INSTITUTIONAL CONTRIBUTIONS
TO FIRM GROWTH
IN UNIVERSITY RELATED RESEARCH PARKS

by

Lavea Brachman

J.D. The University of Chicago Law School (1988)

Submitted to the Department of
Urban Studies and Planning in Partial Fulfillment of
the Requirements for the
Degree of

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ABSTRACT

This thesis surveyed high-technology firms located in three university related research parks (URRPs) to determine which university resources and park services contribute most significantly to firm growth. The thesis examined three URRPs as case studies, the Rensselaer Technology Park in Troy, New York; the Massachusetts Biotechnology Research Park in Worcester, Massachusetts; and Science Park in New Haven, Connecticut, to make recommendations to parks and to universities about what they can do to encourage the growth of firms in these URRPs and, thus, make URRPs a valuable investment for both a university and for the park itself.

The study found that, overall, the most important university resources for firms are, first, the "personnel" a university supplies to firms in the form of graduate students and professors and, second, the informal interactions between a university and industry that grow out of the academic mission. On the other hand, the study found the university's research functions and their outgrowth (sponsored research, and patent and licensing) -- which are often touted as important to industry -- to be significant more often only to early stage firms and to certain types of industries. Moreover, a URRP contributes to a firm's ability to access these university's resource by performing a "brokering" function between the university and the firms in the park. In addition, other park benefits, such as real estate perquisites and incubator services, are attractive but not sufficient by themselves to make a URRP more attractive than other locations proximate to a university.
In conclusion, in order to justify the creation of a URRP and a university's association with it, this study recommends that a university make proactive efforts to establish informal links with industry and that a park encourage these links through brokering. Under these circumstances, a firm is more likely to prosper and grow in a park setting and a university is more likely to reap benefits, either financial or otherwise, from its involvement with a park.

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CHAPTER I

INTRODUCTION

Over the years, the university and the research institution have played a major role in the change and development of our society. Sometimes the use of these institutions to stimulate change has been deliberate; sometimes they have promoted change unwittingly. Nevertheless, knowingly or unknowingly, the university can inspire change because of its many resources and its multidimensional character. Besides its educational function, which has opened opportunities to people of all socioeconomic classes, the university has been known to promote technological change and industrial innovation, spur research, contribute generally to the marketplace of ideas, act as a land developer, and perform a stabilizing function for the surrounding community. As part of this broader university mission, the development of university related research parks (known here as "URRPs"), populated by tenant firms, is based on the premise that the university can provide resources that facilitate firm growth and development and thus ultimate contribute to economic growth.

However, despite the importance of the university to this country's overall development, the university's specific contributions to the growth of industry have been generally accepted but not well documented. This study analyzes whether the university does in fact contribute to firm growth in its affiliated research park, and if it does, then how and to what extent it does so. In looking at three URRPs, this thesis examines the relationships between the high-technology (or "high-tech") firms located in the research parks and the related universities. Through a

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1High-tech firms are best defined as "companies that are engaged in the design, development, and introduction of new products and/or innovative manufacturing processes through the systematic application of scientific and technical knowledge . . ." Office of Technology Assessment, Technology Innovation and Regional Economic Development, OTA-STI-238, Washington, D.C.
series of interviews conducted with firm executives, park managers, university administrators, and community leaders, this thesis sets out to better understand the university's contributions to firm growth.

Moreover, since we are by definition looking at firms that have already chosen to locate in a "university related" entity designed through proximity and structure to promote links with the university, the immediate question posed by this thesis -- the question of whether and how university related factors promote firm growth -- is influenced by the nature of the university's involvement with the research park. Hence, undertaking an examination of the university-firm relationships also entails looking at the parks' relationships with the surrounding universities, which vary from park to park and from university to university, and looking at the park objectives.

In contemplating these complex issues, this thesis will treat the following topics. In the next two chapters, it will provide the historical and theoretical background to the development of URRPs, then it will describe the study's research methodology and the formation and site development of the three research parks. In the fourth chapter, the results of the interviews will be discussed, broken down into groups of findings by type of university resource and park service, and the overall importance of each kind of university resource and park function to the firms will be assessed. Based on these findings, the final chapter will analyze the relations between the university, the park, and the firms, in order to judge the value of a URRP.

Of course, the university cannot act alone as a facilitator of firm growth. Even if the university contributes significantly to a firm in ways that allow the firm to leverage its internal resources -- by offering facilities, research resources,
equipment, or skilled labor -- a university is not a sufficient force alone to grow the firms in these parks. There are also a number of non-university factors -- locational, financial, and economic -- that may have a more determinative affect on firm growth. Nevertheless, there is evidence that, given the right set of park conditions and a supportive university, URRPs can be fertile environments, particularly for new firms; and universities do provide certain ingredients that help these firms develop.
CHAPTER II

UNRAVELING THE RIDDLE: PROBING THE INTEREST IN URRPs BY UNIVERSITIES, GOVERNMENT ENTITIES, AND ACADEMICS

Introduction

There has been an increasing interest in research parks in the last decade by all sectors -- university administrations, government entities, private companies, and academics. This chapter defines URRPs and looks briefly at their origin and development, in order to provide some basis for understanding this recent increased interest in URRPs and in universities as a resource for industry. This background chapter further reviews the literature that has focused on the creation of URRPs and on the university as a component in the growth and development of industry. The literature review illustrates the types of studies that academics have done previously and where this study fits into the existing constellation of research. It also sets forth some of the theories that have developed about the role of the university that, later in this study, will be confirmed, refuted or elaborated upon as a result of the findings here.

Definition and Objectives of URRPs

URRPs are business parks that have links with a proximate university or research institution and that are marketed as a single entity in which the primary activity of the majority of establishments is basic or applied research or new product or process development, rather than manufacturing, sales, headquarters administration, or other business functions.² This excludes "technology-oriented

²This is a variation on the Michael I. Luger and Harvey A. Goldstein definition found in their book, Technology in the Garden: Research Parks and Regional Economic Development, Chapel Hill: The University of North Carolina Press, 1991, p. 5.
complexes" like Route 128, because URRPs are restricted to one contiguous site and require a university affiliation.

Typically, universities get involved in sponsoring and promoting research parks for three discrete reasons. The most important two reasons are, first, to participate in community economic development by promoting job creation and/or providing a stabilizing force for a neighborhood, town or region, and second, to broaden the university's mission by integrating academic research for applied purposes and improving its relationship with industry. The other reason often cited by universities is to generate financial returns, which the university hopes to do by increasing its patenting, licensing, and general technology transfer activity through closer association with firms in the park or through returns on the real estate.

**Origin and Development of URRPs**

The private sector and state and local governments have for a long time looked to universities for help in improving productivity and competitiveness. The 1862 Morrill Land Grant Act, under which the federal government gave land to states to subsidize the development of a system of state colleges with curricula aimed at supporting the needs of local industry, established a precedent for modern-day links between university, government, and industry.³ International competition, decline of the manufacturing base and growing uncertainty about the strength of the American economy have underscored the need to look to additional sources, like universities, and new ways for promoting productivity. In 1980, in an effort to encourage industry to fund research at a university, the U.S. Congress passed legislation that allows universities and businesses to keep patents on inventions discovered under federally-subsidized research, in

exchange for a royalty-free license to the sponsoring federal agency. Before this law, the federal government claimed ownership of inventions made as the result of federal government funding (even if there was also some private money involved).4

The perceived advantages and benefits of fostering industry-university links are access to research, the transfer of technology, the immediate supply and availability of skilled labor and a preexisting, generally supportive community. Universities, government and industry turned to the concept of URRPs to facilitate these links as one method of improving industrial output and fostering economic development. However, the way in which URRPs assist commerce -- and their ultimate efficacy -- is not well understood. Thus, it is important to examine the university-firm links that have been established in URRPs to determine the extent and manner in which universities actually contribute to firm growth and ultimately to strengthening the economy.

The next section reviews the writings relevant to understanding the origin and development of URRPs and the high-tech industries, establishes the place of this study in the existing literature, and highlights the unanswered questions about the university's role that this study will address.

The Creation of URRPs and the High-Technology Industry: The University as a Growth Factor?

The role of the university with respect to high-technology firms is poorly understood despite numerous attempts to disentangle the mystery. In the last thirty years, based on the experience of places like Silicon Valley and Route 128, urban economists, sociologists, business people, and planners have become

increasingly interested in observing what factors were instrumental in propelling these areas into the grand agglomerations of high-technology that they became.\textsuperscript{5}

In studying these high-tech areas, academics and the industrial sector adopted two primary approaches to investigating the reasons behind their development. Under one approach, studies were done in the context of looking at the whys and hows of the areas (parks, in some cases) themselves. Searching for the tools to replicate the Silicon Valleys and Route 128s\textsuperscript{6} that already existed, economists and planners began to evaluate the importance of the roles of the different institutions and players involved, which included the universities, in initiating and developing these areas, with the hope of stimulating the type of economic development that occurred in the northern California and metropolitan Boston areas.

Another way theorists have looked at this complicated question is to study directly the nature of the high-tech industry and evaluate all the factors that contribute to high-tech growth. Then, these theorists will draw conclusions about the university as one of those factors and about the nature of the relationship -- if there is any -- between high-technology growth and the university, and the theorists will analyze the impact -- if any -- of having the two in close geographical proximity.

Thus, some of these studies evaluate the function of the university in initiating and developing high-tech agglomerations or parks; others focus on the

\textsuperscript{5}Of course, Silicon Valley and Route 128 were not the first examples of localization of like-firms. There are plenty of examples of industry agglomerations both in the U.S. (Detroit, e.g.) and in Europe (Italy, e.g.), since the industrial revolution. See Michael Best, \textit{The New Competition: Institutions of Industrial Restructuring}, Cambridge, MA: Harvard University Press, 1990 and Bennett Harrison, "Industrial Districts: Old Wine in New Bottles?" \textit{Regional Studies}, Vol. 26.5, September 1992, pp. 469-483 on agglomerations. However, these are the first major sites of agglomerations of \textit{high-technology} firms, which are the primary focus of URRPs and of this study.

\textsuperscript{6}There are already a number of Silicon Valley "knock offs" that have sprung up around the country, including Louisiana's Silicon Bayou, Maryland's Satellite Alley, and Florida's Silicon Beach.
location decision faced by firms -- or on the factors leading to the startup of firms -- in parks. However, in looking at the university's role in initiating and developing high-tech parks, little is known about which functions undertaken by the universities actually contribute to the growth and success of the firms in these URRPs. No study has examined in depth the impact of university/URRP services on the client firms, and this thesis sets out to address that gap in the existing literature.

The Growth Pole Theory: A Theoretical Basis

The theoretical basis for the concept of research parks -- and the agglomeration of firms it entails -- can be traced back to the 1920s when economist Alfred Marshall propounded his regional location theory. His theory postulated that concentrating firms in a geographical area would facilitate the growth of firms and would benefit the regional economy as a whole, because the conditions for firm development would be naturally improved as the result of their being located in close proximity.

Under this so-called "growth-pole theory," the localization of firms was favored for three reasons: first, concentrating a number of firms in the same or related industries allowed a pooled labor market to develop for workers with specialized skills; second, the need for specialized equipment and other inputs among these concentrated firms would cause supply subsidiary firms to spring up in the neighborhood, and the proximity of these supply firms would reduce the cost of the specialized inputs and allow them to exist in greater variety; and, third, the localization of firms would result in easy and routine information exchange, or
"technological spillovers," about their business which leads to innovation and improved production processes.\textsuperscript{7}

The Marshall location theory has served as the building blocks for contemporary urban economists and business academics, such as Ann Markusen, AnnaLee Saxenian, and Michael Luger and Harvey Goldstein, who attempt to set forth a rationale for apparently unplanned concentrations of industry (the auto manufacturing industry in the midwest and the computer industry along Route 128 in Boston), in order to draw public policy lessons, and for the creation of planned parks as well. Nevertheless, due to either the nature of the industry located in the three parks in our study or to the relatively immature stage of our parks' development, none of the three parks here appear yet to demonstrate the achievement of the three predicted outgrowths of firm localization mentioned above.

**Studies Analyzing A University's Strengths**

The literature on URRPs and firm location decisions in the parks as well as the literature on the growth of the high-technology industry come to conclusions that point in different directions about the importance of the role of the university. For the most part, the studies that start by examining the firms located in existing URRPs are more optimistic about the potential for universities to form a basis for high-tech agglomerations, despite the fact that it has been estimated that over fifty percent of parks that are announced in this country either never become viable or go out of business.\textsuperscript{8} The inherent bias is that it is extremely difficult to study a


URRP that never got off the ground and to determine why it failed. Thus, these studies are limited, although they provide a starting point for this study.

In an attempt to estimate the economic development potential of URPPs, academics of the location theory school have collected evidence that tries to elucidate what the university's draw is for high-tech firms. As Professor Robert Premus observed, "The importance of universities as a determinant of the growth of high-tech agglomerations depends upon the strength of their role as a locational magnet for new and existing high-tech activities," and evidence regarding the university attraction can be obtained by examining the locational requirements of high-tech firms.9

Several studies have examined these requirements. Patricia A. Wheeler, in a doctoral thesis, concluded that the university plays a decisive role and, thus, that it is an active participant in regional economic development.10 Robert Premus also found the university to be "an important determinant of high-tech firm location;"11 Michael Luger and Harvey Goldstein evaluated three parks for the factors that made them a "success," finding the presence of a research university to be one of two critical factors.12

Wheeler's study surveyed two sets of firms, those located in URPPs and those which were non-park firms, to determine the factors that affect the location decisions of the firms in each set. She asked both sets of firms to rank different location factors. Among park firms, affiliation with a university was ranked on

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12Luger and Goldstein, supra, p. 33.
average as the fourth most important factor out of sixteen, after "expansion flexibility/potential, site availability, and land cost/lease rates;" while among non-park firms, it was ranked twelfth. In asking directly whether proximity to a university system was a factor in the location decision of the firm, she found -- not surprisingly -- that seventy-two percent of the overall URRP firms indicated it was a factor of some significance to very significant in their location decision, while only 7.2 percent of the non-park firms indicated that proximity to a university system had been of equal importance in their location choice. Wheeler notes that there is some variation among park firms by size, by type of firm, and by length of time in operation, in how strongly they rate the importance of the university system.

Premus surveyed high-tech firms identified for their ccommitment to research and product development through improved technology and found that, in choosing a location, 74 percent of the companies considered proximity to a university system. Academic institutions ranked fourth among attributes attractive to high-technology companies -- behind skill-level and availability of labor, the cost of labor, and tax climate of the region -- in his study.

These empirical results do not differ dramatically from Wheeler's. However, Premus tempers his enthusiasm for the strength of the "locational bond" between universities and industry based on the identification of other more subtle factors in the relationship. First, and most importantly, Premus' analysis reveals that the strength of the attraction between the two entities depends upon "the value

13Wheeler, supra., p. 165.
14Ibid., p. 167. The "level of significance" scale used here is "some to very," "significant to very significant," and "very significant." In this author's opinion, the power of this conclusion is minimized by the fact that firms already located in URRPs would more likely mention the university as a component in their locational decision-making process. This ex post evaluation of firms' location decisions, that is surveying the reasons for a firm's decision after a firm is already located near a university, leads this author to conclude that Wheeler's results are somewhat tautological.
15Premus, supra., 1986, p. 16.
industry places on the benefits they receive from the university" and the degree to which those university attributes most valued by firms are present in the particular university system. While it may be assumed that a university, because it is an academic institution, has all the attributes necessary to make the relationship with industry worthwhile, in reality it may not have those attributes for which a firm is looking either at all or to a great enough degree.

In his most important finding, Premus' study of these attributes revealed that, in general, it was the academic attributes, the associated factors (college graduates, degree programs for employees, and access to libraries and information systems), and the cultural features of university life that were most important, and not the research attributes -- which are what we might expect to be the crucial elements. The lists of university attributes compiled by Premus, Wheeler and others in their studies were useful in this study as starting points from which to ask firm employees and executives which attributes they could point to as important once they had located in the park. These will also be important later in our study where it becomes clear that the kind of attributes that a university has and to what degree they exist become some of the touchstones to understanding the role of the university in firm growth.

The second reason Premus moderates his views on the university is based on personal interviews with executives of high-tech companies -- in a separate survey -- that revealed that a skilled labor force and a strong university system were not "conditions" for the emergence of high-tech complexes, although they were considered "important." Finally, Premus notes that, in reality, "many high-

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16 Ibid., pp. 21-24. Wheeler also did a survey of the university attributes that firms find important but his conclusions were presented as a laundry list of university attributes with no analysis of what the implications for firms were.

