UNIVERSITY RESEARCH PARKS: A TOOL FOR NATIONAL COMPETITIVENESS OR JUST A REAL ESTATE TRANSACTION?

Elixenia Biron
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by

Elixenia Biron

A Dissertation
Submitted to the Graduate Studies Office
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

Approved:

May 2007
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ELIXENIA BIRON
2007
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ABSTRACT
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Nations searching for a competitive edge in the global economy often focus on the promotion of innovation and advanced technology. A common economic intervention towards this end is the formation of university research parks. University research parks are generally intended to accelerate the transfer of technology from academia to industry.

Porter's cluster model predicts that the core competencies of the universities should align with the technical and workforce needs of the companies located in the university research parks. This study finds that this is not the case. The 504 organizations in 19 United States mid-life University Research Parks demonstrated no correlation between the fields that the companies were engaged and the amount of research funding that the associated university received in that field. There was also no correlation between the number of companies in each field with the numbers of graduating students or faculty in each of the fields at the university. There was a small correlation of the total research funding at a university and the number of companies found in their university research park.

The findings indicate that current economic interventions using university research parks in the USA do not reflect the Porter cluster model. While this study
did not address the economic effectiveness of university research parks, other studies have demonstrated marginal or no value to the economy. Future work should to address if better implementation of the Porter model can result in a more significant impact from university research parks.
ACKNOWLEDGMENTS

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For my family and friends, thank you for your support and encouragement. I am forever thankful to Lawrence and my beloved daughter, Kristina, for understanding the choices I have made.
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CHAPTER I
INTRODUCTION

This study answers the following questions: 1) Is university research strength correlated to the technical needs of firms located in the associated university research park? and 2) Is university human capital strength correlated to the technical needs of firms located in the associated university research park?

This research study has the following structure. The first chapter presents the introduction, definition of terms, overview of university research parks, problem statement, main objectives, hypothesis and relevance of the study. The second chapter presents the chosen theoretical framework of cluster theory and defends the selection of this perspective from other points of view. The third chapter presents and describes the methodology used. The fourth chapter presents the research findings. The fifth chapter draws conclusions and clarifies the implications of the findings.

Definition of Terms

The terms in this study have been used in many ways by different people. At times, they have been confused or used interchangeably with related terms. Therefore, it is important to define these terms as they are used in the context of this project.

University Research Park. “A university research park is defined by the Association of University Research Parks as a property-based venture, which has:

- Master planned property and buildings designed primarily for private/public research and development facilities, high technology and science based companies, and support services
- A contractual, formal or operational relationship with one or more science/research institutions of higher education
- A role in promoting the university's research and development through industry partnerships, assisting in the growth of new ventures and promoting economic development
- A role in aiding the transfer of technology and business skills between university and industry teams
- A role in promoting technology-led economic development for the community or region

The park may be a not-for-profit or for-profit entity owned wholly or partially by a university or a university related entity. Alternatively, the park may be owned by a non-university entity but have a contractual or other formal relationship with a university, including joint or cooperative ventures between a privately developed research park and a university” (Association of University of Research Park, 2003).

Research Park. A research park is a property-based venture, which has:

- Master planned property and buildings designed primarily for private/public research and development facilities, high technology and science based companies, and support services
- A role in promoting technology-led economic development for the community or region (Matkin, 1990).

Technology-based firms. Technology-based firms refer to a company whose dominant factor of production is scientific knowledge (Varga, 1998).
University Research Park Firms or Companies. University Research parks refer to for-profit entities that lease or own real estate or building spaces in a university research park.

Innovation. Innovation refers to the transformation of knowledge through the process of learning, searching, and exploring that result in new products, new services, or new processes, which increase a firm's competitiveness (Porter, 1998).

Technology transfer. Technology transfer refers to the transfer of the outcome of basic and applied research to the commercialization of new or improved products, services, and processes from a university to a for-profit corporation (Matkin, 1990).

Knowledge Spillovers. Knowledge spillovers refer to the knowledge that is unintentionally transmitted to others (Harris, 2001).

Technology Fields. As delineated by the National Science Foundation and further defined in Chapter 3 include only engineering, life sciences, physical sciences, mathematical sciences, and computer sciences (National Science Foundation, 2004).

Clustering. Cluster refers to the agglomeration of similar firms and synergistic organizations within a concentrated geographical area (Porter, 1990).

History of Research Parks

Research parks are used globally by countries seeking economic growth through technology. The growth has been prompted, in part, by the success of Silicon Valley at reinventing itself through a series of different waves of new technologies and, in part, by the effort of other regions to emulate the Silicon Valley Model. This section reviews Research Parks by geographic location.

Research Parks in the United States
The first formal research park, established in 1951 at Stanford University, later became the central element in the development of Silicon Valley. It was designed to attract companies to the intellectual property at Stanford. The assumption was that locating firms in close proximity to Stanford would promote technology transfer. The successful story of Silicon Valley was, in part, the result of a mutually beneficial academic and industrial relationship.

Cornell Business and Technology Park was established in 1952 and Research Triangle Park of North Carolina was established in 1959. In the 1980s, 91 science parks were established in contrast with the 32 parks created between 1951 and 1980 (Nahm, 2000). By 2004, there were 195 parks in 40 states. According to the survey conducted by the Association of University Research Park (2003), the majority of university research parks were established in the 1980's and 1990's. Currently, university research parks have over 2,900 tenants and employ over 235,000 people. The total capital investment exceeds $9 billion, and 61 percent of the parks use public incentives to attract tenant development.

Research Parks in Europe

The majority of European research parks started in the 1980's. The largest number of research parks is concentrated in three countries: France, Germany and the United Kingdom. France is the only country to have research parks on a scale comparable to the United States with 35 parks that accommodate 7,160 firms and employ 146,000 people (European Commission, 2002).

The Sophia-Antipolis was established in 1972 by private venture. In 1977, the French government took control of the park. By the early 1990's, Sophia Antipolis
had approximately 14,000 employees with 9,000 engaged in technological activities (Cooke, 2001). The Sophia-Antipolis consists of three main clusters information, telecommunications and electronics; pharmacology, biology and chemistry; and energy (Castells & Hall, 1994).

The "Cambridge phenomenon" parallels Silicon Valley. The Cambridge Park was created during the 1970’s. Most of the firms are dedicated to computing hardware and software, scientific instruments, electronics, and biotechnology. According to the Cambridge Technopole Report (2003), the park has approximately 3,500 high technology ventures and employs around 50,000 people. Research parks in the United Kingdom have been established and funded by private and public organizations. The majority of these research parks are located in depressed and disadvantaged areas in northern and western Britain, as well as rural and urban environments (Westhead & Batstone, 1998).

Research Parks in Asia

In Asia, the creation of research parks and high technology clusters are the key to major initiatives for enhancing economic growth. Research parks have contributed to the growth of technology-based firms in regions previously dominated by agriculture. Tsukuba Science City was built in Japan in the early 1970’s while other Asian countries established university research parks in the mid-1980. Today, there are more than 200 research parks in Asia. Japan is at the top of the list with 11 research parks, followed by China with 100 parks (Phan, Siegal, & Wright, 2005).

Hsinchu Science Park, one of the oldest in Asia, is located on the west coast of Taiwan; it was established by the government in 1980. The government’s goal was
to attract 150 to 200 high-technology firms and to create between 30,000 and 40,000 jobs by the year 2000 (Castells & Hall, 1994). According to the website of Hsinchu Science Park’s a total of 384 high-tech companies had been established in the park by the end of 2004 (Hsinchu Science Park, 2006).

In China the government has provided broad policy guidance for the development of university research parks throughout the country. It is important to mention that Shanghai is called the “Silicon Valley of the East” because this is the most technologically rich region of China. In Shanghai alone, the government has established three university research parks. Zhangjiang Park was established in 1992, and designated for the development of pharmaceuticals. Coeheijing Park, established in 1988, focuses on semiconductors, optical communications, aerospace and aviation, satellite communications, laser technology, bio-engineering, new materials, and biomedicine. By the year 2000, there were more than thirty U.S. Fortune 500 companies and more than six hundred international high-technology firms in the park. Zizhu Science Based Industrial Park was established in 2002 with the goal to become a leader in microelectronics, photo electronics, digital technology, nanotechnology, optical fiber communication, biological engineering and advanced manufacturing technology in Shanghai (The Allens Consulting Group, 2005).

In addition, India established 13 parks in the late 1980’s; however, only one park has survived, Bangalore Research Park, in India’s own Silicon Valley. Hong Kong and South Korea have two parks each, while Macau, Malaysia, Singapore, and Thailand each have one as well (Phan et al., 2005).

*Research Parks in Latin America*
Since 1993, an increasing number of public and private Brazilian entities have become involved in the creation of research parks; today seven research parks have been established in Sao Paulo and Parana. Latin American countries with small economies have also started to pursue the creation of research parks, for instance, Panama, Costa Rica and Venezuela (Gibson, Conceicao, Nordskog, Burtner, Quandt, 1998).

