, cooperation, and insights of those interviewed in this study.

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