17 Premus, supra, 1986, p. 20, from John Rees and Howard Stafford, "A Review of Regional Growth and Industrial Location Theory: Toward Understanding the Development of High-
tech firms thrive in regions without a strong university system;" while other "great university systems," besides those in the San Francisco and Boston areas, "have failed to spawn significant high-tech activities within their environs.\textsuperscript{18} Thus, Premus concludes somewhat cautiously that:

the preponderance of the empirical evidence is that universities are an important factor in the spatial distribution of high-tech activities in the United States, [but that universities are] neither a necessary nor a significant condition for regional high-tech growth.\textsuperscript{19}

Luger and Goldstein's book, Technology in the Garden, sets out to evaluate the "success" of a park in terms of its economic development potential by measuring the change in employment generation and job quality of the region. Luger and Goldstein focused on the variables leading to the parks' success, finding that successful parks need either a sufficient population\textsuperscript{20} to support agglomerations of economic activity or a strong research university. However, other factors, such as park age, park amenities, strength of the linkages between the park and local institutions, and long-term commitment by sponsoring institutions can influence the outcome.\textsuperscript{21} The significance of Luger and Goldstein's findings for our purposes here is that they suggest that research universities in smaller metropolitan areas may, under certain circumstances, act as a proxy for other conditions that inherently exist in more populated areas. However, again, it must be cautioned that: it is essential to go on to examine, as Premus has done, what characteristics about universities serve as the proxy for

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Technology Complexes in the U.S.,* paper prepared under contract for the Office of Technology Assessment, May 1983.
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\textsuperscript{18}Premus (1986), p. 19. (Emphasis added.)
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\textsuperscript{19}Ibid.
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\textsuperscript{20}A "sufficient" population means one that is concentrated enough to have a critical mass of educated, technical workers and to have engendered the other amenities that these workers tend to value.
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\textsuperscript{21}Luger and Goldstein, supra., pp. 33-48.
\end{flushright}
estimating how universities can contribute to firm and economic growth. This is important to undertake, so as not to mislead small to medium-sized communities into blind reliance on their universities and to ensure that, should these communities embark on a research park with the local university as the centerpiece, the strategy they adopt is based on information that improves their chances of success.

Premus' analysis is far more credible than Wheeler's somewhat facile conclusions about the centrality of the university's role to high-tech firm development. The greater problem is that Wheeler's study and others like hers may cause localities and states to undertake misguided efforts at economic development, based on the simplistic notion that the university will fill the requisite needs. Indeed, Premus' findings start to demythologize the use of the university as an economic development tool, suggesting, for instance, that public policy makers would be misdirected to attempt to direct state or local money towards enhancing the research of a university, when it is not the research functions of a university that firms find useful. Alternatively, then, Premus' findings suggest that a strong research institution may not be sufficient as the centerpiece for an economic development program. However, as the anecdotal evidence in this paper suggests, a university may still be a viable source for a firm needing the other resources (e.g., academic attributes) that a university can provide, and this study will provide a basis for a more precise understanding of when and how universities can matter for firm, and ultimately, economic growth.22

Studies Questioning The University's Role

Markusen, Saxenian, Massey, and Rosegrant and Lampe are much more skeptical with respect to the role of the university. To develop an explanation for

22See Chapter IV for discussion of these other resources.
the large agglomerations that are Silicon Valley and Route 128, these academics and journalists look generally at the evolution of the high-tech industry. They find that universities arise as one among a number of factors contributing to these growth patterns. However, generally, these studies conclude that although there is a role for the university, the role has been exaggerated as a source of innovation and as a generator of high-tech firms, and they suggest that the local business culture, existing commercial and social amenities as well as other factors, such as the government's defense spending, have been the prerequisites to high-tech development.

Doreen Massey, et. al., in High Tech Fantasies: Science Parks in Society, Science and Space, in particular, question the underlying motive for the existence of the science parks that they study in England. They cast doubt on one of the important, central assumptions about the functionality of science parks: that they exist to facilitate the linear process from innovation to commercialization. They argue that the linear industrial model is not really what results in prolific innovation, rather that innovation comes from vertical connections within a firm between the factory floor and the engineers in the firm's research and development laboratory.23 Universities, then, are peripheral to that process.

Other researchers question the importance of the university as a source of high-tech development for different reasons. AnnaLee Saxenian analyzes the continuing Silicon Valley success story and, like Massey, focuses on the nature of the innovative process in the Valley. According to Saxenian's studies of startup firms in the Silicon Valley, the primary source of innovation is not Stanford or the University of California at Berkeley but the unique interplay of cooperation and competition and the informal networks that have developed among Silicon Valley

firms. The industrial structure of the region developed out of a social structure that supported a "complex balance of cooperation and competition," in that, while local firms compete, "they simultaneously rely on dense networks of social and commercial relationships for information, technology, and contracts."24 In Saxenian's view, Stanford contributed to these "informal practices of inter-firm cooperation."25 However, "by the end of the 1960s, neither Stanford University nor its science park were of real significance to the region's rapidly multiplying technology firms. Virtually all of the startups during the 1970s and 1980s were spun off of existing firms...," Saxenian states. She rejects the traditional formula for generating high-tech development, concluding that:

The high-tech recipe overstates the role of such individual institutions as Stanford, its science park, and the venture capital industry in the development of Silicon Valley because it abstracts them from both the industrial structure and the social and economic environment of the region.26

Today, according to Saxenian, Stanford's importance to the region "lies primarily in its role in educating large numbers of engineers and managers."27

In separate studies, Ann Markusen, and Susan Rosegrant and David Lampe trumpet the importance of the defense industry in the founding of Silicon Valley and Route 128, its significance at times overshadowing the importance of academia. Markusen's assessment of the university's role occurs within the context of her theory of high-tech firm location and growth (the profit cycle).28 She hypothesizes that innovative high-tech industries tend to cluster together in

25Ibid., p. 39.
26Ibid., p. 38.
27Ibid., p. 40.
their initial stages. When they enter the market penetration stage, they begin to
disperse, in order to locate closer to their customers, and because they may need
more space to expand, and, thus, need cheaper land.

Using regression analyses, Markusen finds high-tech firms' growth to
derive from three main categories: the existence of urban amenities, accessibility,
and agglomeration. Moreover, similar to Premus' conclusions, Markusen finds
research spending does not prove to be a significant factor in explaining long-
term location patterns of high-tech firms, while, in her study, defense spending
emerges as one of the key variables explaining high-tech growth, particularly
during the 1970s.

In attempting to understand the apparent surprising insignificance of the
research spending variable, Markusen asserts,

that the explanation [for the insignificance of the university] lies in the
importance of the defense variable: what was earlier thought to represent
the importance of fundamental research, as in the growth of high-tech along
Highway 128 around Harvard and MIT, or in Silicon Valley next to Stanford,
really represented very highly concentrated defense spending in one or two
key universities.

Alternatively, she explains that perhaps these universities "happened to have just
the required research strengths in electronic engineering at the critical time," a
view shared in part by Rosegrant and Lampe. In any case, then, based on her
empirical analysis, Markusen concludes, "one of the most cherished myths of
high-tech policy -- that a strong research university is the key to high-tech growth

29 In her regressions, using metropolitan areas as her unit of aggregation, Markusen incorporated
13 variables, representing metropolitan features that she hypothesized to be associated with high-
tech job and plant location. Categorically speaking, the variables selected are labor related (wage
rate, unionization rate, unemployment rate), amenity features (climate index, housing price,
educational options), access features (freeway density, airport access), agglomeration related
(Fortune 500, business services, university research and development), and socio-political features
30 Ibid., p. 177.
-- seems to be without empirical foundation."\textsuperscript{31} Nevertheless, a strong case might be made that in Markusen's study an inadequate measure of the university's output was used. The more important contributions -- as an example of those university-related links that have been undervalued -- may lie in the faculty interactions and other informal connections between the university and the firm, informal links similar to the type that Saxenian describes among firms in Silicon Valley.

Rosegrant and Lampe also acknowledge the centrality of the federal government's defense spending, as one of three factors that explain the burgeoning of Route 128 -- the other two being industry and the university. However, based on anecdotal and historical evidence, they attribute a larger role -- at least as compared with Markusen -- to the university (MIT in particular) in the development of Route 128 firms: ". . . high-tech companies in the region are, in many cases, an extension of the basic academic/research infrastructure. They provide a continuum of research-oriented organizations that help to ease new technologies into the high end of the marketplace."\textsuperscript{32} Like Saxenian, they attribute the success of innovation to the culture of the region, the "practical New England culture and its pervasive, underlying entrepreneurial spirit."\textsuperscript{33}

Taken as a whole, then, the authors reviewing the growth of high-tech parks around universities and the authors studying about high-tech firm location believe the university has some role, but they disagree about the fundamental importance of that role and about when and how it can be important for firms. Some of the authors, such as Wheeler, Premus, and Luger and Goldstein, view -- to varying degrees -- some aspect of a university as capable of making tangible

\textsuperscript{31}\textit{Ibid.}, p. 177.
\textsuperscript{32}Rosegrant and Lampe, \textit{supra.}, p. 183.
\textsuperscript{33}\textit{Ibid.}, pp. 182-3.
contributions to the growth of firms; while the more skeptical writers, Markusen, Saxenian, Massey, and Rosegrant and Lampe, looking at non-university factors, as well, generally conclude that the value of university-firm links are overestimated.

**Conclusion: The Role of This Study**

This background discussion about some of the prominent studies on this subject highlights several reasons why additional research must be conducted. First, the range of opinion displayed about the importance of the university demonstrates the need for further study of the links between the university and the firm. There is certainly some strong evidence that universities do matter for firm growth, but there is also a difference of opinion on what university resources are most influential in firm growth and, further, about what stage in a firm's lifecycle may benefit most from the university-firm links. Moreover, since the links are many and complicated, unless these links are parsed and separately evaluated, subtle but important distinctions may be lost. More complete studies might have undervalued the importance of the university by failing to distinguish the significant from the insignificant links.

One of the challenges to interpreting the role of the university is the inherent difficulty in measuring both the degree and the impact of what is commonly referred to as "technology transfer." Under a broad interpretation of the term, "technology transfer" refers to the movement of basic research from the university laboratory to the company. In the traditional, narrow sense, technology transfer refers to patents and licensing agreements that cover both inventions discovered by faculty while working in the university and while doing collaborative projects between university and industry, such as research done at the university under the financial aegis of a company ("sponsored research"). Increasingly, however, technology transfer is understood to include other less formalized forms of
university-industry associations, such as faculty consultation, graduate students that work in firms, and so on.\textsuperscript{34} David Lampe of the Industrial Liaison Program at MIT notes that the broader technology transfer is "hard to document."\textsuperscript{35} Paul Krugman elaborates on this in his recent book Geography and Trade: "knowledge flows . . . are invisible; they leave no paper trail by which they may be measured and tracked; and there is nothing to prevent the theorist from assuming anything about them that she likes."\textsuperscript{36} By "parsing" the university-firm links here, some of the "knowledge flows" become more "visible" and, therefore, their impact more fully considered.

A second reason for undertaking this study that is apparent from this background discussion is that much of the literature focuses on the firms in Silicon Valley and Route 128, so that conclusions about the university's role are drawn from a rather narrow, unrepresentative sample of quasi-URRPs. Although phenomenally successful, these two high-tech regions cannot be considered representative of the university role for the very reasons that they are most often written about: they are the product of a strong defense industry and scientific achievement that occurred in the right place at the right time.\textsuperscript{37} Moreover, the scales of Silicon Valley and Route 128 are relatively large so that any university influence would necessarily be diluted and widely dispersed, making it even harder to measure.\textsuperscript{38} Finally, as noted above with respect to Markusen's study,

\begin{itemize}
\item Interview with David Lampe, Associate Director, Industrial Liaison Program, MIT, March 12, 1993.
\item Krugman, Paul, Geography and Trade, p. 53.
\item Silicon Valley and Route 128 may not be replicable, nor should they necessarily be.
\item Our study looks at three parks of much smaller scale. Also, the firms in these parks have very little connection, if any, to the defense industry, except occasional firms that receive one-time Small Business Innovation Research grants from federal agencies in the Department of Defense.
\end{itemize}
these studies have not accounted for Stanford and Berkeley's *non*-research (or academic) university attributes -- and the associated individual connections -- which, from the firm's perspective, may be the most influential for firm growth.

Thus, on the one hand, those that champion the URRP concept, particularly as an economic development tool, may do so without the requisite knowledge about the true sources of power within the university as a resource for firms, given the difficulty in measuring the university's influence. On the other hand, those that discount the university's role may also do so without complete information. The case studies and discussion which follow seek to inform and enlighten, if not altogether resolve, this difficult question.
CHAPTER III

DESCRIBING THE RESEARCH METHODOLOGY AND EXPLORING THE FORMATION AND SITE DEVELOPMENT OF THE THREE PARKS

This chapter covers the research methodology used to carry out this study and provides a description of the three parks and their associations with the related universities. A recurring theme of this study is the diversity in the nature of park associations with universities, in the universities' intentions with respect to industry, and in the firms' characteristics. This diversity is deliberate, but it both complicates the conclusions that are drawn about the university role in firm success and, at the same time, makes the conclusions more representative.

Research Methodology

This study was conducted through a series of interviews (not surveys), so that the conclusions that are drawn arise from a hybrid of quantitative and qualitative analyses. The study was carried out in three stages. The first stage involved a selection process that consisted of a series of interviews with park managers from parks all over the country, asking questions about the park's objectives, its relationship with the affiliated university, its history, and the type of firms it promotes. From this series of interviews, and as a result of geographical and resource limitations, the field was narrowed to three parks in the New England region. Following this narrowing of the park field, additional in-depth interviews were conducted with park personnel to gain guidance on selecting which firms in the parks to interview and to learn more about the parks' services

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39 The other park managers interviewed were from parks in Ames, Iowa (Iowa State University); Madison, Wisconsin (University of Wisconsin at Madison); Orlando, Florida (University of Central Florida); West Lafayette, Indiana (Purdue University); and Logan, Utah (Utah State University). These parks were originally chosen for their geographical diversity, in addition to some of the other factors mentioned above.
and origins. Then, a series of interviews with the resident firms were undertaken, as well as interviews with university administrators, and, where necessary, community residents, to gain a full picture of the parks' history and role as it bears on the firms' relationships with the university.

Park Criteria

The three URRPs studied here are Rensselaer Technology Park (RTP) located near Troy, New York; Massachusetts Biotechnology Research Park (MBRP) located in Worcester, Massachusetts; and Science Park located in New Haven, Connecticut. They were chosen based primarily on three criteria:

- diversity in technology and in stage of development among the firms in all three parks,
- the parks' sizes, and
- the parks' relative stability and track record.

These criteria were established to make the project as representative as possible and to keep it manageable. The point of the first criterion is to ensure that the three parks together contain firms in a multiple of industries and that the study as a whole covers a range of firms, since universities provide services that are useful to a wide spectrum of industries. Thus, the firms interviewed included those in biotech, software, electronics, applied physics, and solid waste management, for instance, as well as others that are described below in more detail. As for the second criterion, the three parks are considered to be of small to medium-size, as measured by the number of firms in the parks and the number of employees working in the parks. The final criterion, the parks' stability and track record, means that the parks have been in existence for at least six or seven years and that their objectives are relatively well-established and well-known, so that the parks, the firms in the parks, and the universities associated with the parks are able to generalize about their experiences with each other.
Firm Criteria and Diversity in Firm Types and Stages of Development

Each park contains many more firms than were interviewed. Therefore, three criteria were used to select the firms to be interviewed. The first criterion was that the firms use some university services and resources (or at least there was the perception that they do). Second, the firms had to demonstrate some measure of business success and growth, either based on an increase in the number of employees working at the firm or in the amount of square feet that they occupy, since coming to or starting in the park. The third criterion was that the firms be in a technology-related product development field. The total number of firms interviewed for the study was twenty (seven in Science Park, seven in RTP and six in MBRP).

These criteria for firm selection are appropriate for three reasons. Because the focus of the study is on discerning the importance of university functions to firm growth, it is essential that the sample contain firms that were known to have a relationship with a local university. Also, it is important that the firms demonstrate evidence of some growth or positive change. Although it is difficult to quantify the importance of university services to a firm's growth, without some resulting growth by these firms, finding how universities contribute to firm growth is meaningless. Finally, since two of the parks contain non-high-tech firms, the last criterion offers a way to narrow the field (although it should be noted that it is primarily high-tech firms that benefit from an association with a university anyway.)

As noted, the firms vary by their technological fields as well as in their stages of development. The technological field and the stage of a firm's development are important to note because they can have a significant bearing on the way in which and how much a firm relies on university resources. For instance, firms that are at a more mature stage either do not need to do as much research and development (or "R&D") (presumably their product has already
been developed and they are proceeding to manufacture), or they have the resources to take more of the research in-house, which is preferable where there are concerns about confidentiality.

In the biotechnology\(^{40}\) (or "biotech") park (Worcester), the six firms are, by definition, biotechnology firms, although the interviews with the firms revealed their sub fields to be sufficiently distinguished from each other, implying that the firms are relatively non-competitive in their product development and that compatibility among different processes and products is not an issue.\(^{41}\) The majority of these firms are no more than six years old and are either still in the research and development stage or just emerging from it, as the biotechnology industry has a notoriously long startup time.\(^{42}\) The other two biotech firms,\(^{43}\) although they started over ten years ago, are just now entering the manufacturing stage on a large scale, as evidenced by their plans to begin construction on manufacturing facilities. Even those that are entering the manufacturing stage still

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\(^{41}\) See Blakely, supra., pp. 8-9. For instance, M3RP information describes these firms in the following manner: one is a leader in AIDS and other viral diagnostic markets; another develops genetically engineered bio-polymers for medical and industrial uses; the third develops and commercializes environmentally safe products and systems for the biological control of insect pests, plants and plant disease; the fourth applies anti-sense technology to the development of patentable pharmaceutical products for the treatment of major diseases; the fifth specializes in human growth factors; and the sixth uses gene transfer technology to develop specialized lab animals for medical research and pharmaceutical production.