Problem Statement

Policymakers around the world are searching for tools that will help their regions attract high-tech jobs and become new centers of technology (Malecki, 1991; Varga, 1998). University research parks have developed worldwide as an economic intervention mechanism to foster these high-tech jobs. The current literature suggests that university research parks serve as a mechanism for technology transfer, a source of knowledge spillovers, and a vehicle for national and regional development (Link & Scott, 2005). These university research parks are designed to bring together industry and academia to foster an environment for the commercialization of the discoveries of basic science (Massey, Quintas, & Wield, 1992). In the field of regional economic development, university research parks have been popular because they seem to be an effective tool to encourage innovation activity, nurture technology-based clusters and economic growth (Malecki, 1991; Matkin, 1990).

Interventions fostering the relationship between research, production, and commercialization have been stimulated by the success of Stanford University Industrial Park and growth of the Silicon Valley. This fascination with using the leading success story of Silicon Valley as a model for the development of new
university research parks has significantly outstripped the current understanding of the key factors or elements that support the growth of university research parks.

Studies of the link between universities and firms often focus on the generic importance of universities as determinants for firms' location choices without placing emphasis on the universities specific fields of knowledge and the specific technological needs of research park firms (Goldstein & Luger, 1991; Koh, Kohn, Tschang, 2005; Phillips & Yeung, 2003; Saxenia, 1994; Weber-Bleyle, 2003). Another dimension that has been rarely studied is human capital and its potential role in promoting a link between academia and firms (Audretsch & Feldman, 1996a; Audretsch, Lehmann, & Warning, 2005; Audretsch & Stephan, 1996b; Beeson & Montgomery, 1993; Zucker & Darby, 1998).

This study addresses significant holes in the literature regarding the relationship between universities and university research park firms. The study incorporates cluster theory from the perspectives of agglomeration and knowledge spillovers, as a framework to examine the relationship between universities, as a source of knowledge and specialized labor, in the clustering of related university research park tenants. Instead of focusing on the university as a generic location determinant; this study explores the role that the core competencies of a university play in explaining the clustering of related firms. This study contributes to the broad objective of examining the importance of a university's core competencies as a factor for the clustering of firms in university research parks.

In order for a university to have an impact on the development of an industry cluster, the university must have a significant base of research activities aligned with
the needs of the firms in the cluster (Paytas, Haakensen, & Datla, 2004). Therefore, the size of research and technological resources should matter. It takes a very special type of university with specific links to a particular industry to be able to play the role often claimed by these institutions (universities).

For this study the researcher has developed the following hypotheses:

- There is a correlation between the strength of the university’s research capacity in specific technology fields to the technical needs of firms located in the associated university research park.
- There is a correlation between the number of faculty in specific technical fields at a university and the technical needs of firms located in the associated university research park.
- There is a correlation between the number of graduating students at a university and the technical needs of firms located in the associated university research park.

Relevance of the Study

Relevance to Development Policy and Implementation

From a policy perspective, university research parks are an important area of study because a large number of regions have established university research parks as an economic intervention to promote growth. University research and their related institutions may play a role in the establishment of local technology-based industries in a number of scientific fields. Generally, technology firms, regardless of location, could benefit from university research. Yet, most of cluster creation initiatives are driven by public sector intervention; there is a need to understand how universities
impact the actual development of university research parks. According to the 2003 survey conducted by the Association of Research Park nearly half (48 percent) of the research parks are university affiliated non-profit entities. Another 22.7 percent have a university corporate structure, and 13.3 percent are governmental (non-university). Only 9.3 percent are private, for profit entities, and 6.7 percent are joint ventures (Association of University Research Park, 2003).

This study sheds light on how these initiatives should target areas of perceived market demand based on a university’s core competencies. In addition, this research generates analytical results that can provide insights into the forces that contribute effectively to the development and growth of university research parks; therefore, it provides guidance to local and regional policymakers in designing their development strategies.

\textit{University Relevance}

The study increases the understanding of universities as a source of knowledge for a firm’s innovative activities as well as the impact of university’s assets on the development of industry clusters. Universities are the main sources of new knowledge and specialized labor (Castells & Hall, 1994; Laursen & Salter, 2004; Paytas et al., 2004; Porter, 1998; Varga, 1998) thus, this study serves as guidance to university officials who are involved or may be involved in university research park initiatives. It provides a tool to analyze their resources and expertise in appropriate areas so as to align with the needs of the university research park firms. Also, it shed light on the relevant mechanisms transmitting knowledge spillovers from a university to university research park firms.
Corporate Relevance

The study provides additional approach to analyzing the strategic location decisions for companies. Since knowledge spillovers are expected to decay with distance (Audretsch & Feldman, 1996; Jaffe, 1989; Jaffe, Trajtenberg, & Henderson, 1993; Varga, 1998) the closer the entrepreneurs choose to locate to university, the greater the potential perceived benefit. Entrepreneurs would like to know how spillovers from the universities can be assessed and absorbed; therefore, this research provided insights into the different mechanisms that might seem relevant to firms already located in these parks.
CHAPTER II

LITERATURE REVIEW

This chapter identifies the theoretical framework which justifies policies and implementations related to university research parks and identifies disconnects in the empirical data indicating that the theory or the implementation are somehow flawed. These disconnect lead to the fundamental research questions answered in this study.

The primary theoretical justification uses cluster theory which posits that technology-based firms locating in geographic proximity to universities benefit disproportionately from technology transfer and knowledge spillover which will result in higher economic growth for the region (Audretsch, 1998; Audretsch & Feldman, 1996; Castells & Hall, 1994; Feldman, 1994; Jaffe, 1989; Jaffe et al., 1993; Malecki, 1991; Porter, 1998; Paytas et al., 2004; Saxenia, 1994; Varga, 1998). The published empirical data provides modest evidence that technology-based firms in university research parks outperform those not in university research parks. Likewise, a significant body of empirical data suggests that the regions in which university research parks are located do not show economic value from the park in some cases the costs of the park exceed the benefits to the region (Appold, 2004; Massey et al., 1992; Shearmur & Doloreux, 2000; Westhead & Baststone, 1998).

This disconnects between theory and practice raises a fundamental question: Is the theory wrong, or are the practical implementations of university research parks diverging from the proscriptions of the theory? This question is further reduced to two research questions from which specific data may be gathered.
1) Is university research strength correlated to the technical needs of firms located in the associated university research park? and 2) Is university human capital strength correlated to the technical needs of firms located in the associated university research park?

Cluster Theory

First the overall history and implications of cluster theory are explored. Then the application of cluster theory to technology-based firms is analyzed and a direct line is drawn between these applications and the choice of university research parks as an economic intervention to foster high tech clusters.

Cluster Theory History and Implications

The seminal work of Alfred Marshall, *Principles of Economics*, (1920) provides an explanation for the localized concentrations of economic activity. He posits that firms tend to concentrate to take advantage of specialized labor pools, specialized inputs and services, and technological spillovers. These three localization advantages have been at the core of discussions on industrial clustering and agglomeration. His interest in cluster phenomena is related to the uneven distribution of economic activity over space, in particular, the tendency for firms to locate at certain places over a period of time. Firms are linked directly by business relationships (supply and purchase) as well as indirectly through market labor private and public services. Marshall's initial studies on clusters have been the foundation for subsequent research studies.

Likewise, Ohlin (1935) and Hoover (1937) both provide further explanations for agglomeration economies. They argue that firms tend to agglomerate in regions
that have a varied labor market with specialized skills. Also, the geographical proximity between firms enhances interaction between local suppliers and customers while allowing firms to reduce transportation costs. Weber (1929) first introduced agglomeration in location theory. He too argues that agglomeration of firms provides transportation cost savings.

The Neo-classical economic location theory has suggested that the key factors explaining the location of firms are distance to markets, transportation costs, labor costs, and agglomeration economies (Marshall, 1920; Hoover, 1937; Ohlin, 1935; Weber, 1929).

The literature on new economic geography highlights two opposing forces that explain the spatial configuration of economic activities. These forces are centripetal forces (agglomerating) and centrifugal forces (dispersion).

Agglomerating forces are commonly known as Marshall's externalities (1920). These factors tend to promote the clustering of economic activity in an area. These forces include labor market pooling, technological spillovers, intermediate of goods supply, and market size. On the other hand, the centrifugal forces include immobility of labor, increases in land rents, and external diseconomies (e.g. congestion and environmental problems).

The economic reasons for the geographical concentration of particular industries depends on the presence of unique natural resources, economies of scale in production; in addition to access to markets, labor pools, the presence of local input or equipment suppliers, a shared infrastructure, reduced transaction costs, and

The current literature on clusters considers agglomeration externalities as an essential force behind clustering. Externalities are often defined as side-effects or spillovers that are not reflected in the cost or prices of particular goods or services. These externalities include knowledge spillovers (Kuah, 2002).