\(^{42}\) As compared with the computer and microelectronics industries, the development phase of biotechnology products is relatively long. The average time spent by companies getting their biotechnology products through clinical trials and regulatory review is five years. See also OTA, supra. (1988) and Blakely, supra.

\(^{43}\) These are EcoScience Corporation and Cambridge Biotech Corporation, both public companies.
maintain a need for research and development; and firms at all stages maintain a need to hire well-trained employees -- both provided by the affiliating universities.

Of the firms in the other two parks, the technological focuses range widely. More specifically, they include software firms; a plasma physics firm, an electrochemical firm, a firm developing catalytic ignition technologies, a recycling and solid waste management firm; a firm developing a proprietary fabrication process; and firms manufacturing membrane modules, high performance materials for the electronic and aerospace industries, products for biotech research and for the pharmaceutical industry, radiation detection products, and enzymes for use in bio-engineering and recombinant DNA industry. As with the biotech firms, many of these firms that are manufacturing products also continue to conduct R&D at the same time. All of these firms, except for three of them, are seven years old or less. However, since the time needed for research and development varies from industry to industry, the stage of developmental maturity does not necessarily correspond with the age of the firm.

Interview Sample

The interview subjects were chosen not only for their knowledge about the institutions for which they work but also because they have an understanding of their institution's role in the URRP environment. Those interviewed include a representative from each firm who was familiar with the firm's operations; park managers, or someone of equivalent status; various university staff depending on the university's role; and community people, in certain instances, where they had a hand in the park's creation or development.

The interview sessions with these various sources were designed to elicit the following types of information: the services and resources that the university provided; the park's objectives; the firm's use of university resources; firm development; the firms' relations with other firms in the park; the firm's use of park
services; community relations with the park; technology transfer policies; and the university's view on its obligation to the park.

**Limitations of the Study**

There are two potential limitations to the data that should be noted by readers of the study: this is a limited sample of both parks and firms so that the data collected are necessarily qualitative and thus not altogether subject to quantitative verification. Also, because of the limited sample, the level of generalization from the findings may be subject to some qualifications, which are discussed later.

**The Formation and Site Development of the Three Parks**

The three URRPs covered in this study vary according to mission, degree of community involvement, university role, and type of infrastructure. However, other characteristics are similar, for example, they all rely primarily (but not solely) on multi-tenant buildings that are built and owned by the park. Moreover, although they are all primarily concerned with fostering the growth of small startup firms, financially the parks all need and have "anchor" firms -- larger companies or subsidiaries of large companies which help defray park operating costs by providing stable tenants for the park.

In order to understand their distinctions as well as their similarities, the following section describes the three parks in terms of their objectives, origins, physical attributes, statistics, (i.e. the number of firms and of employees there), technological mix, park facilities, and park infrastructure. This section also looks at how the university(s) associated with each park play a separate and distinct role, depending upon the university's participation in the park's founding; the perceived reasons that the university initially became involved with the park; and the university's educational mission.
Massachusetts Biotechnology Research Park

The biotech park,\textsuperscript{44} begun in 1984 through a city initiative and state support, is situated on a 75-acre parcel carved from land formerly owned by the state. The site is surrounded by state institutions. It is directly adjacent to the University of Massachusetts Medical Center ("UMass Medical") and to land owned by the state Department of Mental Health. Located nearby are seven other major schools (Tufts Veterinary School, the Worcester Foundation for Experimental Biology,\textsuperscript{45} the Worcester Polytechnic Institute ("WPI"), the Medical Center of Central Massachusetts, Holy Cross College and Worcester State College, and Clark University) and some community colleges, and the park is right off major state and interstate roadways.

The Worcester Business Development Corporation (WBDC) -- the non-profit organization and the primary economic development arm of the city of Worcester, which manages and owns the park -- is charged with generating economic development for the Worcester region by encouraging the commercialization of technology and the growth of the biotechnology industry. Originally state-owned land, the WBDC is bound by an agreement with the state to create an "Innovation Center" (an incubator)\textsuperscript{46} and to foster the development of

\textsuperscript{44}Except where specifically indicated, the information about MBRP is derived from the following sources: Interview with Thomas J. Andrews, Assistant Director, MBRP; Letter from T. Andrews to Chris Boettcher, Executive Director of the Association of University Related Research Parks (AURRP), August 9, 1988; and brochures published by the park or its affiliated organizations for the public.

\textsuperscript{45}The Worcester Foundation is starting its own biotech park, the primary objective being to raise revenue to support research at the Foundation. The park will contain primarily single tenant buildings that are suited for larger companies, and, thus, it says it will not be competing with MBRP, whose focus is on smaller, startup companies. Interview with Donald Megathlin, Assistant to President, Worcester Foundation.

\textsuperscript{46}The innovation center, which is run by MBRI and is just starting in 1993, will support very early stage firms for six to 24 months. In return, MBRI gets a piece of equity in the company ranging from 5% to 35%. The center contains the typical incubator facilities, office space, conference rooms, hot and cold rooms, a dark room, and access to a preferred provider network and an advisory group of business leaders.
the biomedical and high-tech industries. In the same year, the state designated the park as its "Center of Excellence" in biotechnology, which made it eligible for certain state funds. This mission guides the park in its endeavors and in its relationships with the surrounding universities.

The park contains three multi-tenant buildings (called One, Two and Three Biotech), with a fourth (Four Biotech) that is pre-leased and under construction. The multi-tenant buildings range in size from 80,000 to 115,000 square feet, so the park will have a total of 325,000 square feet to lease, and are three to four stories high. (See Exhibit A.) The buildings are outfitted for biotech firms, with wet and dry laboratories and darkroom space, which are vital to biotech firms. All of the multi-tenant buildings were built by the park and financed primarily through a consortium of local banks, although the park's infrastructure was financed through state grants. The park's zoning is based on the National Institutes of Health guidelines, which mandate safe biotechnology operation and disposal techniques.

A small, 10,000 square foot building is situated between One Biotech and Two Biotech, containing the Central Massachusetts Magnetic Imaging Center, which is used for biotech related research and clinical diagnosis. The park also contains a "park center," consisting of an inn and restaurant and other service amenities (bank, jewelers, and other commercial vendors) totaling 80,000 square feet. The park significantly altered its master plan to accommodate the first firm to

47In a "Land Disposition Agreement," the WBDC specifically agreed to devote the use of the property to "medical or technological related purposes" such as medical optics, pharmaceutical research and biotechnology and bioengineering.
48The city of Worcester has received two $1 million Community Development Action Grants from the state to fund park infrastructure improvements and a $1 million federal Economic Development Administration grant. Letter from T. Andrews, WBDC to C. Boettcher, AURRP.
49UMass Medical now owns the Two Biotech building where its Program in Molecular Medicine is located.
construct its own building on the park site and will act as an anchor for the park. Where the BASF building is being constructed, the park had planned five 100,000 square foot multi-tenant buildings. The building will ultimately contain 500,000 square feet of usable space and is scheduled for completion in 1993. Currently, there are almost twenty firms in the park and close to 700 employees. The park is not tax-exempt and thus pays full property taxes to the city of Worcester.

The multi-tenant buildings are all accessible off of a main access road (Plantation Street) that comes off of Route 9. The BASF building is located on the other side of the park off of a different access road. The original three Biotech buildings were built with 2.5 parking spaces per 1000 gross square feet, pooled around each building. This ratio turned out to be too low, and the park has determined that 3 spaces per 1000 is preferable. The park plans to add structured parking for Three Biotech at $5000 to $8000 per space.

Although it bills itself as a university related research park, the WBDC is not in the business of brokering ties between the university and the firms. In order to remain successful as an economic development "engine," the WBDC runs the park almost strictly as a real estate venture that is mostly attentive to the bottom line\(^50\) -- sometimes at the expense of cultivating ties with the universities.\(^51\) From the point of view of the WBDC, the universities are marketing tools that the WBDC uses as another resource to attract potential tenants. There are other park institutions that have a more active role with the universities, although they are not relationships that promote the firms' use of the university resources.

\(^{50}\)The park leases space at $9 per square foot per year, without utilities and taxes, and offers debt financing for tenant improvements of up to $60 to $70 per square foot, which is amortized over the term of the lease.
\(^{51}\)According to the park's assistant director, the WBDC leased space in Two Biotech to UMass Medical at a profit which caused some ill-will.
The relationship, then, between the universities and the biotech park has been somewhat ill-defined. Although the universities were involved early on with community leaders in the park planning, the universities never formalized their links with respect to the biotech park either in an ownership capacity -- as in the case of RPI and RTP -- or as investors -- as between Yale and Science Park. Moreover, the universities had self-interested motives for supporting the park plan. For instance, with the increasing "brain drain" problem of good faculty from the area, most of the universities were looking forward to the firms in the park presenting faculty with opportunities to supplement their teaching income. The universities also looked favorably at the park as an opportunity to provide a vehicle for joint training ventures among the universities, ventures that would aid the universities in recruiting faculty and in upgrading their training programs. Thus, the universities on the whole had incentives to support the park, but their associations with the park today remain unstructured, except where the universities rent space from the park or where the Massachusetts Biotechnology Research Institute (MBRI) performs technology brokering services.

It is worth noting, however, that UMass Medical has taken a somewhat different, less salutary attitude toward the park than the other local universities, which more importantly has resulted in less fruitful contact between UMass Medical and the firms in the park. Although the chancellor of UMass Medical

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52 High ranking university administrators from the various universities routinely sat on the Worcester Chamber of Commerce and on the board of the WBDC. Also, according to local leaders, the universities were cooperative in getting the park off the ground through in-kind contributions, such as offering facilities, help from their personnel and development departments and access to scientific advisors. Interview with Dr. Abraham Haddad, Periodontist and Member, City of Worcester Chamber of Commerce. Haddad also says that Clark University actually donated $25,000.

53 UMass Medical does basic and clinical research under the Program in Molecular Medicine in the park; and WPI operates magnetic resonance imaging equipment in the park.

54 Several different interviewees who preferred not to be named have noted that the relationship between UMass Medical and the park has been traditionally cool. Historically, there were individuals at UMass Medical that opposed the transfer of the land from the state to the city,
serves on the WBDC board, UMass Medical views its mission as not to encourage economic development or to benefit the community but strictly to teach students and conduct research.\textsuperscript{55} UMass Medical further declined to take advantage of the technology transfer services offered by the park's technology transfer offices, the non-profit MBRI.\textsuperscript{56} As a result, firms in the park have been inhibited from looking to UMass Medical for assistance, and few firms in the park have benefited from the large amount of research opportunities at UMass Medical, although some firms do conduct clinical trials there. However, there are signs that this policy might be changing, as UMass Medical plans to appoint an official technology transfer officer.\textsuperscript{57}

The park infrastructure has also facilitated some interfirm links in the park, however, which firms noted in interviews. MBRI provides the umbrella organization for the interlocking boards and investments that in part generate an informal network of relationships among firms in the park. Commonwealth Bioventures Inc. (CBI), a venture capital group that provides money for biotech ventures, was originally part of MBRI, but in 1991 MBRI spun out CBI to operate independently because the return on CBI's investments was too great for it to maintain its non-profit status. As a result of crucial seed money that CBI provided for at least two firms in the park (TSI and Alpha Beta), the CEOs of these firms now serve on the MBRI board and offer time and resources for MBRI's because they thought the land belonged to the university. On top of that, the university feels it has not benefited from the state's generosity and from the park's physical proximity.\textsuperscript{55} Interview with David Entin, Director, Office of Research Administration, UMass Medical. \textsuperscript{56} The MBRI was created by the WBDC specifically to spawn new biotech businesses and to "promote industry/academic partnerships," thus providing some structure to the universities' association with the park. MBRI will deal not only in biotechnology and, thus, will not be looking for licensees only among park firms. However, the head of the technology transfer office asserted that the office aids the park firms indirectly because it contributes to the overall image of the area as a "hotbed of technology" so that banks are more comfortable lending to firms in the park. Interview with Mason "Skip" Irving III, Vice President, Commercial Development, MBRI and head of the Unified Office of Technology Transfer located at MBRI. \textsuperscript{57} Interview with D. Entin.
educational component. Also, because CBI retains an investment in these firms and because CBI's profits continue to fund MBRI, MBRI, in its technology transfer role, has some incentive to help out these firms by sending some technology in the direction of these companies.

Rensselaer Technology Park

Located in the town of North Greenbush in upstate New York, five miles south of the Rensselaer Polytechnic Institute (RPI) campus and four miles from Interstate 90, the park is situated on land owned by the university. RPI owns a total of 1250 acres, although only 450 acres have been rezoned for industrial use for the park so far, which permits light manufacturing as well as research and development to go on in the park. The master plan for the park envisions that eventually the park will include a housing component comprising 150 acres adjacent to the technology component; a riverfront component consisting of 150 acres for a hotel/conference center, marina and recreational facilities; and open space of approximately 500 acres between the riverfront and the upland area.

The park currently contains nine 20,000 square foot multi-tenant buildings and seven single tenant occupant buildings, which are constructed by the tenants and held under a ground-lease agreement. The multi-tenants range in size from 25,000 to 30,000 square feet. The parking is pooled around each building, and there are 3 to 4 parking spaces per 1000 square feet. The buildings are accessed from a main road that winds through the park. (See Exhibit B.)

RPI "donated" the land for the park; it also invested $3 million from the institution's endowment for the park's infrastructure and operating costs. (Today, the park generally breaks even; when there is a surplus, the excess goes back to

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58 MBRI will also offer training programs for science teachers in the community, so as to better prepare students for work in science fields. Eventually, the director of the technology transfer office says, the office will expand to offer its services to non-local universities as well.
the university and when there is a deficit, then the university will make up the
difference.) Five of the multi-tenant buildings have been financed through
industrial revenue bonds issued under the auspices of an industrial development
agency, the others through conventional mortgage financing. Eventually, the
park hopes that the rent from the firms in the multi-tenant buildings will support
the park, because rent is more predictable income than the ground lease deals."

The park also contains a quasi-incubator, which it calls the Advanced
Technology Service Center, that leases space to approximately 20 firms, including
a number of service and consulting firms. In total, the park currently has almost
40 firms -- four of which are large firms employing 100 people and up -- for a total
employment of about 1200. (Two of the large firms, branches of NYNEX and
Metropolitan Life, employ over 250 people.) The composition of the park firms is
largely high-tech with a few service firms (advertising, marketing) mostly located
in the incubator. Initially, the park considered that its market would be mostly
"IBM-type" companies. However, this changed when the park administration
recognized that "the real tradition of the area is small business."60

RTP's relationship with its client university is distinguished in at least one
way from the other university-park associations in that the RPI-park relationship
and, ultimately, the RPI-firm links are much more straightforward. The "tech park"
is a department of RPI and an integral part of RPI's educational mission, and,
thus, it and the tenant firms receive direct attention from the university. The firms
in the park are encouraged by both the park and the university administration to
interact fully with faculty and students. RTP's goals are driven by its status as a
component of the university's educational mission and by economic development

59 Interview with Michael Wacholder, Director, RTP.
60 Ibid.
objectives for the region that the university set forth when it originated the park concept.

Based on a vision for RPI laid out by former RPI president George M. Low, the park is part of a long-range university plan to develop opportunities for student involvement with business, industry and government; to encourage faculty to establish and maintain contact with industry; to make an effort to attract high-tech firms to the region; and to provide opportunities for faculty and students to have practical experiences with industry.61

In support of these objectives, this long-range plan set up a "model for innovation" that includes three other components besides the park, all on-campus: an incubator;62 interdisciplinary Innovation Centers,63 which promote industrially-oriented research; and a technology management and entrepreneurship educational program, which includes some courses in which students work on innovative problems in real companies (often in the park) and other courses that teach the principles of entrepreneurship and practical business planning. Together, the four elements of this model are designed to further academic-industry cooperation and links.

Theoretically, the park firms are supposed to benefit from the on-campus components of the model. For instance, the innovation centers are important to the firms in the park, because they provide facilities and equipment for use by the firm employees or professors under firms' sponsorship. Bringing industry onto

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62 This is discussed in detail in Chapter IV.
63 The Center for Industrial Innovation (CII) is the local point for Industrial-related research. Its construction was funded by a $30 million interest free loan from New York State that was matched by RPI. The CII houses four centers, the Center for Manufacturing Productivity and Technology Transfer, the Center for Integrated Electronics, the Center for Advanced Technology In Automation and Robotics (sponsored by the state of New York), and the Center for Intelligent Robotic Systems for Space Exploration.
campus, as the Centers and the incubator do, is designed to generate a high degree of interaction between academic researchers and firms. Under the model, applied research work done in the Center for Industrial Innovation (CII) should lead to the creation of new technologies that lead to creative entrepreneurial insight, resulting in firms started by faculty and student researchers in the incubator, firms that ultimately move to the park. Since over fifty percent of the research at RPI is sponsored by large corporations,64 Professor Pier Abetti, professor of management at RPI and the primary author of the innovation model, calls this "stealing from the rich." According to Abetti, the result is a transfer of research from the big companies to the small companies that are started by faculty and students growing out of ideas stimulated by the research that is being done for large companies. "Technology multiplies, this is not like a restricted pie," Abetti states.65

In the educational program, there are technological entrepreneurship, market research, and management courses that feed into the model. Through their coursework, students work with companies to solve business problems. The companies, then, receive free consulting advice (except for out-of-pocket expenses) from students on business planning or accounting, typically worth $3000, that they would otherwise be unable to afford. Abetti says the courses have helped forty companies in four years, and 150 students have passed through these courses. Then many of the companies hire students. A compulsory marketing and entrepreneurship practicum is being introduced in the program.