The main source of location externalities can be traced to Marshall (1920) and Arrow (1962). These were restated by Romer (1986, 1990), and they are usually referred to in the literature as MAR (Marshall-Arrow-Romer) externalities. MAR externalities include the benefits of a pooled labor supply, access to specialized inputs, and information flows between people and firms. The table 1 shows the benefits for firms to locate in a cluster.

Table 1

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<td><strong>Demand Side</strong></td>
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<td>Customer proximity</td>
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<tr>
<td>Reduced consumer search costs</td>
</tr>
<tr>
<td>Information externalities</td>
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<td>Reputation</td>
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*Note. Adapted from Swann, Prevezer, and Stout (1998) with slight modifications.*

The forces that generate clustering can operate on both the demand and supply sides. On the demand side, firms may cluster in a particular location to take advantage of strong local demand, to take up market share, to find new customers, and to get ideas. On the supply side, firms benefit from the extensive tacit knowledge transfer, a
pool of skilled workers, a specialized labor force, and a pre-existing infrastructure (Swann, Prevezer, & Stout, 1998).

One of the most widely cited works on cluster is Michael Porter's *Competitive Advantage of Nations* (1990). Porter develops a model in which competitive advantage is generated by the spatial proximity of firms in the industry as they interact with regional and national factors. Porter argues that competitive advantage involves managing the firm's entire value system, value chain, suppliers, and buyers. Competitive advantage grows primarily out of improvement, innovation, and change. Firms in a cluster are more likely to gain advantages if they are able to find new and better ways to compete. The main idea of Porter's concept of a cluster is the notion that the competitiveness of a nation or region depends on the competitiveness of the industries. For him, regional clusters of related industries are to be the main sources of jobs, income, export, and innovation. The competitive advantage is the result of both inter-firm rivalry and geographical proximity (Porter, 1990).

Porter's concept of cluster theory includes buyers and suppliers of inputs, services providers, providers of specialized infrastructure, government, and private institutions. Therefore, the competitiveness of an industrial cluster is a result of the concentration of related industries, suppliers and services present, the access to a supporting economic infrastructure, rivalry, and collaborative effort amongst firms and other institutions to exploit knowledge spillovers.

Porter's Diamond Model for Competitive Advantage categorizes four important attributes that shape the environment for firms in the creation of competitive advantage: 1) factors conditions, 2) demand conditions, 3) related and
supporting industries, 4) firm strategies, structure, and rivalry. His model is expanded by the endowment of a skilled workforce, market-specific knowledge, and the presence of a specialized infrastructure. Moreover, rivalry between firms provides an incentive for investment in such factors. At the firm level, geographical concentration is important for organizational improvement and technology innovation for the following reasons: clustering facilities interchange and cooperation between actors of the clusters such as universities, research centers, customers and suppliers, and clustering of firms that share specific knowledge are more likely to attract specialized human capital (Porter, 1998).

Within the literature on clusters, two perspectives describe the dynamic of cluster. The first perspective, dating back to the work of Alfred Marshall, views cluster as a result of traditional agglomeration economies, where firms located in the cluster benefit from the access to specialized inputs, infrastructure, and specialized labor. This perspective is highlighted in the work of Porter. He emphasizes the benefits attributed to traditional agglomeration economies by highlighting the competitive advantage derived from the four elements of his diamond model.

Application of Cluster Theory to University Research Parks

A technology-based firm by definition has scientific knowledge as its primary factor of production. This section analyzes how technology-based firms can most efficiently access their prime factor of production and examines university research parks specifically as an intervention to provide the scientific knowledge factor efficiently and thus provide competitive advantage to a region. To understand this, we first minimally explore basic theories of innovation and thereby explain the
importance of knowledge in a technology-based firm. Using these models rationale this research examines the role of university research parks as an economic intervention to promote clustering.

Innovation Theory

Massey and his colleagues (1992) provide a model in which science pushes technological innovation. Innovation is a straightforward, uni-directional process in which scientific research is translated through product development into marketable products. This traditional model for innovation is described as market (demand) pull and science (opportunity) push. Market pull starts with a need or change in demand, product enhancement, or production problems that lead to research and development. The science push consists of pure science leading to technological development and, finally to commercial application (Monck, Porter, Quintas, & Storey, 1988). This model proscribes that research, development, production, and commercialization follow one another consequently.

The innovation process does not necessarily follow a linear path from basic research to applied research to the development and implementation of new processes and new products. Instead, it is characterized as a feedback mechanism (Nelson, 1986; Edquist, 1997). Kline and Rosenberg (1986) put forth an alternative model called the chained linked model of innovation. This approach emphasizes the interdependencies and dynamic feedback among the stages of the innovation processes.

The traditional model for research park has been criticized for relying on an outdate linear model of innovation (Massey et al., 1992; Monck et al., 1988;
Shearmur & Doloreux, 2000). Empirical evidence suggests that the contributions of science to innovation and the relationships between knowledge producers, in particular universities and researcher centers and firms are not all straightforward mechanisms.

However, the research park model has been promoted not only in developed nations, but also in developing nations as well. For instance, in the United States, research parks have become a common phenomenon. The main assumption about research parks is that they act as a vehicle for regional development. The proximity to a university's research to an industry research environment would create an atmosphere that fosters synergies.

The dynamic model of innovation is a significant justifier of the need for university research parks. The need for an interactive environment suggests the colocation of industry and academia while the linear model with a single point of contact needed for the university to pass the information to the firm is less supportive of the need for university research parks or clustering.

On the other hand, the capacity of the firm to exploit the knowledge produced at universities depends highly on the level of prior related knowledge already embedded in the firm. This type of knowledge refers to the ability of the firm to recognize the value of new information, assimilate it, and apply it to commercial purposes. These abilities are what Cohen and Levinthal (1990) call absorptive capacity. The authors suggest that investment in in-house R&D is essential for a firm to develop its absorptive capacity to utilize knowledge spillovers. Thus, a firm must
be in a related field in order to benefit from knowledge spillover and technology transfer.

*University Research Parks and Innovation for Regional Competitiveness*

In organizing this research study, the researcher has adopted the perspective that research parks could be regarded as a cluster of firms, universities, and supporting or related organizations. This approach helps provide a framework to understand the role of the actors in the cluster, particularly, the university. Likewise, there are few attempts in the literature on research parks to link the growing body of evidence detailing the agglomeration of technology-based firms near universities to support the existing cluster theory.

In this section, three factors, research (new knowledge), faculty and students, will be demonstrated to have the critical impact on clustering of technology-based firms. As universities are the prime producers of these three factors, it will be argued that economic interventions which facilitate universities efficient transfer of these factors to technology-based firms will promote regional economic growth.

According to Link and Scott (2005), a university research park serves as a mechanism for technology transfer, a source of knowledge spillovers, and a catalyst for national and regional development. They are designed to bring together industry and academia to nurture an environment for the commercialization of basic science discoveries (Massey et al., 1992). The following table presents some of the missions of university research parks.
### Table 2

**Mission of University Research Parks.**

<table>
<thead>
<tr>
<th>Missions</th>
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<tbody>
<tr>
<td>To promote economic development and innovation.</td>
</tr>
<tr>
<td>To provide corporations with sustained access to relevant research resources of the university.</td>
</tr>
<tr>
<td>To bring assistance to technology-based companies at the early stage.</td>
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<tr>
<td>To foster relationships between universities and high technology companies through the access of human and physical resources at the university.</td>
</tr>
<tr>
<td>To provide technology-based companies access to the intellectual capital and resources at the university.</td>
</tr>
<tr>
<td>To provide access to university resources such as research, students, faculty and facilities.</td>
</tr>
<tr>
<td>To foster the development and exchange of ideas, information, and solutions to parks tenants.</td>
</tr>
<tr>
<td>To offer to life science companies an environment designed to foster and support discovery, innovation, and commerce and to catalyze high-tech development.</td>
</tr>
<tr>
<td>To foster and promote research, technological, scientific and educational activities and to create jobs and employment opportunities.</td>
</tr>
<tr>
<td>To create opportunities for students, faculty, and general public.</td>
</tr>
<tr>
<td>To provide facilities, technology services, programs and expertise aiming to stimulate and support technology-based companies.</td>
</tr>
<tr>
<td>To develop high-technology companies by fostering collaboration with a university through advance research.</td>
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</table>

*Note.* Researcher's elaboration based on university research parks' websites.

Universities are the main sources of research and scientific expertise; therefore, university research parks are viewed as a way to build university-industry relationships, facilitate technology transfer, and apply university research to commercial needs. University research parks can fulfill these functions mentioned through establishing academic start-ups and facilitating the access of academic resources to university research park firms (Massey et al., 1992). The core of the argument is that universities are good at generating new discoveries, but they lack the resources or the will to take these discoveries to the market place.
Westhead and Batstone (1998) suggest that university research parks provide the catalytic environment for the transformation of basic research into marketable products. Therefore, university research parks exist not only to promote science, but also its application to technology. University research parks provide an ideal means for universities to aggregate the demands of firms through research and training programs. They also offer universities to target strategically areas of research where universities can build reputation.

Figure 1. The Role of Universities in the Cluster.

Note. From Literature Review and "The competitive advantage of nations" by Michael Porter, 1990, p.163. Model is slightly modified.
Porter's Diamond Model for Competitive Advantage is used to elaborate on the universities' role in the economy. Figure 2 describes the role of universities in the cluster. Porter (1990) suggests that the role of universities is seen as core, especially in terms of strengthening the knowledge base of existing clusters or developing new technology-based clusters. Taking the Porter model of competitive advantage we can identify university inputs for each of the four attributes of the model.

A university affects each of the four attributes of the cluster. In the context of factor conditions, Porter (1990) argues that universities are responsible for creating advanced and specialized factors such as highly educated work force by developing educational programs that require sophisticated human resources and technology. Besides, universities provide scientific and technological infrastructure as well as research efforts related to the technology of the cluster.

Universities also support firms in the cluster through consultancies. In the context of the firm strategy and rivalry, university research opens the doors to new entrants. A university's research requires advanced scientific equipment that may lead to the development of new technology-based firms as well as generate university spin-off firms (Link & Scott, 2005). Thus, more firms and a better quality of output place pressure on the existing firms to look for new strategies or mechanisms to maintain their success in the economic arena (Gulbrandsen, 1997).

In the context of related and supporting industries, the main idea is not based only on the notion that it is beneficial for a firm to have its customers and suppliers nearby, but also the fact that innovation and competitiveness tend to spill across firms and industries located in the same clusters. For example, the presence of a university
nearby may positively impact the competitiveness of firms because universities may provide new research, a pre-existing scientific and technological infrastructure, and a specialized labor pool to industries in the cluster (Porter, 1990; Castells & Hall, 1994). Also, a university spin-off serves as a mechanism to attract more financial and business services to the cluster.

In the context of demand conditions, a university's research requires special instrumentation and sophisticated testing facilities. Universities often work with the government and private sector to create streamlined, innovative regulatory standards. The affect on the cluster is to reduce regulatory uncertainty, stimulate early adoption of technologies, encourage innovation, or the development of new production processes. Moreover, many clusters develop by chance, and one potential input to that process is the presence of a research concentration and significant new scientific discoveries.

In addition, cluster theory describes how factors external to the firm impact its competitiveness and innovation. It is not the individual characteristic of firms that develop a competitiveness cluster. Regional external factors also affect cluster development. Universities are one such “regional factor” that impact cluster competitiveness in the following ways:

1. Universities as an asset that increases the quality of inputs and producers by disseminating knowledge and improving human capital.

2. Universities promote economic diversity (Paytas et al., 2004).

Likewise, Castells and Hall (1994) posit that the university plays three essential functions in the development of an innovation cluster. The first function and
most important role of the university is to generate new knowledge, both basic and applied. The second function is the training of a skilled labor force of scientists, engineers, and technicians. This skilled labor force will provide a key component for the growth of technologically-advance industries. The third function is to support the process of spin off of their research. Likewise, firms that are in close proximity to a university can gain access not only to leading-edge technologies, but also to students, professors, and the university’s facilities. A firm can gain prestige and acceptance from its stakeholder through its association with a university (Santoro & Chakrabarti, 2002).

Consequently, the broader view of industrial clusters from Porter’s perspective implies that productivity and innovation advantages of clusters can be part of spillovers and externalities that involve public entities at particular universities. Due to such developments the literature shows the relationship between innovation, university research, and regional development (Audretsch, 1998; Audretsch & Feldman, 1996; Audretsch et al., 2005; Feldman, 1994; Jaffe, 1989; Jaffe et al., 1993; Varga, 1998).

On the other hand, Krugman’s seminal work, Geography and Trade (1991), focuses on the interaction between market structure and economic geography. His theory of regional specialization is based on the advantage specialized labor pools, intermediate inputs and, the presence of externalities offers to firm looking to settle in a cluster. His work emphasizes three major sources of agglomeration economies and firm agglomeration: labor market pooling, intermediate inputs, and technology spillovers. At the same time, he argues that technology spillovers are difficult to
measure. He suggests that economists should focus on other factors that are easier to
measure. Like Marshall's explanation of agglomeration factors, Krugman states that
the concentration of firms in the same industry creates a pool of workers with similar
skills. Furthermore, the provision of intermediate inputs such as specialized suppliers
of specific inputs and services lowers the cost of production. The presence of
technological spillover explains why firms locate close to the sources of spillovers.
Thus, this is obviously compelling factor for clustering.

Cohen and Levinthal (1990) argue that a firm's technological regime is a
result of its geographical location and the spatial distribution of innovative activity.
Moreover, Baptista and Swann (1998) posit that technological opportunity affects the
rate of innovation; therefore, the spatial location of innovators is affected by where
technological opportunity is available and accessible to firms. This technological
opportunity depends on the kind of knowledge-base related with each firm's activity.
With types of knowledge that cannot be codified through scientific papers or
instructions, location plays a much larger role.

In the same line of argument concerning the location of innovation activity,
Feldman (1994) develops the theory that location mitigates the inherent uncertainties
of innovative activities. She presents five facts about the innovation process:
uncertainty, complexity, reliance upon basic research, importance of leaning by
doing, and cumulativeness. Certainly, the commercial and technical outputs of
innovation efforts are by their very nature complex and uncertain. Firms located in
innovation clusters can benefit from knowledge spillovers, and therefore, reduce the
costs of scientific discovery and commercialization. She also argues that geographical
proximity provides the necessary knowledge inputs that contribute to the
development of a technological infrastructure. Each stage of the innovation process
receives inputs from external sources, whether they are formal or informal. The
origins of these knowledge inputs make up the technological infrastructure that
supports innovative activity. This innovation activity tends to be geographically
concentrated close to this infrastructure. Therefore, locations close to sources of knowledge and technology allow firms to reduce the costs and the uncertainty associated with innovation. Universities are considered one of the key components in this process. The impact of a university’s R&D on a firm’s innovation performance is often cited as a result of localized knowledge spillovers. Universities provide critical inputs for a firm’s innovative activities through students. For example, universities with a high reputation for research attract high performing students. Consequently, this provides a big push for the creation of a localized market for a highly skilled labor force. Likewise, research universities may provide specialized intermediate inputs in the form of consultancies. Baptista and Swann (1998) posit that geographical proximity to universities gives firms direct access to sources of basic scientific knowledge as well as individuals. These individuals can turn information into usable knowledge, making commercial control over a technology an efficient process. Enright and Roberts (2001) posit that local universities provide specific research to industry and specialized training. These investments allow firms within a cluster to leverage their own investments in innovative activities.
The cluster theory and innovation model help to determine which aspects of the universities matter most in the location patterns of firms in university research parks. In fact, one can easily accept that innovation produced in a given region results, in a large extent, from well-structured networks of firms and academics. The production of basic research and technology as well as the formation of a highly-skilled labor force fits well into a university's functions. As results, generating of new firms and maintaining the innovation circle dynamics becomes second-nature to university's research operations.

The relationship between industrial agglomeration and industry competitiveness is often explained in terms of local knowledge and collective learning rather than the traditional views of external economies of scale and natural advantages (Malmberg & Maskell, 2002). The main argument is that the key resources for competitiveness in the economy are localized patterns of knowledge creation, knowledge sharing as well as learning and innovation.

On the other hand, the knowledge spillovers approach views the innovative performance of firms as a result of the interaction of firms and research institutions. In other words, firms located in the right environment are more likely to learn faster and become more competitive than their counterparts, particularly, when knowledge creation and spillovers are important aspects of a firm's competitiveness (Martin & Sunley, 2003). Knowledge spillovers are often described as Marshallian externalities. As Audretsch (1998) states:

The theory of knowledge spillovers, derived from the knowledge production function, suggests that the propensity for innovative activity to cluster
spatially will be the greatest in industries where tacit knowledge plays an
important role...it is tacit knowledge, as opposed to information, which can
only be transmitted informally and typically demands direct and repeated
contacts. (p. 23)

The knowledge spillover approach focuses on tacit knowledge rather than
codified knowledge. Tacit knowledge refers to knowledge that individuals acquire in
the course of their scientific work that is uncodified (Polanyi, 1962). This kind of
knowledge is difficult to codify because it is highly subjective and varies from person
to person. However, it is this type of knowledge that tends to be locally embedded.
Therefore, in the knowledge based economy, spatial proximity is crucial for accessing
and commercially exploiting this type of knowledge (Wolfe, 2005). Tacit knowledge
is highly personalized and often extremely localized. This highlights the significance
of geographical proximity in the process of knowledge transfer. This theory of
localized knowledge spillovers assumes that locating close to a knowledge source
firm aids firms reducing their knowledge acquisition costs (Audrestsch & Feldman,

The tenets of the knowledge spillover theory emphasize the importance of
geographical proximity for a firm’s growth and innovation because the cost of
transmitting tacit knowledge is said to increase with distance from the source

Baptista and Swann (1998) suggest that one of the most important factors
driving the location of innovation activity is the opportunity to establish direct contact
with organizations that can produce knowledge and knowledge spillovers. Whether it
is new knowledge, market information or tacit, all are important aspects to consider in analyzing clusters and the co-location of the firms within them. Furthermore, Audretsch and Feldman (1996) argue that in technology-based industries innovation often originates near the organization where the knowledge spillover originated. The existence of a high level of research in an area seems to be an important component of knowledge spillovers.