64 Interview with Mark Rice, Manager Director, Center for Entrepreneurship of New Technological Ventures, Rensselaer Polytechnic Institute. At most universities, the amount of research sponsored by corporations is less than 10%. The balance is funded by government.
65 Interview with Professor Pier Abetti, Professor of Management of Technology and Entrepreneurship, School of Management, RPI.
The components of the model are not entirely well-integrated. While the on-campus links between the incubator and the Centers and the links between the Centers and the park firms are both relatively strong, the incubator-park links appear to be the weakest in the model. Two-thirds of the companies in the incubator grow out of an RPI connection. However, as between the park and the incubator, the incubator has only fed six out of fifty firms to the park, and no incubator firms are currently tenants in the park. In order to formalize the relationship between the faculty and the RTP and the incubator, RPI started the Center for Entrepreneurship to integrate the school of management and engineering faculties with companies. Now, when companies need help, the park and incubator directors theoretically refer them to professors that give them help initially free of charge. In reality, companies rely more often on informal connections than these references.

The park's contributions to the area are difficult to measure. Eighty percent of the firms in the park come from the local area to begin with, although the park does pay taxes to the town. In 1985, the town supervisor estimated that after three years of operation, the park had added $5 million to the assessed valuation of town property.

Science Park

Science Park occupies 80 acres in the middle of the Dixwell and Newhallville neighborhoods in a blighted area of urban New Haven. Although called a research park, of all three parks, Science Park is most like an incubator, because of the services (shared) and benefits (flexible rent rates) it provides to all its tenant firms. The park is committed to two main goals: (1) developing high-tech businesses and (2) contributing directly to the development and stability of

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66 ibid.
67 Little Report, p. 43.
the surrounding neighborhood. The original partners in this endeavor were Yale University, the city of New Haven, and the Olin Corporation, whose buildings the park currently occupies. However, as the park has evolved since its founding in 1982, the roles of these various partners have changed, and more recently the State of Connecticut has devoted additional resources and attention to the park.

The buildings in the park were originally occupied by the Olin Corporation, which conducted manufacturing and research activities on the site, including the production of Winchester rifles which continues today. When the Olin Corporation decided to close down its New Haven operations in the early eighties, it consulted with Yale and the city of New Haven about the future of the site. It was proposed that the site be devoted to the development of a high-tech park for established companies and startup companies that would result in employment for residents in the surrounding neighborhoods. Together, Olin, Yale and the city created a non-profit entity called the Science Park Development Corporation (SPDC) to manage the development of the site and to carry out the park's missions. The SPDC actively manages the park, responding to tenant firm requests, and promotes community development.

The park's physical layout remains much as it stood when Olin left the site, although increasingly the buildings are being renovated or razed to make way for new construction. Winchester Avenue, a New Haven city street, is the main thoroughfare for the park, which is bordered by Division and Munson Streets on the north and south and Shelton and Prospect Streets on the east and west. The park is gated at both ends of Winchester with security guard booths marking the entrances and exits. (See Exhibit C.)

68 Interview with William Ginsberg, Director, Science Park Development Corporation.
69 SPDC publication.
In order to further its first goal of developing high-tech businesses, the SPDC has developed two large multi-tenant buildings (called Buildings 5 and 25), of three and six floors respectively and totaling 260,000 square feet, as incubators for startup firms. Building 25, the six floor, U-shaped building, contains lab space on portions of three of its six floors.\textsuperscript{70} The park has plans to renovate six to eight free-standing empty buildings, ranging in size from 5000 to 17,000 square feet, to be devoted to light manufacturing for graduates of the incubator and other manufacturing firms. The current incubator buildings are 80% occupied, containing approximately ninety to one hundred firms and employing approximately 1200 people. The incubator space is filled with a mixture of high-tech and non-high-tech, service related firms, including consulting, advertising, public relations, and real estate development firms, as well as several community development organizations that work with the SPDC on community issues. The park also contains two large non-high-tech companies, which act as anchors for the park;\textsuperscript{71} representatives from several state fund programs to help businesses with capital needs and other resources; and the city has a jobs placement office there. The parking is scattered, pooled for Building 5, but only on-street parking is available for Building 25.

As is common for incubator space, the park provides flexible lease terms to the firms in the multi-tenant buildings, ranging from $6 to $12 per square foot per year, which include utilities, security, parking, property taxes and janitorial services. There are other shared services that the park offers such as one free consultation with a business planning firm, an answering service and hook up with a central telephone system.

\textsuperscript{70}Building 25 is actually across the street from the gated area.
\textsuperscript{71}The "anchor" companies are U.S. Repeating Arms, which is expanding its operations into a new building being constructed for them by the park, and Sonecor, a division of Southern New England Telephone (SNET). Together, these two anchors employ almost 700 people.
Since the park's initial development, the state's role has expanded. In 1990, when the size of the park's debt had grown so that it cast doubt over the park's ability to survive, the state stepped in and committed $12 million to the park. The state's intervention here into the park's financial operations was part of a larger state plan to focus on the high-tech industry as an economic development strategy for Connecticut, incorporating the park as a central part of this strategy, for attracting high-tech firms, increasing the state's high-tech industry and creating new jobs. Alongside this focus on high-tech industries is the state's intention to encourage Connecticut's universities, particularly Yale, to be "more entrepreneurial" and to generate a "cultural change" with respect to industry at Yale and other universities.

Yale promoted Science Park early on with loans and by lending its name and public support to the project. Nevertheless, Yale's role with respect to the park has remained relatively ill-defined. It has supported the park financially and also loaned money for local community projects that are being undertaken as joint ventures between the park, the federal government and community groups. In fact, the park is often cited to be "Yale's largest local investment," having invested up to $3 million, according to park sources. Still, other than its limited financial role, Yale's primary links to the park are informal through faculty and graduates that are involved on the firm level. The Office of Cooperative Research, the office charged with performing a liaison role with outside industry, only deals

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72 Previously, the difference between the SPDC's operating costs and its income had been made up for by small grants from the state and loans from Olin and Yale.
73 Interview with W. Ginsberg.
74 Interview with Ted Carnavales, Deputy Director, Center for Theoretical and Applied Neurosciences.
75 The first executive director of the park was the former Dean of Students and Secretary at Yale, Henry Chauncey, Jr. Chauncey left the university to take over responsibility of the park.
76 Interviews with W. Ginsberg and Paul McCraven, Vice President, Community and Government Relations, SPDC.
with at most 5% of the firms in the park on an annual basis, and the director of the office expresses some frustration with the park "not identifying what it wants out of Yale."\textsuperscript{77}

Yet, two park-related projects may be a harbinger of some movement in Yale's involvement with the park and with industry in general. The first is a multidisciplinary research and development center in the neurological sciences, called the Center for Theoretical and Applied Neurosciences (CTAN), to be located in part on the Yale campus and in part in a building in the park, specially rehabilitated for this purpose. The second is Yale Medical School's stated commitment to planning a biotech park in cooperation with SPDC.\textsuperscript{78}

The CTAN park facilities, scheduled to open in the Spring of 1993, include a high-powered computer network, a confocal laser scanning microscope, and an image analysis system, which will all be leased for industry use on a contract basis. CTAN, which will bring together scientists from neuroscience, pharmacology, psychology, as well as the computer sciences, is a hallmark project for Yale, in that it represents the first time that Yale has committed to doing significant research off-campus.\textsuperscript{79}

Science Park's other goal, to contribute to the development and stability of the surrounding neighborhood, is reflected in the intensity of its community outreach efforts.\textsuperscript{80} As compared with the other parks, Science Park's development efforts are more community-based. Because of the nature of the neighborhood surrounding the park, Science Park has received federal and state

\textsuperscript{77}Interview with Bob Bickerton, Yale Office of Cooperative Research.
\textsuperscript{78}The state has nominated the SPDC to craft a master plan for a second park in New Haven focusing on the biotech industry and is being done with support from the state (a $350,000 planning grant). The site is along Route 34 near the Yale Medical School.
\textsuperscript{79}Interview with W. Ginsberg.
\textsuperscript{80}Interview with P. McCraven.
grants and loans from private non-profits to institute jobs and housing programs and community improvement plans under the auspices of the park administration.

Even though these community development efforts occasionally benefit the high-tech firms in the park, the park administration estimates that of the 1200 jobs in the startup firms in the park, only ten percent are filled by neighborhood people. In order to increase the number of local employees, Science Park hopes to lure more labor intensive companies to the park -- which typically are not high-tech firms. This may demonstrate a tension in Science Park's objectives -- between promoting community development and generating high-tech firms -- which could result in a reduction in the park's effectiveness in pursuing either, particularly without the extensive support the state is providing.

Conclusion

As we see, the very descriptions of the parks' origins and objectives form the context for a relationship between the universities and the parks, between the universities and the firms, and for the growth of high-tech firms in the park. The next chapters will explore how these relationships are played out within these structures and whether there are prescriptive answers for involving the university with the park at the start of the parks' formation and development.

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81 The park is part of the New Haven Partnership for Community Development, which receives funding from Seedco (a Ford Foundation funded entity) to rebuild housing stock and renovate a school. In a symbolic move, Yale has invested $200,000 in each multimillion dollar project that the partnership has planned.

82 One federal program, called Project Jobs, provides funding through a Health and Human Services grant to the park, which then loans the money to companies, as long as the companies promise to fill a specified number of positions with low income neighborhood people. Twelve park firms have benefited from the program, and a total of 97 new jobs were created (including jobs with one company outside the park) in the first year (1991-92).
CHAPTER IV

FINDINGS ON UNIVERSITY/PARK CONTRIBUTIONS TO FIRM GROWTH

This study of RTP, MBRP, and Science Park uncovered resources and services that assist firms' growth. These resources and services are of two types: the resources of the university and the services of the research park. By making this distinction, it is easier to understand and compare the relative influence of each resource or service. To be sure, there are many factors outside of the university and URRP context which contribute substantially to a firm's growth and success. The purpose of this section of the study is to isolate the university and URRP factors and evaluate their importance to the client firms, as well as to understand how these resources and services are provided at each different park. This analysis will be done by defining each university resource and park service, describing how each resource or service is provided, and evaluating its importance to the firms.

University Resources

There are a variety of resources that a university can make available that potentially contribute to the growth of high-tech firms. RPI represents the most aggressive of the three universities in taking proactive steps to create a structure that will facilitate the flow of knowledge and technology from the university to industry as well as to attract money and other resources into the university for research projects. Yale's chosen position as a self-contained "ivory" research tower has heretofore prevented it from opening its doors to industry in either direction, except on a case-by-case basis. UMass Medical is restricted in its relations with industry in part by its status as a state university and in part, according to some observers, by the arms' length relationship it maintains with
industry; and the Tufts Veterinary School and the Worcester Foundation appear to encourage tepidly the development of working relationships with firms.

Thus, a university's role can range from being a sort of "two-way transfer station" vis-a-vis industry for research and knowledge, to being an isolated research institution that explores knowledge for knowledge's sake. These different attitudes taken by universities toward industry are reflected in the resources that each university makes available to firms. (See Exhibit D.) This range of resources can be broken into five categories, which are:

- knowledge generation through sponsored or joint research;
- providing physical facilities, such as laboratories, library services, computers, and equipment;
- identification and supply of personnel, such as students and/or professors as employees or consultants;
- education (academic mission); and
- technology brokering in the patent and/or licensing process.

(1) **Knowledge Generation**

The university resource most commonly believed to be beneficial to firms is that of generating knowledge through industry-sponsored or joint research between faculty and industry. Sponsored research happens in a similar way from university to university and occurs when a firm financially supports basic research to be done by a professor (and Ph.D. students working under the professor) in his or her lab at an academic or research institution. Joint research occurs when a professor and representatives from a firm work together on a research project. Typically, both the sponsored and the joint research are in an area of interest to the professor, and, in addition to increasing the firm's knowledge base, the money
also generally serves to underwrite the professors' laboratory operations, overhead, and other costs incurred by the professor. This underwriting provides the opportunity for faculty to do research they would most likely want to do anyway. The research needs of high-tech firms, which are the firms that are the focus of this study, run along a continuum, ranging from basic to applied research to research supporting product commercialization. In the case of small startup firms, sponsored research is undertaken most often in the firm's initial years, in the development of basic research that might have a practical application.\textsuperscript{83}

With sponsored or joint research comes the question of ownership of the intellectual property. Should a discovery be made in the course of joint or sponsored research, who owns the patent -- the university, the professor, the firm, or all three? The different contractual approaches to resolving this question are reviewed later in the discussion about university technology brokering. Suffice to say here, that a liberal patent policy allowing individuals and firms to retain substantial ownership of patents to discoveries made during jointly sponsored research, regardless of the place of the discovery, encourages joint or sponsored research with university personnel.

Seven of the twenty firms interviewed had sponsored or were sponsoring research at a local university.\textsuperscript{84} In the case of at least three of these firms, sponsored research was no longer being done but had occurred early in the development of the firm. Perhaps equally important is the fact that we found an additional five firms that do sponsored research at non-local universities. Among the firms currently doing sponsored research with local universities, two of them

\textsuperscript{83}Mostly, it is the government that sponsors research at universities, largely funded through NIH (in the case of biotechnology), or the Department of Defense, depending upon what the research objective is. Large corporations also sponsor research at universities (usually less than 10%), although the benefit to the corporations of this usually basic research is disputed.

\textsuperscript{84}For purposes of this study, a "local" university is considered to be located within five miles of the URRP. Two of these firms were sponsoring research at non-local universities also.
(the biotech firms) are between three and five years old.\textsuperscript{85} The other firms are older (six to twelve years old). Joint research \textit{per se} occurred more rarely among firms in our sample. Only one firm specifically identified having undertaken joint research with an associated university.

The value of sponsored and joint research for startup firms can vary, but generally, firms sponsor research in order to "leverage" their existing resources.\textsuperscript{86} Firms view this leveraging as important, because it is a way that smaller companies can be "competitive" with larger companies, in terms of "expertise" and "sophisticated capabilities."\textsuperscript{87} Firms will often sponsor research in anticipation of filing a grant application or when they need someone to do research in a discrete area of expertise. Typically, the firms studied here would use sponsored research when applying for a Small Business Innovative Research (SBIR) grants\textsuperscript{88} or the like. Then, collaboration with outside scientists lends credibility and scientific depth to the proposal. Moreover, if the firm receives the grant, the scientist will help carry out the work, and the funding will benefit the general research operations of the university laboratory. These grants often provide the crucial piece of funding that sustains these startup firms in the early stages and, without sponsored research, firms might be unable to apply for them.

Thus, the findings here bear out what was noted above: that it is in the early stages of a firm's development that sponsored research (or joint research)

\textsuperscript{85}The phase "early stage of development" implies different time periods for different industries. In the biotechnology industry, the first cycle of development can last as long as seven years, which is the average time it takes to bring a product to market in that field.

\textsuperscript{86}As one firm in the MBRP describes it, "Academic places are an extension of the company's R&D (research and development), it is a way to leverage the company's resources." Interview with MBRP firm.

\textsuperscript{87}Interview with RTP firm. Six firms unsolicitedly stated their opinion that the best use of the university is as a leveraging source. Among other firms, their use of university resources reflected their intention to leverage the firm's existing capital resources.

\textsuperscript{88}SBIR grants were obtained variously and at different phases from the Department of the Air Force, the National Aeronautics and Space Administration (NASA), the Department of the Army, the Environmental Protection Agency (EPA), and N/H.
plays the most important role. Overall, then, in balancing the relatively infrequent use of sponsored research by firms at local universities and the limited time period in the firm cycle in which it is useful, on the one hand, with the important role that sponsored research plays in starting up many types of high-tech firms, on the other hand, we conclude here that sponsored research is of moderate significance to firms.

(2) Physical Facilities

A second category of resources offered by universities is access to its physical facilities, such as laboratories, library services, computers, equipment, and even athletic facilities. The use of the university's laboratories and equipment occurs in the course of sponsored or joint research. However, this functional category does not include those uses; instead it refers to those instances in which firms rent university lab space or lease the use of certain equipment located at the university, so that firm employees actually work in the lab or operate the equipment. Generally, firms rent the lab space or the equipment on an hourly basis. Sometimes firms use expensive equipment on a "time share" basis or have joint ownership of the equipment. This is useful particularly for firms in their nascent years where the equipment is extremely expensive. Firms also use university libraries and computers as part of the URRP relationship. They are given access to the libraries or computers through a card or password, sometimes for a fee.

At Yale, there is actually a paucity of lab space, so that there is no extra space to be leased by park firms.\textsuperscript{89} Also, none of the firms have access to equipment at Yale -- although this may change in the future with the siting in the park of the new Yale center containing new equipment for use by outside firms.

\textsuperscript{89}Interview with B. Bickerton.
In the two parks, then, where lab space and equipment in local universities are available, five firms out of thirteen rent either lab space, equipment or both. Two of those firms (both in RTP) believed that renting these facilities was crucial to their development. Use of library, computer and athletic facilities occurs in the case of fourteen of the twenty firms, which makes this the most frequently used resource, so it must be dubbed important -- and all but one of the firms stated they used the library frequently (that is at least once a month, and most used it at least once per week). Overall, we conclude that the university's physical facilities are of moderate significance to firms.

(3) University Personnel

The third function, that of supplying personnel for employment in the firms, appears to be one of the most important components of locating near a research university. For purposes of this study, supplying personnel for employment in firms occurs when a university's graduates and faculty members are hired on a part-time, temporary or full-time, permanent basis by firms in the park. The advantages of the labor supply studied here is that generally it is, by definition, well-trained and knowledgeable. Many of the firms in the parks also hire graduates of the local community colleges as lab technicians, but these hirings are not included in the count below.

Thirteen out of the twenty firms in the three parks stated that they hired graduates from the local universities to be permanent employees; and eight of these firms hire students on a part-time basis as interns. Those firms that employed graduate students from the local schools usually hired more than one and did so routinely. Although not noted in the interviews by firm executives as
crucial to their development, the frequency with which these firms hire graduate students points to it as an important function of the university.⁹⁰

Professors acting as consultants also proves to be important for two reasons, although again in most instances firm executives do not stress this as a pivotal component to their firms' growth. First, it also occurs relatively frequently (in twelve out of the twenty firms); second, the consulting function performed by professors continues throughout the life of the firm. It is not limited to the early stages of a firm's cycle. At the startup stage, it is cost-effective for a firm to hire knowledgeable academics on a project by project basis; and later, as the research becomes more applied (and probably goes in-house, as it often does), then the professor is hired to intervene as a consultant providing specialized expertise in crucial but discrete moments in the transition from the research to the commercialization stages. In conclusion, then, supplying personnel would seem to be a very important resource that universities offer. Based on the number of firms that draw upon graduates and professors and the duration of the contacts, supplying "personnel" for employment proves to be a very significant function that the university provides.

Proximity to the university and association with professors also confer prestige on these fledgling firms. Although difficult to measure, it remains valuable to many firms. The image of being associated with world-renowned research and technical institutions, such as RPI, Yale, and the UMass Medical/Tufts/Worcester Foundation group, was noted by almost all the firms in two of the parks, specifically, the firms located in RTP and Science Park. They noted that being located in a park bearing the name of a prestigious university bolsters their image, particularly among non-local clients and potential

⁹⁰In addition, half of the firms found that they hired lab technicians from the community colleges.
employees. For high-tech firms, the image of being associated with a top research university is meaningful -- particularly in the case of small startup firms where their mailing address may grant them additional cachet in the business world.

(4) Educational/Academic Mission

The educational function, such as classes and degree programs, is one that sometimes gets overlooked in the discussion about technology transfer or about university links with firms, because it is assumed that the university's educational/academic mission is unrelated to any links that are promoted between the university and industry. On a first look, this may be true, and our findings indicate that in only three firms did employees take classes at a local university, although, in the case of RPI, where entrepreneurship is part of the university's philosophy of education, the links that derive from its educational function are unusually strong. Three of the seven RTP firm executives reported

91 The location of firms in the parks also may serve as a plus for attracting potential employees in the same way that several universities observed they serve to help them attract faculty.
92 The "cachet" may also work the other way. In several interviews with university representatives at the three parks examined here, as well as with other university administrators at other parks not included in this study, one of the primary motivations for creating a research park for a university was to help attract and retain faculty, particularly in the more remote locations, such as at Purdue University in West Lafayette, Indiana, Iowa State University In Ames, Iowa, and University of Wisconsin in Madison. According to these university employees, the incentives for faculty are that they have the opportunity to work outside the university, thus providing extra income and real-world applications for their work. Also, a proximately located research park provides greater opportunity for employment of the spouses of faculty that a university is trying to lure. This may work similarly for the firms in the park, in that the existence of a park and the conglomeration of firms located there may in fact also make it easier for the firms to attract top-notch employees who find appealing the existence of work opportunities for their spouses and the community of high-tech companies with the potential for exchange and increased learning. If this proves to be a factor at all, then the use of the park to attract employees is a more important factor among parks that are relatively isolated, such as the one in Troy, than for the other parks.
that their employees had taken classes at RPI or obtained additional degrees there.\textsuperscript{93}

However, essential informal interactions take place in the context of the university's academic mission. They include access to alumni and connections made with professors or graduate students that occur through preexisting individual associations or personal connections. One interesting finding from this study is that the most active informal networks occur among firms in the two parks (Science Park and RTP) where a high number of firms founded by faculty or university graduates (often called "spin-offs") exist. The faculty and graduate students maintain ties with their academic departments and take advantage of their preexisting personal contacts for the benefit of the firm's growth. At RPI, an educational organization called VARPI (Venture Affiliates of RPI) sponsors breakfast meetings six or eight times per year and seminars that cover legal and other issues of concern to startups. Five to ten RTP companies belong, along with twenty to twenty-five companies in the community; and the firms in RPI's "incubator"\textsuperscript{94} are automatic members and their dues are included in the rent rates.\textsuperscript{95} VARPI is an educational benefit put together by the entrepreneurial and management faculty team at RPI, and it offers firms an opportunity to network with other firms, to meet professionals and to get access to RPI students. Three of the RPI firms interviewed noted its importance as a source of development.

Of our three parks, these informal networks occur most often in RTP and Science Park, where collectively more than half (eight) of the firms were founded by faculty or university graduates. Of the MBRP firms, only one was founded by a

\textsuperscript{93}The anomalous commingling of Rensselaer's educational mission with entrepreneurialism to foster university-industry links and its importance to firms' growth will be explored in greater detail in the next section.

\textsuperscript{94}The RPI Incubator is discussed below.

\textsuperscript{95}Interview with M. Rice.
scientist associated with one of the research institutions (the Worcester Foundation). That firm’s relationship with the Worcester Foundation remains extremely close, described as “familial” by one firm employee, in that the firm employs up to ten consultants from WF at any one time.

The Science Park and RTP firms credit their informal, personal associations with leading to a number of important, more formal relationships that have assisted their firms’ development and growth, including faculty as board members, sponsored research done by former colleagues of an RPI faculty member, financial support from other university alumnae, university administrators acting as advisors to firms, finding graduates to hire and specialists to perform discrete studies or technical work for a firm, and knowledge about the university infrastructure that leads to money-saving hiring and purchasing decisions that can be made through the university. In each of these instances, firm representatives concur that the hiring, the research, the advice, or the financial support would not have come about through more formalized channels.

For instance, ten RPI faculty members who are knowledgeable about membranes but who are all from different disciplines now sit on the board of a park firm that was founded by an older RPI alumnus, and six different faculty are doing sponsored research for them. Another firm, founded by a former RPI professor, has the professor’s colleagues undertake sponsored research for the firm and uses “millions of dollars of equipment” at the Center for Integrated Electronics, located in the CII. The firm, which has grown from three employees to twenty, hires one-third of its employees from RPI and often sends employees back to RPI for their Ph.Ds.96

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96 Interviews with two RTP firms.
The firm held up anecdotally as the paradigm of a successful product of the RPI model is MapInfo Corporation. MapInfo was started seven years ago by undergraduate students who, in the course of filling their requirement for one of the entrepreneurship classes, came up with a workable business plan. Their plan was recognized by RPI faculty as having potential, and the faculty found them space (not in the RPI incubator) and initial seed money as well as extensive moral support and business advice early on. Today, the company has 140 employees and is listed as one of the fastest growing entrepreneurial companies in the country by Inc. Magazine. The firm has grown too large for its space in downtown Troy and will be moving into a 40,000 square foot building that they are constructing in RTP; one of the firm founders stated that they wanted to move to the park because they wish to maintain the very important personal and professional ties they have to RPI. An RPI trustee as well as faculty serve on the company’s board, and the company continues to employ recent RPI graduates as well as older RPI graduates that move back to the area.

Another park firm founded by a 1982 RPI graduate moved to RTP after experiencing failure and bad advice. The firm's president acknowledges that, in moving to the park, he "turned to his roots [at RPI]" and that "the park took him under its wing." He found a new circle of advisors in various RPI faculty and administrators whom he calls "stakeholders" in his company, including the former director of the incubator who is currently director of the Center for Entrepreneurship, and others. The firm's gross sales are now $5 million annually, and it employs fifty-five people. The firm also subcontracts some work to a startup software company in the incubator center, and it looks to the Center for

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97 MapInfo makes "desktop mapping" software for business analysis.
98 Interview with Laszlo Bardos, Co-founder and Director, Product Marketing, MapInfo.
Entrepreneurship director as a source of resumes of potential employees. Thus, the firm is intricately interrelated to RPI and its entrepreneurial structure.\footnote{Interview with RTP firm.}

Again, anecdotally, there are firms in the Science Park that maintain informal links with Yale. These links have formed in spite of the park. One firm, which is a branch office of a firm doing technical solid waste management work, was started by a Yale School of Management graduate and a Yale professor who now both work in the Yale program on solid waste and the environment. The firm maintains links with these two, who do crucial technical support work and strategic planning on the economics of solid waste. These links have "plugged them into the Yale community," directing them to other specialists at Yale who do "indispensable" consulting work for them.\footnote{Interview with Science Park firm.}

Another firm at Science Park was founded by a Yale professor who, because of his position at Yale (he is still a full professor there)\footnote{Like many universities, Yale has a policy that allows its professors to work a total of one day per week on paid projects outside of Yale.}, has knowledge about the inner workings of Yale. The professor uses his Yale charge card to purchase things from the stock room, which is good for Yale because it disposes of its surplus and good for the firm, which acquires supplies inexpensively. The firm also hires a "bursary" student, an undergraduate on scholarship, which has saved the firm money, because Yale bills the park and the park bills the firm. According to the professor, they "bill late," which is "good for cash flow."

In the case of two more firms, the situation of the firms' foundings placed them within Yale's orbit. Two Yalies, a postdoctoral student and a graduate, founded the firm which is developing a proprietary fabrication process, and thus established personal relationships with the engineering department which was "the primary reason that the firm located in the park." These relationships led to
the hiring of former Yale faculty, two scientists with Ph.Ds from Yale, and two Yale graduates on a part-time basis. However, one of the firm's partners averred that their contacts would produce even more productive relationships, except that the Yale faculty are resistant to altering their work habits to work with firms rather than with NIH. 102

The ultimate in informal but crucial Yale links is represented by the firm founded by a father and son-in-law whose respective daughter and wife is a Yale professor in chemical engineering. There, the firm, which develops catalytic ignition technologies and has twelve patents, does joint and sponsored research with the wife and consults with other professors in other departments. The firm hires Yale graduates on a part-time and full-time basis each term, and the president states that there is lots of informal exchange, which he called "sharing of thoughts," in that the firm will loan equipment to Yale professors who will in return offer advice on a quid pro quo basis. This link to Yale is the "major thing holding us in the park," the firm president observed.

Thus, despite the more intangible nature of the academic mission for firms, the informal connections that derive from this mission often serve as the prerequisite to the establishment of the other more tangible links, sponsored research, graduate students as employees, and consulting relationships, that in sum are so crucial to the firms' growth. Moreover, where a university supplies graduates and professors to work for park firms on part-time or full-time bases, it creates the potential for generating new informal links or augmenting existing links between their employer and the university from which they came. In turn, the university graduates that become employees at parks firms are trained at the university, another benefit arising out of the educational process. The academic

102 Interview with three Science Park firms.
function, then, takes on substantial importance as a contributing factor to a firm's growth.

(5) Technology Broker

The final university function is as a technology broker, which includes patenting and licensing functions usually performed by a university technology transfer office or its equivalent. A university may take out a patent on a discovery that is "novel, non-obvious and useful" within one year of publication.\textsuperscript{103} In considering whether to patent an invention, a university generally weighs the cost of the patent process, which can be upwards of $20,000 to $50,000, against the value of the discovery. The value of the discovery depends on its ultimate commercial application and appeal, which is based on an assessment of the current and future market potential, among other criteria. Assessing the market potential is a tricky process that varies according to the particular field. For instance, in biotechnology, a field relevant to this study, it may be two to five years -- or longer, depending upon how basic the discovery -- before a discovery's commercial potential becomes evident.\textsuperscript{104} In this study, it appears that only one firm holds a patent from work done at or with a local university.\textsuperscript{105} All the other patents held by the firms derive from research done on their own, or at other universities (Harvard, MIT, UMass Amherst).

Many universities will not initiate the patent process unless there is already a "licensee" who agrees to defray or absorb the patenting costs. A "licensee" is a company working in the field in which the discovery was made that, for a fee,

\textsuperscript{103}Nelsen, Lita, "Identifying, Reporting and Evaluating Innovative Research Results from the University," Draft, March, 1992, Not for further distribution, pp. 13, 18. The meaning of publication is any type of written disclosure, even when the researcher did not intend to disclose the discovery. Publications by others more than a year before the patent filing will bar patenting by the inventors. \textit{Ibid.}, p. 13.

\textsuperscript{104}\textit{Ibid.}, pp. 17-18.

\textsuperscript{105}The patent is jointly held by a firm in Science Park and Yale.
obtains the rights from the university (the "licensor") to develop applications for the discovery. For a licensee, the best circumstances are to obtain an "exclusive license," which means that it is the only firm with the rights to the patented discovery. For instance, TSI Corporation, a company in the MBRP, refused to undertake sponsored research unless it were granted an exclusive license to the commercial rights over anything "in our field of use" that arose from their research in UMass Amherst labs. UMass Amherst retains commercial rights outside of that field. TSI has no royalty obligation to UMass, and the rationale is that TSI has funded the research and the labs' operations to the tune of $200,000 to 300,000 per year.\footnote{Interview with James Sherbloom, former CEO and President, TSI Corporation.} In our study, only one firm (located in the MBRP) was an exclusive licensee from a local university, which was the Worcester Foundation. In a fashion similar to the role played by non-local universities in the patent discussion, other firms in the study were found to hold licenses from non-local universities or from other larger companies (General Electric, UMass Amherst, MIT, Harvard and others).

The issue of ownership of patent rights as between the scientist and the university or between the firm and the university is a preliminary issue that is usually resolved through long-standing university policy or through individual contractual agreements set up at the time sponsored or joint research is undertaken. (Discoveries that arise from research done solely by firm employees on university premises but using university resources such as labs or equipment, are generally held jointly by both the firm and a university.) As between the university and its faculty inventors, a standard policy (the one propagated by MIT, which is often used as a model by other universities that are new to the technology transfer field) is that the university owns the patent to any discoveries
made by faculty or students arising from a research grant or from significant use of university facilities.\textsuperscript{107}

However, other universities are more flexible, in that they will negotiate over patent rights where the inventor agrees to finance the patenting process\textsuperscript{108} or will share the patent. For instance, in the case of a faculty-founded firm located in the RPI incubator, RPI initially held the rights to the patent, but before the patent was taken out, the faculty member negotiated with RPI to obtain the patent rights.\textsuperscript{109} In the case of another firm in Science Park, the faculty member has sole ownership of the patent, because he paid all of the patenting fees. He offered to split the fees with Yale and then establish joint ownership of the patent, but Yale refused.\textsuperscript{110} Under the standard case, where the university takes ownership of the patent, the inventor commonly gets about one-third of the royalties, after the university takes out unrecovered patenting and administrative costs.\textsuperscript{111}

As for dividing ownership rights between the university and industry over discoveries that result from sponsored research, the stated policies are similar from university to university but, in reality, differ on a case by case basis within the universities. The standard agreement at UMass Medical, RPI, and Yale is that any discoveries arising out of sponsored research belong to the universities, and the sponsor gets the first option to an exclusive license.\textsuperscript{112}

However, where there is no transfer technology office and no effort to promote contacts with industry, such as at UMass Medical, the university cannot

\textsuperscript{107}Nelsen, p. 8.
\textsuperscript{108}One firm in Science Park started by a Yale faculty member offered to finance the patent in exchange for ownership of the patent, and Yale refused the offer.
\textsuperscript{109}Interview with firm located in RPI incubator.
\textsuperscript{110}Interview with Science Park firm. A fraction of the royalties goes to a Yale-related not-for-profit research corporation that evaluated the discovery for commercial potential; the rest of the royalties goes to the inventor and the university.
\textsuperscript{111}Nelsen, p 10.
\textsuperscript{112}Interviews with D. Entin, M. Rice, and B. Bickerton.
monitor the licensing process, which in turn discourages firms from entering into an agreement with UMass Medical professors to sponsor research. From their end, UMass Medical faculty may be discouraged from working with industry as a result of the conflict of interest statute governing their activities as employees of a state institution.\textsuperscript{113} RPI, by distinction, appears to be relatively casual about determining ownership, focusing its efforts on its "innovation model" instead.\textsuperscript{114} Even though most of the firms in Science Park doing sponsored research at Yale found that their relationships developed individually, the formal ownership policy usually prevailed. Where negotiation over ownership rights is common practice, smaller firms may suffer a disadvantage, because they do not have the leverage that larger firms do and cannot afford to pay the patenting fees.