These two perspectives, agglomeration and knowledge spillovers, often overlap each other in their mechanisms and benefits of clustering, and they complement one another by providing a theoretical framework to explain the clustering phenomenon. In writings on agglomeration, the phenomenon of clustering is explained in terms of cost based advantages. On the other side, the literature on knowledge spillover explains phenomenon of clustering in terms of geographical proximity to the sources of innovation and knowledge.

Porter defines the spatial dimension of clusters as "being geographically proximate" while other authors define clusters across political jurisdictions such as states, counties, and the Metropolitan Statistical Areas (Audretsch & Feldman, 1996; Jaffe, 1989; Jaffe et al., 1993). The geographical boundary of the cluster often is determined before analysis; therefore, it becomes an implicit assumption. There is a consensus in the literature that proximity and localized economic activity are pivotal features for the development of industries. Proximity among organizations can facilitate links between firms, customers, and actors in the cluster. The knowledge spillover approach emphasizes proximity and face-to-face interactions between individuals and organizations to achieve externalities. A theme in the knowledge
spillover literature is that innovation activity and knowledge spillovers tend to occur close to the sources of innovation and knowledge (Audretsch, 1998; Audretsch & Feldman, 1996; Feldman, 1994, Varga, 1998). One can assume that firms tend to cluster near organizations influential in the development of knowledge, new products, and processes. A spatial approach to a cluster can be a descriptive tool for theorizing and analyzing factors that foment the clustering of firms in a particular place.

Universities play a crucial role in the research and development systems of the United States. From the agglomeration perspective, empirical studies often analyze the location patterns of firms by exploring the importance of universities as determinant factor for firm's location choices. Based on location theories, the location decisions are emphasized on factors of costs and demand. The main premise of the location argument is that firms reduce their knowledge acquisition costs by locating near the knowledge sources, universities (Audretsch & Feldman, 1996; Audretsch et al., 2005; Feldman, 1994). On the other hand, from the knowledge spillover approach, the literature focuses on the existence and geographical distribution of university spillovers.

Likewise, Porter (1990) states that university research has two advantages that augment the economic competitiveness of regions: university research compliments the innovative capacity of firms located geographical close to universities and also creates concentrations of skilled labor.

The basic research generated at a university serves as a complimentary to applied research. This complementary relationship between the two kinds of research (the concentration of basic research at a university and the applied research in the
private sector) assumes an intensive interaction between universities and firms (Florax, 1992). The knowledge produced at universities can be transferred to firms through different technology transfer channels such as cooperation in R&D activities, faculty consulting, academic publications, and industrial associations. The only technology transfer mechanism that requires spatial proximity, it should be noted, is the existence of a specialized labor pool (Varga, 1998).

The interaction between universities and firms may take place through graduates employed by the firms as well as the faculty's consulting services. Access to graduate students, trained students, and a supply of scientists and engineers represent, major university-industry links (Varga, 1998). Consequently, a labor market of scientists and engineers promotes technology transfer. Bania, Calkins, and Dalenberg (1992) argue that faculty scientists and engineers are more likely to move to nearby firms when they decide to change jobs; furthermore, faculty scientists tend to be tied, formally or informally, to university spin-off firms (Zucker & Darby, 1998) and biotechnology firms (Audretsch & Stephan, 1996). Malecki (1986) suggests that graduate students tend to look for jobs to the university.

Universities, often considered “engines of growth” (Laursen & Salter, 2004), appear to be a potential source of knowledge and a significant factor in the clustering of technology-based firms.

Many processes might cause the agglomeration of firms. In the case of knowledge spillover, one can contend that firms, in particular technology-based firms, may choose to locate near established organizations in their field to benefit from these localized knowledge externalities (Audretsch & Feldman, 1996; Jaffe,
1989; Jaffe et al., 1993; Kuah, 2002). Secondly, the emergence of a specialized labor force and specialized suppliers are two developments spurring agglomeration (Swann, et al., 1998; Stuart & Olav, 2003).

Paytas et al. (2004) and Wolfe (2005) put forward the cluster framework for examining the role of universities in cluster development.

**Empirical Evidence of University Effect on Economic Activity**

Case studies of the most successful university research parks are highly favorable to regional economic growth and the competitiveness of park tenants. Broader studies addressing the overall population of university research parks show no substantive effect on regional economic growth and only a minor improvement in park tenant competitiveness. Furthermore, studies not specifically addressing research parks show that clustering of small technology-based companies around universities occurs without research parks while the presence of a university is not a significant location determinant for large companies, drawing into question the need for economic interventions.

*Empirical Evidence of University Research Park Success*

Goldstein and Luger’s (1991) extensive study addressed the impact of research parks on regional economic development and the benefits of such parks among population groups. Employing multiple case studies and a quasi-experimental design, they compared economic growth differentials between areas with and without research parks. The findings show that the economic benefits are sizeable for Research Triangle Park and Stanford Research Park; however, taken as a whole, university research parks had no impact on the local economies. Even successful
parks, in terms of job creation, technology transfer, and increased opportunities for collaboration, may be so expensive to own and operate that they generate net losses for the university. In regions with small populations and without research universities, the probability of successful park development may be very low, especially for newly developed parks. The study suggests that research parks can be a tool for economic development; however, the success rate among all parks is relatively low.

Westhead and Batstone's (1998) study suggests that university research parks have little to do with technology transfer or knowledge spillover. Rather, they favor the formation of high-tech firms by providing small units with flexible lease terms. Furthermore, for a firm manager, the most compelling reason to locate in a university research park is the prestige and overall image of the site, accompanied with the prestige of being linked to higher education institution or research center. A firm can gain prestige and acceptance from its stakeholder through its association with a university (Santoro & Chakrabarti, 2002).

Shearmur and Doloreux (2000), in their study of 16 university research parks in Canada, conclude that university research parks do not seem to have any effect upon regional industrial structure because there is no direct evidence of the effect parks have on the creation of high-tech jobs. They suggest that firms tend to locate in university research parks for the prestige of the university. In terms of the role of university research parks as a mechanism to accelerate the formation of clusters, the findings show that university research parks alone have neither a positive nor a
negative effect upon cluster formation. They argue that university research parks do not provide any regional competitive advantage.

Saxenia’s (1994) study of Silicon Valley and Route 128 highlight general elements of a successful cluster. Among the factors mentioned in her study, Saxenia indicates the presence of universities with advanced and highly recognized research in specific technological areas is essential for the development of high-technology cluster. Koh et al. (2005) analyzed Silicon Valley, Cambridge Science Parks, and Hsinchu Science District. The presence of universities and scientists as factors in the level of research and development capabilities within the three research parks were highlighted. In this study, the authors emphasize the presence of universities and scientists as significant factors in the level of research and development capabilities within the three research parks. However, they do not provide specific details of how universities help to enhance the technological capacity of research parks.

Siegel, Westhead, and Wright (2003) examined whether university-based research parks in the United Kingdom have higher productivity levels. The researchers created a longitudinal database containing performance indicators for firms located on parks and a control group of off park firms. The sample consisted of 89 university research parks firms and 88 off- park firms. The findings indicate that research parks tenants generate slightly more patents, new products, and services than their counterparts. However, the research has limitations; the empirical analysis is based on data that is a decade old. This may be problematic, since it is conceivable that the benefits associated with being located in a research park may shift over time. Furthermore, in the study, the researchers do not distinguish between the different
types of research parks (managed and non-managed research parks). Managed science parks have full time managers who may prove useful in facilitating knowledge spillovers from universities to firms located in the same research parks.

Studies testing the hypothesis about the role of research parks in boosting the profitability of firms and in creating technology-based firms (Link & Scott, 2005; Lofsten & Lindelof, 2001; Westhead & Batstone, 1998) did not find any significant evidence that would support this claim.

Furthermore, Appold (2004) examines the effectiveness of University Research Parks in attracting research activity to a local area. The study examined 3,024 US counties between 1960 and 1985. The author gathers information about factors that create external economies such as the number of private industrial laboratories, the number of Fortune 500 firm headquarters, the number of distinguished university departments in four fields, the percentage of the workforce in white-collar occupations, the percentage of workforce in the finance and real estate industry, the average household income, and the number of university research parks. The findings show that university research parks seem not to be an effective economic development tool. They failed to attract any research activity, but, many university research parks are located in areas which already have significant levels of research activity. This indicates that they are beneficial for the growth of research activity.