In fact, some firms will refuse to work with a research institution unless the institution agrees to allow the firm all the rights to the intellectual property in the area. One firm in Science Park stated that it had "gone out of its way to keep [its] intellectual property unconstrained," meaning it was arranged so that the firm took ownership of the property with the freedom to license it to another party of its choice.\textsuperscript{115} In its agreements, an MBRP firm conducting sponsored research with

\textsuperscript{113}The state conflict of interest statute governing all public employees restricts to less than one percent the amount of equity that a UMass Medical faculty member can take in a company, where a faculty member has a variety of relationships with a firm. The statute is invoked, for instance, where a faculty member is doing research for a firm on behalf of the university and is a co-founder of the same firm. M.G.L. c. 268A. Furthermore, UMass Medical has in principle opposed establishing relationships with industry, and it has discouraged its faculty from doing so. Where faculty do establish relationships with industry, UMass Medical explicitly discourages professors from being associated with firms in the park or from locating firms that they start in the park, because of the belief that the proximity will tarnish the university's academic research.

\textsuperscript{114}Moreover, the director of RPI's Center for Entrepreneurship states that very little sponsored research results in a discovery of importance to a company (usually large companies are at issue here). Because of the differences in ethos between academia and industry, the research done in a university is not "results driven," and a company rarely is able to pick up where a university leaves off to carry the basic research to the applied stage. Thus, the ownership issue becomes moot. Instead, sponsored research is a way for companies to find students that could be potential employees. Interview with M. Rice.

\textsuperscript{115}Interview with Science Park firm.
mostly non-local universities takes ownership of anything invented solely by firm employees; the university owns any invention made solely by university people, and joint discoveries are jointly owned. The firm admitted that determining who made the invention is often a "struggle," however, in the firm's opinion, the specificity of this arrangement preserves the firm's ability to license the patent later -- the same concern held by the Science Park firm.116 The less proprietary a university's attitude is toward discoveries made on its premises, the greater the incentive -- or at least the barriers are reduced -- for companies to work with university personnel through sponsored research or otherwise. The benefit of this more liberal approach is more research money in the near future, but the drawback is the occasional loss of potentially large sums of money, later, when the product arising out of the patent is marketed.117

In these three universities, then, the patent and licensing process is not a formalized one, in the sense that MIT has developed. Instead, these processes are done on an ad hoc basis. In fact, none of the universities in our study has an active technology transfer office. Indeed, until MBRI set up its technology transfer office in the park, neither Tufts nor the Worcester Foundation had any technology transfer office. UMass Medical does not currently have a technology transfer office but is in the process of setting one up.118

Yale's Office of Cooperative Research serves as the technology broker, but only about 5% of its research is industry sponsored, despite active efforts to attract more industry.119 It may be restricted in its efforts due to the perception of

116 Interview with MBRP firm.
117 A licensor's (the university's) royalties are based on a percentage (like 3% or 5%) of sales of the product arising from the patent rather than on a single sum.
118 Interview with D. Entin. According to Entin, there is currently a "preaward office" that reviews all the grants and contracts, all industry-sponsored research, pharmaceutical trials, and other traditional grants, such as federal grants.
119 Interview with B. Bickerton.
Yale as being anti-industry. RPI has no official technology transfer office; the Director of the Center for Industrial Innovation doubles as the technology transfer officer. The extremely low number of firms in our study that are actually licensees (one) or have patents (one) from the local universities, combined with the lack of formalized technology transfer apparatus at the universities, are strong indicators that this represents a relatively insignificant link between the university and local industry, and, thus, not a fertile source of technology transfer for URRP firms overall.

Summary

By themselves the findings regarding the university resources are not so dissimilar from what Premus observed in his study ten years ago or from what Rosegrant and Lampe noted about MIT: Of the potential university functions, it is the academic mission and the informal contacts between firms and the graduates and professors as well as the personnel function that prove most significant to the firms in their growth. The remaining functions are of modest importance, depending on various factors, or are generally not significant to local URRP firms (technology brokering).

Park Services

The firms in our sample pointed to specific factors related to their locating in and association with the research park that contributed to their growth. These factors fall into three main categories: (1) incubator services; (2) services offered by the park administration, and (3) informal associations among the park firms. (See Exhibit D.) This section defines each of these functions and discusses the relevance that they were found to have to the firms in this study.

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120 Ibid.
121 Interview with M. Rice.
(1) Incubator Facilities

"Incubator facilities" typically provide a nurturing environment with temporary space for a period of two to three years and essential business services at a reduced rate for startup businesses, until these firms are able to exist on their own without financial supplements. The services in an incubator include shared secretarial services, telephone answering and administrative services (copying, computers, etc.); low-rent space; legal and accounting advice, and fitted lab space for those companies needing it. Startup firms in incubators also gain some psychic benefit from being near other struggling firms and having the opportunity to share common concerns as well as solutions to common problems. The incubator concept is generally attributed to Edgar Hoover, Raymond Vernon and others working on the New York Regional Plan Study in the late 1950s and early 1960s. In the last twenty years, incubators have gained popularity among state governments as an important tool for stimulating "pure" economic development, because they generate new wealth- and value- creating entities, rather than wooing entities away from other states.

Definitonally speaking, the very environment of a research park -- or certain buildings in the park itself -- can exhibit some incubator-type characteristics, even if they are not officially described as incubators. For instance, according to firm and park accounts, the first building constructed in the MBRP in 1984, called One Biotech, served initially as an incubator for the early companies in the park -- although it no longer serves such a purpose now.

Similarly, the first building built in the RTP also informally offered some incubator

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122 Blakely, supra., p. 4.
services to early firms in the park. However, the main distinction between an incubator and the rest of the research park is that the park does not offer reduced rental rates or the benefits of shared services. A park firm must compete on the same terms as any other firm.

As for our three parks, as noted above, two of them have a track record with formal incubators (RTP and Science Park), and one (MBRP) is preparing to open an incubator facility this year, which will offer all the typical services and perquisites. One highly significant factor is that the RTP-associated incubator is located right on the RPI campus, in keeping with the university's philosophy of promoting a nexus between industry and the university, an objective that is facilitated by having firms in close physical proximity. Because RPI's incubator is such a good example, it will be discussed in detail.

Started in 1982, the incubator is one piece of the RPI "model for innovation," along with three other major initiatives: a collection of interdisciplinary industrial innovation centers; the RTP; and education and research in technology management and technological entrepreneurship at the RPI School of Management. The renovations of the incubator building (which was built at the turn of the century as an old Catholic home for wayward children) were financed by bonds issued by the Troy Industrial Development Authority and the New York State Urban Development Corporation. The costs of developing and operating the incubator program have been borne by RPI, but the program has been

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124 To the extent that the incubator services in Biotech One and the RTP building have contributed to the growth of any firm(s) interviewed for this study, the firms are included in the discussion of those firms that have benefited from incubator services -- even though the MBRP is only this year opening a formal incubator, and the RTP does not today have an incubator within the boundaries of the park site.

financially self-sustaining since inception. Unlike most other campus buildings, the university pays taxes on the incubator building.

RPI's incubator has its own director and staff, distinct from the park's, who report directly to the university administration. It offers rent based on a graduated payment structure that allows companies new to the incubator to pay less; a receptionist, answering service, and photocopying equipment; and direct access to RPI's computers, libraries, database system, shops, laboratories (although there are no labs in the incubator building), testing equipment and faculty consultants. Besides these tangible benefits, the incubator firms attest to the importance of the interaction that takes place among firms in the incubator, for professional reasons (to exchange hints on computer glitches, for example) and for morale-boosting purposes.\textsuperscript{126} The average time a company stays in the incubator is two and a half years, although the incubator does not have a policy limiting the amount of time a firm may stay in the incubator. The cost of renting space in the incubator is somewhat below market;\textsuperscript{127} however, the perquisites that the incubator provides, such as those mentioned above, greatly reduce the incentive for the firms to graduate out of the incubator.

On average, the incubator receives ten to twenty business plans per year,\textsuperscript{128} and the incubator screens these applicants by applying five distinct criteria. The potential tenants must have: (1) a technology-related product or service; (2) the potential for positive interaction with RPI faculty and students; (3)

\textsuperscript{126}Interviews with two firms in the RPI incubator confirmed this observation made by Glenn Doell, Director, Incubator Center and M. Rice, who also serves as executive director of the incubator.
\textsuperscript{127}In the Spring of 1993, firms were paying $7.50 per square foot in their first year in the incubator; with stepped up rates of $8.50 and $9.50 in the second and third years thereafter, according to M. Rice.
\textsuperscript{128}This compares with the Incubators in Austin, Texas and Boulder, Colorado, which receive 3-400 and 150 to 200 business plans respectively per year. If this is a measure of the entrepreneurial climate, then Rice notes that the Capitol Region is less "entrepreneurial" than other areas of the country; however, Rice also points out that there is a lot of "preselection' with respect to the RPI incubator, because it has been around much longer.
an acceptable business plan; (4) an entrepreneurial team with the capability to implement the business plan; and (5) the ability to pay rent and be willing to let RPI take 2% equity participation.\textsuperscript{129} These criteria are designed to promote a greater probability of success among the firms, to ensure that the entrepreneur has considered marketplace needs and is not just pursuing technological innovation for the sake of it (the "better mousetrap syndrome"), and finally to further RPI's purposes as an educational institution.\textsuperscript{130}

Once the firms are in the incubator, the incubator staff make proactive efforts to connect the firms to facilities on campus. Currently, one company uses the animal labs for experiments; others contract to use the electronic microscope (for which they pay the university) or other equipment located in the Center for Industrial Innovation (CII). The 40,000 square feet of space available in the main building is suitable for computer companies and other similar firms that just need working office facilities, not laboratories. The basement can accommodate light manufacturing and processing, as well. It has expanded into an additional building with lab space that is a ten-minute drive from campus, and they are considering expansion into a manufacturing building in downtown Troy.

The "success" rate of the incubator is difficult to measure in the abstract, and the rate greatly depends upon the stated objectives for it. The incubator's close physical and administrative connections with the university means that nearly two-thirds of the firms in the incubator are started by faculty, RPI staff or recent graduates. Indeed, the RPI faculty and staff are quick to note that the incubator is not only an economic development tool for the region but also a "vehicle for enhancing RPI's traditional engineering and scientific education by

\textsuperscript{129}Abetti, supra., p. 72-74 and the RPI Incubator Program Fact Sheet.\textsuperscript{130}Abetti, supra., p. 74.
providing a living laboratory for applied research."\textsuperscript{131} A total of 50 firms have graduated from the incubator since its inception. Of those, twenty percent are no longer in business, so there is about an eighty percent survival rate; eight or nine have ended up in the park; four or five have left the area altogether; and the rest reside in the Capital region.\textsuperscript{132} Currently, however, there are no firms in the park that came out of the incubator, therefore, none of the current park firms can be said to have benefited from the incubator services. Furthermore, although the Capitol Region as a whole seems to benefit economically from the incubator,\textsuperscript{133} the link between the incubator and the park is relatively weak and, thus, this means that the power of the coupling between academia and business that RPI is trying to achieve and that occurs initially in the incubator lessens -- or at least is not maintained in the same proportions -- as a firm grows up and expands.

In Science Park, the firms and the park administration, SPDC, consider their primary lease space, the multi-tenant buildings, to be incubators: the firms are small, employing on average, approximately less than twenty people, and they are young, meaning five years old or less. Moreover, the seven Science Park firms located in the incubator that were interviewed cite a variety of factors associated with the incubator building that influenced their growth. Most often noted (three firms) was the ready-made lab space left from the Olin Corporation days -- with the 42-inch high benches and running water. Other incubator benefits mentioned were the low cost of the space; the free business planning consulting offered by Science Park Associated (SPA) upon entering the incubator; the guard and cleaning services and the patent library downstairs; and the general flexibility that being in the incubator allowed the firms. This flexibility

\textsuperscript{131}Ibid., p. 73.
\textsuperscript{132}Interview with M. Rice.
\textsuperscript{133}RPI says the incubator firms have lead to the creation of approximately 600 jobs and possess aggregate sales totaling approximately $20 million. RPI Incubator Program Fact Sheet.
allowed one firm to test loud engines and emit combustion as part of its business, because the park is zoned for this type of light industrial activity; to get a month to month lease, instead of committing to a year; and to expand and knock holes in the walls.\textsuperscript{134} Although recognizing that the tradeoff is cheaper space, some firms also complained about the physical disrepair of the incubator buildings in Science Park and noted there are constraints to being in a building with many other tenants, in that as a firm has specialized rather than generic needs, these needs are more complicated and more expensive for Science Park to accommodate.\textsuperscript{135}

Nevertheless, despite the incubator environment that Science Park markets and maintains, the multitenant buildings in Science Park also contain some medium-sized firms, some older firms that have been in the park since it started (almost ten years ago), and a large percentage (almost 25%) of non-high-tech firms, which are all inconsistent with the incubator concept. There are several reasons for this. The primary reason is that Science Park currently lacks facilities for firms of intermediate maturity, i.e. those firms that are no longer startups, but neither are they established firms or branches of large conglomerates. Second, SPDC may look to larger, older firms for additional financial security that high-tech startup firms by definition do not supply and encourages them to stay in the park. Third, since the park's objectives are twofold as discussed above -- to stimulate local and regional economic development and to "grow" high-tech, university related businesses\textsuperscript{136} -- the park must occasionally site non-high-tech firms that promote local employment, in order to achieve both objectives.\textsuperscript{137}

\textsuperscript{134}Interview with Science Park firm.
\textsuperscript{135}\textit{Ibid.}
\textsuperscript{136}Interviews with W. Ginsberg.
\textsuperscript{137}See Chapter V for a discussion of the ramifications of park objectives.
This means, however, that there are firms located in Science Park that continue to benefit from the expensive incubator services long after most incubators would prohibit them from doing so, thus reducing the distinction between a park -- strictly speaking, a setting consisting of contiguous sites for high-tech firms -- and an incubator -- which makes specific contributions to a firm's startup efforts and costs. Furthermore, this demonstrates the tension in the park's stated goals and may, in fact, ironically contribute to the financial instability the park has experienced in recent years. as the park stretches its resources to address both objectives.

Finally, in the MBRP, the original incubator services were a component of the initial programmatic approach toward economic development initiated by the Worcester Chamber of Commerce and carried out under the auspices of the WBDC and the MBRI. Under that approach, the WBDC offered inexpensive space (attractive lease arrangements); shared office arrangements (copy machine and a secretary); and shared lab space. The park was able to provide these low-cost services in part due to federal, state and city financial support for the park project as a whole.

Two of the park's first firms (also the two initially funded by the park's venture capital group), TSI Corporation, which, with fifty employees in the park and 700 worldwide, now anchors Three Biotech, and Alpha-Beta Technology, which is in the process of building a commercial plant in Rhode Island, took

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138 The new formal incubator, called the "Innovation Center," will have office space; conference rooms, three labs; access to advisory group of business leaders; shared washing rooms, hot and cold rooms and a dark room, a librarian; and access to a "preferred provider" network (business planners, tax attorneys, public relations firms) that invest sweat equity in hopes of generating clients. The firms will be limited to two years in the incubator.

139 Of course, there are public policy issues regarding whether this type of public investment reaps meaningful results so as to make the investment worthwhile, and how those results might be measured (number of firms spawned, the number of new jobs created, etc.) that are beyond the scope of this study.
advantage of these incubator services. As the first tenant in the park, Cambridge Biotech was also lured there by these favorable arrangements, although it was really at the end of its startup phase.\textsuperscript{140} The park terminated the incubator services in One Biotech when expansion requests from companies in the park and pent-up demand for lab space caused the park management (WBDC) to make the financially-driven decision to lease space at market rate rather than to continue to provide the space cheaply to inchoate firms.\textsuperscript{141}

In sum, the incubator concept is ill-defined as implemented and varies widely from park to park, thus making it difficult to draw conclusions about its effectiveness in growing firms. In parks like Science Park, it is difficult to distinguish the incubator concept from the park as a whole, while at RPI, the incubator and the park have distinct identities. Furthermore, in our two parks with incubators, the long-term impact of the "leg up" assistance that the incubators provide, i.e. the long-term success of incubator firms once they graduate from the incubator, is not yet settled. Even the former director of the RPI incubator casts some doubt on the growth potential of these firms and on the degree to which these firms are considered "successful," observing that only five or six of the incubator graduates have broken one million dollars in annual revenues, while the others are between a quarter and a half of a million. He calls these "survival statistics," that are "not necessarily successful."\textsuperscript{142} As for the Science Park firms, they either remain in the incubator or SPDC does not have statistics on the

\textsuperscript{140}Dr. Haddad commented that Cambridge Biotech was given financial incentives by Governor Dukakis' administration, such as money for equipment and a dramatically reduced rental rate, to lure it to the park. The state had already targetted the park project as one of its economic development priorities and wanted to see the park succeed, so Cambridge Biotech served as the park's first much-needed anchor. Dr. Haddad, thus, did not consider Cambridge Biotech a true example of the ways in which the park has contributed to firm growth or to local economic development. Interview with Dr. A. Haddad.

\textsuperscript{141}Interview with T. Andrews.

\textsuperscript{142}Interview with M. Rice.
number that have passed through the incubator and survived. We must
conclude, then, that incubator services are of modest significance to URRP firms.

(2) Administrative Services

The other park-related services that firms have pointed to as contributing
to their growth, such as brokering benefits between outside entities (government,
university, and community) and the park firms and favorable real estate options
(flexibility in rental payments and expansion needs, and structural benefits, such
as labs and existing buildings, are much more significant across the board, to a
wider range of firms, than are the incubator services.

i) Brokering

The parks function, in various instances, as an intermediary between their
tenant firms and financial resources, between their tenant firms and the
community, and between their tenant firms and the universities. Although the
parks do not themselves provide financial assistance directly to the firms, in some
cases they have been able to funnel much-needed capital to park firms from other
sources, including from venture capital funds and from government sources. In
the case of both the RTP and the MBRP, venture capital funds have developed as
the result of or in conjunction with each respective park and which serve as the
primary source of financing to which the parks would refer prospective firms.