Lofsten and Lindelof (2002) investigate the differences between the performance of new technology-based firms (NTBFs) located in university research parks and those that locate elsewhere. At the same time, they examine the university-
industry relationship as a means of encouraging innovation and production. They include 10 university research parks in Sweden. The total number of firms in these 10 university research parks is 477. The off-park sample consists of 500 independent firms. Research park firms were matched with a similar group of off-park firms. Firms located in university research parks are more likely to have a relationship with a local university. Also, NTBFs in university research parks have a higher rate of job creation than NTBFs located elsewhere.

Massey et al. (1992) in *High-Tech Fantasies: Science Parks in Society, Science and Space*, argue that the university research park model is inaccurate because the concept does not reflect what is really happening. Their study of two United Kingdom University Research Parks, Cambridge and Aston, indicate that University Research Parks are not significant as locations for employment of scientists and engineers. The authors argue that the role of university research parks in economic development depends on the nature of the local economy and the social history of the region. The authors conducted interviews with senior management of eighty-eight research parks. The findings indicate that both geographical regions Cambridge and Aston have shortage of skilled and specialized labor force. However, more shortage was reported in Cambridge than Aston. The research park located on Cambridge was mentioned occasionally as a way of attracting highly specialized labor pool. The authors concluded that the shortage and the bargaining power of the specialized and skilled workers increase the cost of production to companies through location costs and salaries. This study provides inconclusive results, the author fails to provide evidences why research parks as strategy for job creation fail to attract and
retain a specialized labor pool. Instead the authors emphasize on the historical and geographical aspects of these two regions.

In addition, Phillips and Yeung (2003) argue that establishing research parks requires a selective strategy designed to attract a certain kinds of firms and institutions. In their study on the role of Singapore Science Park as a place of R&D activities, the findings from surveys and interviews indicates that there is a huge difference between firms that actively engage in R&D and those that do not. Of those that are involved in R&D, some tend to focus on the development aspect while foreign firms are most likely to be involved in a variety of activities other than R&D. The sample size of the study is very small. It includes 19 foreign firms and 15 local firms. According to the findings, foreign firms are more likely to be involved in activities other than R&D. Also, data from the interviews indicates that the presence of universities does not enhance the R&D activities of the park’s tenants. Spatial proximity to universities is neither harmful nor useful to most firms. However, these studies do suggest that university research parks could be an important spillover mechanism since they appear to enhance research productivity.

Link and Scott (2005) examine the factors in the formation of university spin-off firms within university research parks. The authors hypothesize that the more research intensive the university is, the greater the probability that spin-off firms will develop. They also speculate that the formation of university spin-off firms occurs more often in older parks than in newer ones. The dataset of university research parks was collected through interview surveys sent to 51 university research parks in the United States. Each of the 51 university research parks was identified as being one of
the top 100 universities in terms of R&D expenditures. The authors control for other university and park characteristics such as the distance between the university and its university research park, if the university is a private or state university, if the park is operated by university or other agencies, if the university research park has a technological focus, and finally, the region in which the university and the parks are located. The results indicate that more research-oriented universities, measured by the level of their R&D expenditures, have a greater proportion of tenants that are university spin-off firms. Furthermore, older parks have a greater percentage of tenants that are spin-off firms. Another important observation is that distance matters in relation to the percentage of spin-off firms. Those universities with university research parks closer to their campus have a greater percentage of spin-off firms. In addition, the technological focus of the university research park influences the proportion of spin-off firms. The percentage of spin-off firms is greater in parks that have a biotechnology focus than in parks with either an information technology focus or none at all. This study sheds light on the importance of the tacit knowledge that resides in universities. Also, it provides an understanding of the characteristics of universities and parks that generate new firms. This study offers new insights on the role of universities in the development and growth of university research parks.

Studies concerning the impact of research parks in economic development (Link & Scott, 2005; Goldstein & Luger, 1991; Massey et al., 1992; Shearmur & Doloreux, 2000) show inconclusive results because it is difficult to evaluate the effectiveness of research parks because the objectives of research parks are not consistent. Each actor in research parks has different objectives and goals (Monck et
Nevertheless, the most commonly success factor cited in these types of studies includes the proximity to a university. It is important to notice that behind the list of successful factors there is a consensus that the performance of research parks depend on the relationships between universities and firms. Rowe (1987) argues that a key ingredient in the success of a research park is a strong university to which research park firms can turn to for technological expertise, graduate students, and a pre-existing specialized infrastructure.

Moreover, studies focuses on empirical research that intends to test the hypothesis concerning the role of research parks in boosting the profitability of firms and creating new technology-based companies (Lofsten & Lindelof, 2002; Siegel et al., 2003; Phillips et al., 2003; Westhead & Baststone, 1998). These studies that focus on the benefits of research parks on firm performance suggest that firms located in university research parks have slightly higher research productivity than off-park firms, but, the data on technology and knowledge transfer from a university to firms seems inconclusive. Research parks are alleged to stimulate spillovers from university to firms. Despite this assumption, there is no empirical evidence that university research parks have an impact on the research performance of firms.

University Effects on Economics without Research Parks

Jaffe's study Real Effect of Academic Research (1989), proposes identifying the extent that research generate spillovers occur through an econometric model based on the knowledge production function as first formalized by Griliches in 1979. Jaffe was the first to examine the geographic impact of knowledge spillovers. He examines multi-state-level time series data on corporate patents, corporate R&D, and
university research. He uses this data on the distribution of firms' patents by technological class to determine the distance between them. Patents were classified in four broad academic fields: drugs, chemicals, electronics, and the mechanical arts. The results indicate that the number of patents of each US state for each technological area is a positive function of the R&D generated by local universities. Consequently, the relationship between patents and university R&D is interpreted as a sign of some localized knowledge spillovers from universities into the local business area. Moreover, Jaffe proposes two types of innovation production functions, one for large firms and the other for small ones. The results show that geographical coincidence is significant only for small firms. This suggests that university R&D is more likely to be important for small firms in part because university R&D is a substitute for a small firm's internal R&D. Jaffe's study shows that innovative small firms are more likely to subcontract their research projects to universities in order to reduce cost.

Four years later, Jaffe et al. (1993) studied the spatial patterns of university patent citations in order to determine whether there is a strong propensity for these citations to be located in geographical proximity to the originating academic institutions. By matching firm citations of university patents by state and Metropolitan Statistical Areas (MSAs), they found that patents are localized geographically around universities. The results show that innovative firms are more likely to quote research from nearby universities that conduct relevant research to these firms than from similar universities located elsewhere.

Almeida and Kogut (1999) conduct a similar study; however, they only focus on the semi-conductor industry. Like Jaffe et al. (1993), they match citations of
university patents with semiconductor firms. They reached similar conclusions. The findings further the claim that knowledge spillovers from university research to firms are highly localized.

According to Galbraith (1985), forty percent of the firms in Orange County, California, cited university proximity as one of the main factors for their locating in the region. Yet other similar studies indicate that the university effect is not equally important to all high technology firms. Lyons's study (1995) concludes that proximity to a university is listed among the least important factors for placement decisions. Likewise, a study by Howell (1986) shows that pharmaceutical research laboratories in England do not consider a university as an important factor for locating in the area.

Markusen, Hall, and Glasmeier (1986) investigate the factors determining the spatial distribution of high technology firms among cities and their adjacent rural areas. The authors considered in their analysis the following factors: climate, educational options, freeway density, and business services. University R&D funding was used to test the hypothesis. The dataset included 264 metropolitan statistical areas (MSAs). Their findings indicate that university research is not an important factor in the distributions of firms. Oakey (1981) also indicates that high-tech firms rarely have strong links with external sources of knowledge for example, universities in particular.

Following the work of Audretsch and Stephan (1996), Zucker and Darby (1998) examined the localized knowledge spillovers from universities to industry in the biotechnology firms. The authors provide a specific structure of the role of universities and their respective faculties in encouraging local economic development.
by quantifying the effects of individual scientists, major universities, and the degree of federal research support. They hypothesize that the entry of firms into the biotechnology industry in a given year is determined by the geographic distribution of star scientists. The authors define star scientists as a scientist that has discovered more than forty genetic sequences listed in the Gene Bank (database of nucleotide sequences). To test their hypothesis, the authors use a dataset of 751 new firms over a period of 14 years (1976-1989) and across 183 economic regions. Their findings indicated a connection between the intellectual human capital created by cutting edge researchers and the founding of biotechnology firms. The results highlight the role of research universities and their top scientists as central factors in the formation of new high tech industries spawned by scientific breakthroughs. It also indicates that firms where university researchers hold administrative positions tend to locate near universities.