For the RTP, the financing source was a fund created by the town of North
Greenbush, where the park is located. At around the time the park opened, a gap
in the availability of venture capital in the Capital Region became apparent. In part
to fill this gap, North Greenbush created a venture capital fund with $750,000 in
seed money obtained from the federal Department of Housing and Urban
Development economic development fund. Usually in exchange for some equity
in the company, the fund will invest a limit of $100,000 in local startup firms. This
limitation means that the town can only fund companies in their earliest startup
stage, which is particularly relevant for park firms.\textsuperscript{143} Half the RTP firms in this study had been in contact with the North Greenbush Venture Capital Fund through the park executive director, although only one had actually received capital from the fund. (One firm did not apply for the fund, because it was not interested in offering any equity, and it did not want to deal with the "bureaucratic procedures" imposed by the city.)\textsuperscript{144}

In the MBRP there is more than one way that the park administration (WBDC) aids firms financially. CBI, a venture capital fund that provides funds to Massachusetts-based biotechnology startups, was developed because the WBDC needed a way to support itself financially. Initially, as a non-profit owned by MBRI, it raised $5 million from the Worcester community. By 1991, CBI had become too profitable and had to be spun off as a separate entity, although MBRI remains a general partner in CBI. CBI provided venture money to half of the MBRP firms in this study. The WBDC also helps firms obtain debt financing, instead of equity, to do construction modeling of inside space. By financing these tenant improvements in conjunction with the construction financing it obtains to build the multitenant buildings, the WBDC spreads the risk from the lenders' perspective and reduces the financing costs for the tenants.\textsuperscript{145}

Finally, in a limited number of instances, the park administrations have facilitated firm access directly to government sources and financing programs in their states or indirectly by obtaining state money for park improvements that ultimately redound to the benefit of park firms. For instance, in the case of Science Park, cooperation between the park and the state of Connecticut, pursuant to recent state interest in seeing the park prosper as part of its

\textsuperscript{144}Interview with RTP firm.
\textsuperscript{145}Interview with T. Andrews.
economic development strategy, led to $12 million from the state. There, in providing capital, Science Park acted as an intermediary between the firms and the community. The park supplied startup firms in the park with needed capital that came from a federal Health and Human Services (HHS) grant. The park received a grant from HHS that was to be used by firms to fund marketing, management consulting, equipment purchases, and training, in exchange for the firms agreeing to employ local people who needed employment.\textsuperscript{146} The park VP for Community and Government Relations said, "Companies are delighted because it gives them the capital to grow."\textsuperscript{147} One firm in our study received about $7500 per job that it filled with a local person.\textsuperscript{148} The park has also used money from the HHS grant to fund renovations of the manufacturing development center, mentioned above, which will provide space that will allow at least two firms now in the incubator to continue to grow in the park.\textsuperscript{149}

Of the three parks, Science Park and the RTP make the most efforts to "broker" university resources, in particular, to assist in linking firms with faculty having compatible interests who could provide consulting services or conduct joint or sponsored research with a firm, or in finding university equipment for a firm's use. Historically, Science Park has not played a significant role as an intermediary between the park firms and Yale; but Science Park's role appears to be in the process of expanding. The current executive director observes that, as the relationship between the two entities has evolved over the last couple of

\textsuperscript{146} Interviews with P. McCraven and W. Ginsberg.
\textsuperscript{147} Interview with P. McCraven.
\textsuperscript{148} Interview with Science Park firm.
\textsuperscript{149} In a couple of cases in the RTP and Science Park, it was the state economic development agencies that led the firms to the park, rather than vice versa. Interview with Science Park firm, which learned about the park through the Connecticut Small Business Development Corporation; and Interview with RTP firm., which learned about RTP from the New York State Science and Technology Council.
years, the park has increased its efforts to reach out to the university on behalf of
the park firms.

There is some evidence of firms benefiting from Science Park's increased
brokering efforts. First, of course, there is CTAN, the new Connecticut-Yale joint
venture, which did not result only from the park's efforts, but from coordination on
the part of the park, Yale and the state. Also, since 1992, the Director of the
Center for Molecular Medicine at the Yale Medical School, the chairman of the
Yale department of biology, and the Secretary of the University have been
brought on to the park Board of Directors. One firm has benefited from
connections it has made through the Director of the Center for Molecular
Medicine with scientists in the pathology and molecular departments. So far,
these scientists have offered informal suggestions about a range of issues such
as product ideas, new technology and about potential joint efforts.¹⁵⁰

Another firm is "generally disappointed" with the response from Yale faculty
and from the university,¹⁵¹ suggesting it is often the university that remains
unresponsive despite increasing overtures from the park -- or from firms directly.
However, one firm founder who is a Yale faculty member stated that he believed
the park could perform more of a "nurturing role" to let firms know what Yale
offers and what firms' needs are. Together, Science Park and the Office of
Cooperative Research (OCR) at Yale could perform a "marriage broker" role, he
suggests, and form consortia that will work with universities doing applied
research. Such consortia could consist of the park executive director, the director
of the OCR and firm representatives that would suggest better ways to "couple"
the Science Park with Yale work.¹⁵²

¹⁵⁰Interview with Dr. Richard Steinfeld, General Manager, Marketing and Development, formerly
International Biotechnologies, Inc., now IBI, a division of Kodak, in Science Park.
¹⁵¹Interview with Science Park firm.
¹⁵²Ibid.
Another firm criticizes the park for providing "no framework for university contacts." All the contacts, he says, are done through "preexisting relationships with individual faculty members."\textsuperscript{153} From the perspective of the firms, then, on the whole, and regardless of efforts on the behalf of the park, Yale's current policies do not encourage an easy exchange between it and industry (even local firms), although individual relationships between Yale faculty and graduates and firms do exist, as noted above in discussing university functions.

For RTP, "brokering" RPI's facilities is a natural outgrowth of the close RTP-RPI nexus. RTP has helped some of the RTP firms that we interviewed by setting up meetings with faculty in different departments (chemical engineering, analytical and organic chemistry).\textsuperscript{154} Of course, since many of the firms had already established relations with RPI faculty and others, the park could be most helpful to them by providing help to maintain the "personal and professional ties to the RPI community" and to enhance those ties.\textsuperscript{155}

In MBRP, the WBDC does not undertake any brokering functions. However, in the course of performing its official technology brokering service for member universities, a related entity, MBRI, may occasionally bring some technology to the attention of a park firm, if it is appropriate. It is not a priority for MBRI to broker technology to park firms, unless they are the best for the job. Since the MBRI technology brokering is new within the last six months, there are no examples yet to cite of this occurring.

The character of these brokering relationships between the park and the universities is an essential component to the relationships that develop between the firms and the university. It is no coincidence that the two parks that "broker"

\textsuperscript{153}ibid.
\textsuperscript{154}Interviews with two RTP firms.
\textsuperscript{155}Interviews with L. Bardos and three other RTP firms.
more actively between the firms and the university, RTP and Science Park, also contain more tenant firms exploiting the important informal relationships with the university.\textsuperscript{156} Thus, the brokering undertaken by these three parks has had a moderate impact on firm growth, but it has the potential to be more effective.

ii) \textit{Real Estate Perquisites}

The real estate perquisites have been discussed already to some extent, particularly in Science Park, where a larger proportion of the firms benefit from the favorable lease arrangements available in the multi-tenant buildings serving as an incubator. Where part of the mission of a park is to grow high-tech firms, then there may be extra risks that a park is willing to take that it would not otherwise take if it were concerned purely with being a financially successful real estate venture. RTP, for instance, admits to occasionally allowing late rental payments (sometimes months late) to help a struggling firm that, in the executive director's studied opinion, seems on the verge of exploding into a lucrative phase. (Two firms in our study that were allowed to run late in rental payments are now booming.) This picking of winners (an industrial policy in miniature) is risky for the financial stability of the park, however, and not always successful.

WBDC, even though it tends to have a narrower, more purely real estate-oriented mission, also exhibited a willingness to work out financial problems with tenants, but it is not as willing to take a loss if necessary, which RTP has demonstrated a willingness to do on a limited and exceptional basis. In one case, the park allowed a firm to fall behind in its rental payments, with the knowledge that the firm has patent rights it could sell, as well as opportunities for a merger or acquisition that would increase the cash flow and ensure payment of its debt. Also, the park's view is when firms are financed with venture capital, like the ones

\textsuperscript{156}See Chapter V for further discussion on this point.
in the biotech park, this indicates they are less of a risk, because venture capital investors are more risk-averse these days.

In general, the real estate-related perquisites offered by the parks allow startup firms to "concentrate on the business and not on being a real estate developer," as one firm in the RTP stated.\textsuperscript{157} Startup firms do not want to have to be concerned with their physical environment or spend any of their equity on real estate, and they want to do as "little tenant improvements as possible."\textsuperscript{158} The director of the MBRP feels that this is one major reason that the firms take advantage of the park. The buildings are already outfitted with facilities that firms need for their work (labs, cold and hot water, etc.), especially in the case of the biotech park; and the parks all regularly accommodate the expansion needs of the firms with little trouble. (Almost every firm mentioned that the parks had accommodated their expansion needs, although some with greater rapidity than others.) This proves particularly useful, because these growing firms do not need to change locations each time they need more space, nor do they do need to anticipate the amount of space they need, which reduces the cost of overhead for startup firms. Other developmental advantages to all the firms that settle in the parks are the necessary governmental permits and the zoning changes that the parks have already obtained, thus alleviating the burden for the firms.

As a whole, we conclude that these administrative services -- brokering and real estate perquisites -- are of modest significance to park firms.

3) Informal Networking

Finally, informal networking among park firms occurs most often in the MBRP and Science Park in various ways. The CEOs of the MBRP firms have monthly breakfast meetings, serve on each others' boards, and participate in the

\textsuperscript{157}Interview with RTP firm.
\textsuperscript{158}Interview with T. Andrews.
MBRI educational outreach mission. The biotech firms are less likely to consult with each other about technological issues, perhaps because the nature of the biotechnology industry inhibits the dissemination of information about their discoveries, since the startup time in obtaining a patent is so long that other firms may use the information in the meantime.\textsuperscript{159} All of the Science Park firms noted informal interaction, sometimes even leading to more formal links, such as making joint grant applications or one firm supplying equipment to another. The informal exchanges that the firms mentioned included routinely exchanging information, using each other’s equipment, borrowing software, and giving and getting advice from each other about procedural issues, like where to get insurance, what to patent, and how to send a letter to Tokyo.\textsuperscript{160} The firms in the RTP noted the least amount of cooperation among them, probably because the buildings they occupy are more physically dispersed and their industries vary so widely.

This informal networking is really a continuation of the type of informal contacts discussed above with respect to university resources, although without the direct emphasis on a university nexus. Much of what was said in that section applies here as well; because the primary connection involving informal contacts for park firms revolves around the university and not the park \textit{per se}, we conclude here that the park informal networking, while still modestly significant to park firms, is less meaningful than the university-related contacts from the perspective of firm growth and success.

Summary

In summary, except for the incubator, all the park functions mentioned here -- brokering, offering real estate perquisites, and acting as a forum for informal associations -- appear to be evenly rated, as of moderate significance to firm

\textsuperscript{159}\textit{Ibid.}
\textsuperscript{160}Interviews with five Science Park firms.
growth. As would be expected, the park's contributions to firm growth are more structural, while the university's contributions are namely substantive, meaning knowledge-based or knowledge-enhancing. The ramifications of these findings on how the park functions and the university services bear on firm growth are discussed in the following chapter.
CHAPTER V

AN ANALYSIS OF THE PARK-UNIVERSITY-FIRM TRIANGLE: IS IT A USEFUL CONSTRUCT?

This thesis has focused on identifying what the potential benefits of the university and the related research park are to the firm's development, from the firm's perspective. Our findings show the most useful university resources to be the informal relationships that the university fosters as a natural outgrowth of its academic mission, and the "personnel" that the university supplies to firms. In light of these findings and the experience of the three universities, this study concludes that generally the university is not inherently a fertile source for industry without proactive effort and outreach on the university's part. (This conclusion is particularly true where the university is not a world-renowned research institution located in a booming metropolitan area that naturally offers accessibility, cultural amenities, and an educated workforce, e.g. MIT.) This outreach can occur in several ways, including, in some cases, (1) by setting up opportunities that stimulate the all-important informal interactions; (2) through an active technology transfer office that brings in sponsored research and brings the innovations out to firms; and (3) sometimes by creating or becoming associated with a URRP.

Our study also identifies benefits to firms which locate in a park affiliated with a university. Firms need more reasons to come to a park than proximity to a university, however, because proximity can be arranged merely by locating near a university but outside a park. Therefore, the park also offers certain real estate benefits; brokering services between the firms and the university and the firms and the rest of the outside world that ease a startup's entry into the business community; other shared services in some cases; and some psychological
advantages, such as moral support and prestige,\textsuperscript{161} as well. These park services are considered by the tenant firms to be generally useful and supportive of their growth.

However, creating a URRP is not premised only on what the firm will gain from the university or from its location in the park. The park must also have some value to the related university, otherwise it cannot be justified as a sound investment. As we have seen, URRPs can take on a number of different forms. The models set forth here vary in terms of their forms of ownership and management, development approaches,\textsuperscript{162} sources of financing, degree of proximity to the university, objectives, and type of tenant firms. These variations mean that for a university to benefit as fully as possible from its investment in a park, it must, first, be flexible in planning the park. Second, despite the variation in park models, a park's objectives must be clear, particularly with regard to the type of firm it is trying to attract and the extent to which a park intends to provide assistance to the firms, and the importance a park places on its economic development role, if any. Yet, finally, the university must also clearly establish its own objectives in becoming involved in a park and identify the needs it has that the park and the tenant firms in the park will address.

\textsuperscript{161}William Whyte has noted that often large firms make location or relocation decisions based solely on the cachet of a university address or on other non-business factors, such as proximity to the CEO's home. Whyte, William H., City: Rediscovering the Center, New York: Doubleday, 1968, pp. 287-89, 298-301. In particular, if non-substantive characteristics, such as image and the boss' commute time, are what is attracting firms to relocate, then it may be legitimate to question whether substantial industry-university links are destined to develop at all, and whether it is valuable for a university to improve upon the serious "business development" resources it offers and upon the mechanisms by which it transfers these resources to industry.

\textsuperscript{162}The background to the park's development includes an important aspect not covered in this thesis; that is the political imperatives that accompany the local permitting and zoning process. Political imperatives imposed by the locality or any other governmental entity that has a financial or legal interest in the park property may bear heavily on the park's ultimate objectives and operational structure.
Based on the findings regarding which university resources and park services are of most benefit to the firm, this chapter draws some conclusions about the approaches that a university can adopt to generate productive links with firms and some lessons for universities considering involvement with a URRP.

**Forms of University Outreach**

The universities in our study demonstrate a range of proactive efforts in some areas, as well as a paucity of efforts in others.

*Intensifying The University-Firm Informal Links*

The most important finding of this study is the importance of "informal" relations between the university and the firms. The importance of these relations cannot be underscored enough. However, the ways in which a university can generate these informal links is less clear. One of the strengths of RPI is its ability to foster a large volume of informal links, while on the other hand, UMass Medical does not.

These informal relations do not arise in a vacuum. In the case of RPI, the university's positive attitude toward industry is responsible for spawning a prolific number of informal relationships with firms both in the park and beyond. In the RTP, this study uncovered numerous interpersonal and informal connections between firm founders and RPI just among those interviewed. The RPI objective, one of integrating industry into the educational environment, certainly provides the context for these relations. Some of these connections among these firms grew out of specific institutional constructs, such as the RPI entrepreneurship classes and the use of the facilities at the RPI Centers. However, many of the ties arise from the general availability of advisors who are expert on starting companies, from a faculty that is being groomed to have a
positive attitude toward industry, from open access to university facilities and from 
contacts within the park itself.

The relationships in Science Park firms are not as extensive or as intimate, 
except in the case of the wife and husband team, as those described in RTP. 
However, they do demonstrate the cooperative relationships that can develop as 
long as there is no deliberate interference.

As for UMass Medical, far from generating informal relationships, it deters 
any form of technology transfer to industry --- even the more traditional type. 
Because UMass Medical has no systematic way of letting firms know what their 
professors are doing, and due to the existence of "research fiefdoms" that 
continue to get their own funding from government sources, UMass Medical 
deters firms from working with its professors, thus inhibiting working relationships 
from developing between firms and a university, relationships that would most 
likely generate informal links.

Thus, the proof of the importance of creating a structure that fosters 
informal links between the professors and firms, and between graduates of a 
university and industry, is in the demonstrable positive impact of extensive 
informal relations between RPI and industry and the distinct paucity of these 
relations (and their positive impact) between UMass Medical and industry. This 
suggests that there ought to be a central source at the university or the park 
which monitors and fosters these informal links.