Recently, Audretsch et al. (2005) examined the impact location choice has on firms that locate near universities as a means to access spillovers from these institutions. The dependent variable is the distance of a new knowledge based firm from the closest university; whereas, the independent variables are categorized into three groups: the spillover mechanisms variables (research and human capital), locational variables (university and firms), and firm-specific variables. The findings show that new firms in high-tech industries are influenced by both the traditional regional characteristics and the opportunity to access knowledge generated by a university. New firms do not locate within close proximity to universities with a high research output in the natural sciences while the tacit knowledge transmitted through
publications in the social science leads new firms to locate closer to a university. An important contribution of this research is that the impact of a university's output on a new firm's location is sensitive to the types of knowledge produced and the mechanisms used to access that knowledge.

The empirical studies show that university research positively influences the innovative outputs of nearby firms. A review of the literature reveals two overall approaches utilized to analyze the impact universities have on the clustering of firms. The first approach is firm location analysis. This type of research studies emphasizes the presence of a university in a firm's location decisions, high-technology firms in particular. The second approach focuses on studies focus of public knowledge infrastructures, and how they might influence the geography of industrial R&D.

Overall the interaction between universities and industry is very complex in particular, how the knowledge of universities attracts technology-based firms to locate nearby. University research and human capital are enticing effects that motivate firms to base their operations in neighboring research parks. Universities are for the most part engaged in the production of basic research; nevertheless, universities do perform applied research that generates scientific knowledge that results in a new product or a process. Applied research is primarily performed by private firms and research institutes. The basic research generated at a university serves as a complimentary to applied research. This complementary relationship between the two kinds of research, the concentration of basic research at a university and the applied research in the private sector, assumes an intensive interaction between universities and firms (Florax, 1992). The knowledge produced at
universities can be transferred to firms through different technology transfer channels such as cooperation in R&D activities, faculty consulting, academic publications, and industrial associations. The only technology transfer mechanism that requires spatial proximity, it should be noted, is the existence of a specialized labor pool (Varga, 1998).

The interaction between universities and firms may take place through graduates employed by the firms as well as the faculty's consulting services. Access to graduate students, trained students, and a supply of scientists and engineers represent, major university-industry links (Varga, 1998). Consequently, a labor market of scientists and engineers promotes technology transfer. Bania et al. (1992) argues that faculty scientists and engineers are more likely to move to nearby firms when they decide to change jobs; furthermore, faculty scientists tend to be tied, formally or informally, to university spin-off firms (Zucker & Darby, 1998) and biotechnology firms (Audretsch & Stephan, 1996). Malecki (1986) suggests that graduate students tend to look for jobs to the university.

Universities, often considered "engines of growth" (Laursen & Salter, 2004), appear to be a potential source of knowledge and a significant factor in the clustering of technology-based firms. Empirical studies conducted weight the importance of university proximity in the clustering of firms.

Given the increasing attention place on universities as a source of knowledge and the importance of technology-based firms in economic development, research studies related to innovation and the location of choices of technology-based firms has become the cornerstone of regional economics.
Theory and Empirical Data Disconnects Provide Research Question

Cluster theory posits that technology-based firms locating in geographic proximity to universities will benefit disproportionally from technology transfer and knowledge spillover which will result in higher economic growth for the region. The published empirical data provides mixed evidence that technology-based firms in university research parks outperform those not in university research parks. However, a significant body of empirical data suggests that the regions in which university research parks are located do not show economic value from the park and in some cases the costs of the park exceed the benefits to the region.

The disconnect between theory and practice raises a fundamental question: Is the theory wrong, or are the practical implementations of university research parks diverging from the proscriptions of the theory? This question is then reduced to two research questions from which specific data may be gathered.

1) Is university research strength correlated to the technical needs of firms located in the associated university research park? and 2) Is university human capital strength correlated to the technical needs of firms located in the associated university research park?
CHAPTER III

METHODOLOGY

The dependent variable consists of a dataset of 504 university research park tenants located in 19 university research parks in the United States. These were categorized by the field of technology from which they would most likely benefit. The independent variables were determined using the technical fields of strength for each of the 19 universities using an academic research funding database of the National Science Foundation, the number of graduating students in technology fields from the National Center for Education Statistics, and the number of faculty in each field from each universities' website. The dependent variable was correlated against the three independent variables.

The majority of literature on research parks shows that most university research parks are not effective economic interventions. This is surprising because cluster theory suggests that university research parks ought to be effective economic interventions. It is possible that the implementation of university research park is not following the prescriptions of cluster theory and that addressing this shortcoming may provide more effective economic intervention. Alternatively, it may be that there is a flaw in cluster theory.

1) Is university research strength correlated to the technical needs of firms located in the associated university research park? and 2) Is university human capital strength correlated to the technical needs of firms located in the associated university research park?
Table 3

*Research Hypotheses.*

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H1</strong> There is a correlation between the strength of the university’s research capacity in specific technology fields to the technical needs of firms located in the associated university research park.</td>
<td>The variable research capacity refers the university’s R&amp;D activities. This variable has been used in the studies Almeida and Kogut (1999), Feldman (1994), Jaffe, (1989), Jaffe et al. (1993), and Varga (1998).</td>
</tr>
<tr>
<td><strong>H2</strong> There is a correlation between the number of faculty in specific technical fields at a university and the technical needs of firms located in the associated university research park.</td>
<td>The variable human capital refers the total number of scientists in science and technology fields. Firms obtain knowledge by establishing alliances with university scientists. This variable has been used in the studies of Audrets and Stephan (1997), Mansfield and Lee (1996), Zucker and Darby (1998).</td>
</tr>
<tr>
<td><strong>H3</strong> There is a correlation between the number of graduating students at a university and the technical needs of firms located in the associated university research park.</td>
<td>A Specialized labor pool refers total number of degrees granted at university in science and technology fields. This variable has been used also in the studies of Audrets, et al. (2005), and Besson and Montgomery (1993).</td>
</tr>
</tbody>
</table>
Determining the Variables

Dependent Variable

The dependent variable was the number of technology-based firms in a university research park in each of six technology fields. The specific definition of each technology field is presented.

The unit of analysis is the technology-based firm tenant of a university research park. The firm was selected over the number of employees because the empirical data suggests that the university-industry linkage is strongest for start-up firms. If we were to see a correlation between university activities and the activities of firms in the university research parks indicative of clustering, it would most likely be seen in smaller companies.

Only university research parks that are between 10 to 20 years old were chosen. University research parks less than 10 years old are often poorly developed and parks greater than 20 years old may be so full that they will not accurately reflect the start-up company activity stemming from the university.

The researcher relied on the 2003 survey conducted by the Association of University Research Parks. From this survey of 79 university research parks, the researcher identified 52 university research parks that were owned or partially owned by universities. Sixteen are between one and nine years, 24 between ten and twenty years and 6 between twenty one and thirty years old and 3 are more than thirty years old. Of the 24 which meet the qualifications, it was not possible to gather information on the tenants in 5 of them, leaving a sample size of 19 university research parks.
The qualifying university research parks are listed below. They represent a diverse sector of geographies including all regions of the USA and population densities.

Table 4

_University Research Parks Studied._

<table>
<thead>
<tr>
<th>Parks</th>
<th>University Affiliation</th>
<th>Established</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delaware Technology Park</td>
<td>University of Delaware</td>
<td>1992</td>
</tr>
<tr>
<td>Oakdale Research Park</td>
<td>The University of Iowa</td>
<td>1991</td>
</tr>
<tr>
<td>Northwestern University/Evanston Research Park</td>
<td>Northwestern University</td>
<td>1987</td>
</tr>
<tr>
<td>University Park</td>
<td>Southern Illinois University</td>
<td>1991</td>
</tr>
<tr>
<td>Cold stream Research Campus</td>
<td>University of Kentucky</td>
<td>1990</td>
</tr>
<tr>
<td>Louisiana Business and Technology Center</td>
<td>Louisiana State University</td>
<td>1988</td>
</tr>
<tr>
<td>Biosquare at Boston University Medical Center</td>
<td>Boston University</td>
<td>1993</td>
</tr>
<tr>
<td>Missouri Research Park</td>
<td>University of Missouri System</td>
<td>1989</td>
</tr>
<tr>
<td>Mississippi Research and Technology Park</td>
<td>Mississippi State University</td>
<td>1988</td>
</tr>
<tr>
<td>Centennial Campus</td>
<td>North Caroline State University</td>
<td>1989</td>
</tr>
<tr>
<td>Cornell Business and Technology Park</td>
<td>Cornell University</td>
<td>1986</td>
</tr>
<tr>
<td>Miami Valley Research Foundation</td>
<td>Multiple Universities</td>
<td>1985</td>
</tr>
<tr>
<td>Riverfront Research Park</td>
<td>University of Oregon</td>
<td>1993</td>
</tr>
<tr>
<td>Innovation Park at Penn State</td>
<td>The Pennsylvania State University</td>
<td>1988</td>
</tr>
<tr>
<td>Texas Research Park Foundation</td>
<td>University of Texas at San Antonio</td>
<td>1990</td>
</tr>
<tr>
<td>Utah State University Innovation Campus</td>
<td>Utah State University</td>
<td>1986</td>
</tr>
<tr>
<td>Fontaine Research Park</td>
<td>University of Virginia</td>
<td>1994</td>
</tr>
<tr>
<td>Virginia Tech Corporate Research Center</td>
<td>Virginia Tech</td>
<td>1985</td>
</tr>
<tr>
<td>Tri Cities Science and Technology Park</td>
<td>Washington State University</td>
<td>1990</td>
</tr>
</tbody>
</table>

The university research parks’ websites were used to obtain listings of the tenant firms. The tenant firms’ websites, Standard & Poor’s and Nexis Lexus were used to develop a summary of each firms business activities. These summaries used exact quotes from these three sources. Three sources were used to minimize misunderstanding of these firms activities by the expert panel.