The Importance of Sponsored Research and Technology Transfer

None of the universities in our study were particularly strong in the areas of 
sponsored research and technology transfer, although again UMass Medical 
demonstrates the least inclination toward transferring technology. At first glance, 
based on the findings, this would seem to be unimportant. Initially, the findings 
suggest that these are not significant university resources. However, a closer
look indicates that for very early stage firms and particularly for biotech firms, the basic research that comes from universities either through sponsored research or through technology licensing is exceptionally important to their development. Sponsored research is significantly more important to firms in their early stage of growth than our findings initially suggest.\textsuperscript{163} Firms in their early stages of development derive unique and manifest benefits from their university relationships. Research activities conducted at a university with or under the sponsorship of a startup firm, consulting by university professors, and a firm's use of expensive, university-owned equipment are particularly important to a firm's ability to leverage -- or enhance -- its own resources. Startup high tech companies cannot otherwise afford to buy the sophisticated equipment or to hire the expertise that they need to develop a product.

This observation seems to hold for all types of firms across the board. For instance, the more mature firms all indicated that the most important aspect of their research relationships was "early on," and that since then, they had taken as much research "in-house" as possible. Doing research in-house ultimately becomes less expensive and reduces any confidentiality concerns. This means that the non-research links propagated by the university, such as supplying personnel and informal relations, are all the more important, because they continue to assist firms beyond their R&D stage and into their product cycle.

Compared with firms in the computer or microelectronics industries, biotech startup firms rely more heavily and more often on universities as the initial source of innovation than other types of startups. As one university technology transfer officer observed, "For the biotechnology industry . . . the university is the

\textsuperscript{163}This finding is consistent with some other analyses, particularly those covering the biotech industry. Blakely, \textit{supra.}, pp. 8-15.
primary source of new product ideas. The typical new product concept arises
directly from a scientific finding."164

Because of the diversity of firms in our sample, sponsored research, for
instance, received a relatively low rating for its significance in contributing to firm
growth. The findings suggested that the firms did not avail themselves of the
research opportunities from local universities as frequently as they did other
opportunities. However, the interesting factor differentiating biotech firms from
the others is that the biotech firms display strong research affiliations with non-
local universities, either because they had preexisting relationships with a
university before moving to the biotech park (perhaps they obtained their original
patent or license from a non-local university or the original firm founders came
from a non-local university), or because these other universities offered certain,
very particular expertise that the firm sought. Thus, the relatively low amount of
sponsored research with local universities that comes out of this study actually
masks the frequency with which biotech firms take advantage of sponsored
research from universities generally. (This finding is also true for some non-
biotech firms that began elsewhere before moving to a park.)

An important conclusion to draw is that proximity does not drive biotech
firms' use of the university's research resources, and thus the results of this study
may somewhat dilute the importance of universities as a whole to the
development of a local startup biotech firm. Several of the biotech firms in our
study made precisely that observation, not only with respect to the firm's research
needs but regarding personnel decisions. One firm stated that, but for the fact
that they started in "this region," they could be located anywhere, because their

164Nelsen, Lita, "The Lifeblood of Biotechnology: University-Industry Technology Transfer," from
The Business of Biotechnology: From the Bench to the Street, Boston: Butterworth-Heinemann,
1991, p. 41.
research came from many universities. Another firm agreed, saying that "universities are crucial" to it, but proximity to the universities is not that important, due to the "mobility of the workforce," in that they hire from all over the world, and due to the scattered geographical locations of the research institutions with which they collaborate. (These observations are not restricted to biotech firms, where the non-biotech firms are also heavily research-oriented.)

The bottom line is that efforts made by universities to encourage sponsored research and technology transfer may pay off particularly well with respect to the biotech industry, though not necessarily in the university's backyard (or in its own URRP). The corollary, of course, is that lack of such efforts can obstruct any benefits that firms might otherwise enjoy. An instructive instance where biotech firms have been frustrated by such a lack of outreach is with respect to UMass Medical.

UMass Medical has no institutionalized method of dealing with industry or firms individually, and, with the park, UMass Medical has historically had cool relations. Moreover, since the WBDC in the biotech park is charged only with managing the park property, it does not broker university resources with the firms. The technology transfer process at UMass Medical is largely untenable for most firms. According to one firm, when a firm does approach UMass Medical after reading about a professor's discovery, the professor's reaction is either to reject the firm's overtures because she does not need the funding, or to assign an unrealistic value to the discovery, well beyond its worth. UMass Medical, unlike MIT, does not monitor the price and transfer of the technology, and biotech executives find it is a real deterrent to cultivating any working relationships. Not

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165 See Chapter III for a description of the MBRP.
166 The UMass Medical professors "want to become multimillionaires immediately," the firm CEO comments. Interview with MBRP firm.
only do firms have trouble setting up informal links with professors at the institution as discussed earlier, but UMass Medical is not set up to transfer technology on a formal basis, which discourages potential industry interest. Furthermore, UMass Medical discourages professors from starting their own firms out of their discoveries.

In some institutions, then, a liberal attitude toward licensing and patenting on the part of universities can encourage firms to interact with these institutions, because there is room for the firms to negotiate favorable terms for ownership of the intellectual property. However, on the other hand, as we see, too unsystematic, unpredictable or uncoordinated an approach by the university toward formal technology transfer can also deter a firm from establishing a relationship with a university.

Moreover, this lack of coordination means that the university is not able to capitalize on the discoveries made in its research labs. For example, the director of the UMass Medical office that currently oversees grants and research says that there is "no control over the technology that is transferred or over the publication of discoveries" at UMass Medical. According to him, the technology is just "walking out the door, without the university getting a piece of it."^168

If these findings are valid for the biotech industry generally, then theoretically the best policies for universities to adopt for encouraging links is to foster more shared research opportunities and to establish a technology transfer administrative operation. However, the merits of this recommendation will depend on the unique circumstances, financial and otherwise, of the university considering it. Also, some critics warn that too much outside research and

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^167 See Chapter IV.
^168 Interview with D. Entin.
commercialization of intellectual property may in fact injure the primary mission of most academic institutions, which, they believe, is to educate.\textsuperscript{169}

Part of what may contribute to making a URRP a success, then, is making the university more approachable for industry and more active in seeking out industry links. One suggestion is for the university to institute incentives for professors and graduates to spin off companies or to work outside the university in existing companies. Siting a park nearby may be sufficient to induce these activities. However, other instances may require government or third-party intervention, as in the case of Science Park,\textsuperscript{170} to instigate real research cooperation.

**Park Benefits to Firms**

If a university is only partially achieving its potential in attracting industry to its doors, or at least to its neighborhood, then the park services must provide an additional incentive for a firm to locate nearby. Our findings indicate mixed sentiment about the degree to which firms benefit from park services.

**Real Estate Perquisites**

The purely real estate perquisites are viewed as most valuable, at least in comparison with the other park related services. The biotech park’s real estate related perquisites allow the firm to ignore the real estate development problems and to concentrate on the more important, technical aspect of the business, such as research and development and product development. In the MBRP, for

\textsuperscript{169}Negin, Elliott, "Why College Tuitions Are So High," *The Atlantic Monthly*, March 1993, pp. 32-44

Negin argues that skyrocketing college tuitions can be attributed to universities catering to industry research needs, in that universities are spending increasing amounts of money on modernizing laboratories and that these costs are being borne through increased tuitions.

\textsuperscript{170}Government assistance to a URRP makes sense where firm growth in the park is part of a larger economic development plan constructed by the state or locality and where the park is meant to achieve larger goals than just fostering ties between a university and industry. Where this is the scenario, government intervention may provide greater incentive for university and industry to cooperate through enhanced university outreach and industry receptivity.
instance, one firm noted the advantage of being able to move into a pre-constructed building that contains wet and dry labs and that the park will provide debt financing for any improvements at very favorable terms. Of course, a private developer could provide these features as well. On the other hand, to other firms in the park, the biotech park represents "nothing more than a building; the park does not provide other services or resources." As several firm employees expressed, their location was more the result of a personal tie to the area, usually because the founders were from the region, than because of an imperative that they be located near the universities in the area. The bottom line is that there is no real reason (from a firm impact point of view) for the university to be involved solely in a real estate deal unless its purpose is to subsidize tenant firms.

**Brokering**

The brokering services may supplement the university outreach that we discussed above, but it cannot replace it altogether in importance. For example, even if the MBRP administration performed more interventionist brokering practices, without responsiveness from UMass Medical, their efforts would not be fruitful. This has been the case, in part, in Science Park, where the park administration has recently been less passive about soliciting Yale. With Science Park there is the perception that, even though the SPDC offers its services in contacting Yale for research and consulting assistance, SPDC is really impotent to carry out these services -- because of the unresponsiveness of Yale and because of the SPDC's other obligations -- and that the firm-university relations really are autonomous.

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171. Park will provide debt financing for tenant fit-up of up to $60 to $70 per square foot, amortized over the term of the lease.
172. Interview with MBRP firm.
173. See Chapter III.
On the other hand, RTP is bound to be most successful at its brokering because of RPI's commitment to fostering relations, as we have already discussed. The primary difference between the Science Park firms and the RTP firms is that firms in Science Park that do not start out with the benefit of a Yale connection have less of a chance of cultivating one than do firms in RTP, as a result of the aggressive stance taken by the park and by RPI together. As part of RPI's robust structure built to encourage entrepreneurship, RTP and the unique on-campus intermediary organizations, such as the Center for Entrepreneurship, "broker" between the park firms and RPI professors, funneling firms to the proper professors and research laboratories and vice versa. At Science Park, as one of the firms with Yale connections put it, "The park provides no framework for university contacts. The contacts are done through preexisting relationships with individual faculty members."\textsuperscript{174} The test for Yale will be the new CTAN, the links with industry it generates, and the type of industry links that Yale will tolerate.

Because of the importance of university outreach and contacts, attention to the brokering role is one of the most important proactive steps a URRP can take. Regardless of the initial position taken by the affiliated university, having an energetic contact point at the URRP for the promotion and development of university links is extremely valuable to the entire enterprise, and it can serve to improve the university-firm relationships at even recalcitrant universities.

**Shared Services**

The remaining question mark is whether shared services are worth the cost of providing them. The more a park acts as an incubator, such as in Science Park, the less can the park be operated according to real estate financial requirements. It is no coincidence that Science Park has found itself in

\textsuperscript{174}Interview with Science Park firm.
increasingly severe financial straits, in part due to the below-cost services it provides in its two incubator buildings. On the one hand, parks that are more proactive in controlling the park environment and funneling the necessary nutrients to firms (brokering) create a more stimulating environment for their tenant firms. Very early stage startup firms find the nurturing environment to be essential to their very livelihood. On the other hand, the jury is still out on the long-term advantages to the firm of a "nurturing environment" and the strain on the park's budget may not justify extending pro bono services at all or to any great degree.

Assessing the Benefits of the URRP to the University

As we have seen, the models for the ownership, management and financing of a URRP are varied, and ultimately the financial stability of a park may depend upon the real estate governance aspects of the park, such as lease terms and the extent of the services provided by the park. A decision about this aspect of the park's administration determines in many ways to what extent the park intends to be an "incubator" and ultimately bears on the park's financial stability and on its ability to run itself as a real estate development enterprise. For instance, there are years when Science Park and RTP often are not able to operate without subsidies from outside sources, i.e. the state in the case of Science Park, and the university in the case of RTP. A university considering an association with a park should examine the park model closely for signs of stability and for the details about the services it provides.

A university should also examine closely its own motives and the park objectives in evaluating what a URRP's value is to a university. A URRP's value to a university can be measured in several different ways. The increased amounts of sponsored research that may arise from the firms in a URRP can improve and increase the research opportunities at the university, allowing the professors to
undertake research projects they would otherwise be unable afford. Second, through sponsored research and other research relationships, a URRP may increase a university's patent or licensing interactions, which may result in increased financial returns in the long-term.

Moreover, the proximity to a university of a geographic concentration of firms may be a plus in a university's faculty hiring and recruitment process, because there are immediate opportunities for the faculty to work nearby -- or for their spouses to get jobs at the nearby firms -- thereby supplementing their professorial incomes. As with RPI, a park's existence may actually enhance a university's educational mission by providing opportunities for students to work in the "real" world and for professors to gain technical skills that hone their theoretical analyses. Finally, a university might intend to cultivate economic development opportunities in the region through its participation with the park. Equally important is that the university's motives in becoming involved with a research park be consistent with the park's objectives.

Where a university examines the park model for stability, establishes clear objectives for becoming involved with the park, and finds its objectives to be consistent with the park objectives, then, only after careful consideration of all these factors, does associating with a URRP have the potential to be a sound investment for a university.
CHAPTER VI

CONCLUSION: LOOKING AHEAD

A university should embark on a URRP cautiously and with careful attention to the factors discussed in the previous chapter. Indeed, for those parks that set forth economic development as one of their objectives, there are further studies that could prove useful in determining whether URRPs are an efficient and cost effective way to achieve this goal.

One study would be to evaluate how many firms in a park are homegrown and how many firms have relocated, and to track what the location and growth of these firms are over time. A related study with important implications would be a cost/benefit analysis of the governmental subsidies invested in the park, comparing the amount invested with the amount of economic growth related to the park that has financially benefited the state. The result of studies like these might get at what industry really needs from universities and from other institutions to grow. It might indicate a need to link university efforts with other non-technical and marketing assistance that address the needs of industry in the commercialization stage rather than the product development stage, which is the stage most often focused on by URRPs.

There is a reluctance to make a definitive judgment about the importance of a research park in part due to the still nascent stage of most URRPs around the country, except the Stanford research park. The outcomes of the studies suggested above would provide additional information that would help a university -- and a community -- decide whether to invest in a URRP and further how to make an economic development venture most effective.
Bibliography


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Appendix

The research for this thesis is derived from interviews with individuals representing firms in the URRPs, the park management, the universities associated with these parks, as well as some community people. The names of all of the individuals interviewed, their titles and the institutions they represent, are listed by park here in this appendix. For reasons of confidentiality, many of the firm employees requested not to be quoted directly in the text. (The firm employees that are named in the text are those that work for public companies.)

**Massachusetts Biotechnology Research Park**
Andrews, Thomas, Assistant Director, Worcester Biotechnology Development Corporation.

D'Andrea, Mark, Director of Operations, Institute of Molecular Biology.

Entin, David, Director, Office of Research Administration, UMass Medical Center.

Findeisen, Christina, Product Director, Hybridon, Inc.

Haddad, Dr. Abraham, Periodontist and Member, City of Worcester Chamber of Commerce.

Hunt, John, Chairman, Worcester Biotechnology Development Corporation

Irving III, Mason (Skip), Vice President Commercial Development, Massachusetts Biotechnology Research Institute.

Jamas, Spiro, CEO and President, Alpha-Beta Technology, Inc.


Megathlin, Donald, Assistant to President, Worcester Foundation.

Sherbloom, Jim, former CEO and President, TSI Corporation.

Wylie, James, President and CEO, EcoScience Corporation.

**Rensselaer Technology Park**
Abetti, Dr. Pier A., Professor Management of Technology and Entrepreneurship, School of Management, Rensselaer Polytechnic Institute.
Bardos, Laszlo, Co-founder and Director, Product Marketing, MapInfo Corporation.

Barrett, Dan, Mempro Membrane Products Company.

Bousquet, Mary D, Treasurer and Scientific Programmer, Meso Inc.

Doell, Glenn, Director, Incubator Center, Rensselaer Polytechnic Institute.

Evans, Ph.D, Dale B., President and CEO, Coromed Inc.

Evans, Sr., Milton L., President and CEO, High Technology Systems Inc.

Fedory, Alice G., Vice President and Chief Operations Officer, Coromed Inc.

Finley II, John M., President, Mempro Membrane Products Company.

Godgart, Robert, President, Image Systems Technology, Inc

Kapij, Mark, Product Development, CamSys, Inc.

Molloy, Thomas F., President, Executech.

Reynolds, Dorothy, Manager of Marketing and Leasing, Rensselaer Technology Park.

Rice, Mark, Manager Director, Center for Entrepreneurship of New Technological Ventures, Rensselaer Polytechnic Institute.

Wacholder, Michael, Director, Rensselaer Technology Park.

Waight III, Kenneth T., Vice President, Meso Inc.

Woo, James, President, InterScience Inc.

**Science Park**

Apfel, Robert, President, Apfel Enterprises, Inc.

Bickerton, Bob, Director, Office of Cooperative Research, Yale University.

Burns, Kevin, President, Precision Combustion, Inc.
Carnavales, Ted, Deputy Director, Center for Theoretical and Applied Neurosciences.

Ginsberg, William, Director, Science Park Development Corporation.


Lampkin, Robert, Executive Director, Newhallville Restoration Corp.

Leka, George, President, Jule Biotechnologies, Inc.

McCraven, Paul, Vice President, Community and Government Relations, Science Park Development Corporation.

Oxley, Dr. James, President, Oxley Research, Inc.

Peake, Tripp, Science Park Associates.

Steinfeld, Dr. Richard, General Manager, Marketing and Development, International Biotechnologies, Inc.

Von Stein, Ed, Cal Recovery, Inc.
EXHIBIT D

NOT SIGNIFICANT

UNIVERSITY RESOURCES

Technology Brokering

MODERATELY SIGNIFICANT

Knowledge Generation

Physical Facilities

PARK SERVICES

Incubator Facilities

Brokering

Real Estate Perquisites

Informal Firm Networks

VERY SIGNIFICANT

University Personnel

Educational Mission/Informal Links