From a total of 636 university research park tenants, information on 509 of was gathered. Most of university research parks firms are small and new. As a result information was difficult to gather, both databases Lexis-Nexis and Standard Poor's,
often provided information related only to medium and large firms. Also, some of the firms did not have websites; this impeded the researcher to gather the relevant information from those firms. Nevertheless, the sample size of 509 university research park tenants is a right sample because it is higher of than the original estimated sample size. The dataset of 509 organizations included technology-based firms, non-profit organizations, law and business services, regional development organizations, and government and university research centers and others.

To determine the field of technology which each of the tenant firms would most likely benefit, a panel of experts was assembled. Each was an expert in a specific technology field. To qualify, the expert must have more than two years of experience working at a technology-based firm, two or more years of experience working for a university, have an MS degree or higher and have all three of these be in the same technology field. The experts for this study and their qualifications were:

Table 5

The Experts and their Qualifications.

<table>
<thead>
<tr>
<th>Panelists</th>
<th>Qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vance Flosenzier</td>
<td>B.S. in Chemical Engineering and M.S. in Chemical Engineering. He has sixteen years in the specialty chemical industry, research and development, process technology, and operations management.</td>
</tr>
<tr>
<td>El-Sawi Khaled</td>
<td>B.S. degree in Computer Sciences, M.S. Computer Sciences, and Ph.D. His research area of expertise includes computer sciences-robotics, artificial intelligence, visualization, and software engineering</td>
</tr>
<tr>
<td>Ken, Malone</td>
<td>B.S. degree in Biochemistry and Ph.D. in Polymer Science. He has more than 10 years working for private business.</td>
</tr>
</tbody>
</table>

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The experts were assembled together, presented with the summaries (Appendix I) using a PowerPoint presentation. They were given several minutes to read each summary and come to a consensus on the field of technology most applicable to that firm.

Using expert panels as a consensus method is intended to correct the lack of conclusive data by putting the expertise of practitioners and other experts in touch with all available information (Kosecoff, Fink, Chassin, & Brook, 1984). In the case of this study, the expert panel may be considered a reliable tool as there is a reproducible procedure for bringing experts together to reach a consensus.

The experts classified firms in more than one category as some firms rely on research from multiple technology fields. The information was recorded for each firm in a systematic manner. The panel could not reach a consensus on the classification of five firms. Later, the researcher contacted these five firms’ managers by telephone to gather information about the types of university research that are more likely to be related to their firm’s applied technology. None of the firm’s administrators provided information, so these five firms were excluded from the study. The final dataset of 504 organizations in 19 university research parks that were between 10 and 20 years old serves as the dependent variable.

**Independent Variables – Knowledge and Human Capital at Universities**

The independent variables were taken from databases and websites. The independent variables serve as proxies for university knowledge and university human capital.
Table 6

*Independent Variables and Proxies.*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Proxy</th>
</tr>
</thead>
<tbody>
<tr>
<td>University knowledge</td>
<td>R&amp;D expenditures in science and technology fields.</td>
</tr>
<tr>
<td>University human capital</td>
<td>Number of faculty members in science and technology fields.</td>
</tr>
<tr>
<td>University human capital</td>
<td>Number of degrees awarded within the university in the science</td>
</tr>
<tr>
<td></td>
<td>and technology fields at the bachelor, master, and Ph.D. levels.</td>
</tr>
</tbody>
</table>

Only one university research park, Miami Valley, in this study is owned by more than one university. For Miami Valley, all of the associated universities independent variables were summed.

*University Knowledge – R&D Expenditures as a Proxy*

The variable university knowledge is measured by the amount of research expenditures by field, compiled annually by the National Science Foundation. The amount of research expenditures is a common choice to measure a university’s knowledge production because of its availability and comparability across institutions (Varga, 1998). The National Science Foundation’s database is self reported by universities and includes all research funding obtained by the university.

The NSF database reports research funding by technology field. The six broad fields that NSF (Appendix II) uses were the convenient method for categorizing all of the other independent and dependent variables.

*University Human Capital – Faculty as Independent Variable Proxy*

Human capital was measured by the total number of faculty in the six fields of technology. The technology fields used the National Science Foundation definitions given in section.
Information concerning faculty was gathered through universities’ websites. Each science and technology department of each university is examined and a count the number of faculty is taken. Only faculty members at the status of professor, associate professor, assistant professor, and research professor are included. Some professors are listed in more than one department. In these cases, the professor is categorized based on the professor’s Ph.D. field of specialization. For instance, if the professor has a Ph.D. in chemistry and he/she is listed in the department of chemistry and the department of chemical engineering; the professor is categorized as a chemist.

University Human Capital – Graduating Students as Independent Variable Proxy

The second human capital variable is measured by the total number of degrees awarded within the university in technology fields at the undergraduate, master, and Ph.D. levels for the 2004 to 2005 academic year. The year was chosen because it is the only data available at each of the university levels. This data is available through the National Center for Education Statistics. This measure indicates the relative amount of human capital created and the extent of that university’s teaching activity focused on undergraduate and graduate studies in the sciences and technology fields. This type of instruction is directly applicable to knowledge intensive firm employment. A database is created to classify the total amount of university degrees granted in each fields based on the National Science Foundation’s classification from section.

Analysis

The three independent variables are correlated to the dependent variable. This section provides information on the methods used and addresses issues of validity.
Population and Sample

A sample can be extracted either an unknown or known population (Lomax, 2003). In this case, this sample of university research parks firms was extracted from a population of firms located in 19 known university research parks. Applying the formula

\[ N = \frac{(p \cdot q) \cdot Z^2}{E^2} = n \]

Level of confidence of 95% and an error of 5%
Z=1.96
\( e = 0.05 \) Estimating of % of firms to be 5%
Applying the formula
n = 385 (Sample size without knowing the population)

Then, the estimated population of university research firms is 639 then applying the formula
n = 240 (The estimated sample size)

Issues of Validity

Yin (1994) recommends three techniques for assuring construct validity.

These include use of multiple sources of information, establishing chain of evidence, and having key informants review the study.

Multiple sources of information were used in this study. First, literature a review of previous empirical studies was conducted; second, information from secondary data sources such as databases like the National Center for Education Statistics, Nexis Lexus, Standard and Poor’s, and the National Science Foundation, university websites were used. Third information from experts in the fields of science and technology was gathered.

Establishing chain of information was achieved by two steps. First, a literature review provides a constructive framework by documenting the relevance of
the study as well as creating a benchmark for comparing the current findings with previous research studies. Second, the variables used in the study have been used previously. Third, the study applies methods and instruments that have been used previously by other researchers. For instance, the classification methodology is also employed by the National Science Foundation to gather national information about universities in the United States. Also, the data collection was consistent at both the university and firm level. At the university level, all three measures were gathered using the classification methodology and same databases and years. At the firm level, the firms were classified using the same classification methodology.

Having key informants reviewing the report was an important component of this research. A panel of experts was assembled consisting of individuals with extensive experience in academia and the business sector. Furthermore, the classification methodology was reviewed by two professors to ensure validity.

Reliability Issues

Information was also provided by other researchers. For instance, information regarding a university's R&D activities has been employed by previous researchers (Almeida and Kogut, 1999; Feldman, 1994; Jaffe, 1989; Jaffe et al., 1993; Varga, 1998). They often have relied on the National Science Foundation's data in (R&D) expenditures. With regards to information concerning a university's human capital, previous researchers have relied on the National Center for Education Statistics. Likewise, for information concerning university research parks, previous researchers have used the Association of University Research Park's survey. The measures employed in this research can produce results on university research parks research.
similar studies conducted by future researchers. First of all, the researcher has described the method as clearly as possible. Regarding research design a panel of experts is a difficult criterion to fulfill because the opinion of the experts is more or less subjective. However, the literature review and the categorization of data are based on previous researchers who conducted similar studies. Therefore, the researcher has tried to avoid subject error or bias. It is important to highlight that this empirical study was conducted using secondary data and data provided by experts. The researcher believes that these methodologies can lower the chances of error or bias. The statistical data analysis and interpretations could be recreated.

Statistical Methods

The sequence of statistical procedures applied in this dissertation has been documented in a systematic manner. After coding and processing the data, results were statistically analyzed using statistical packages. For example, after gathering the information about university research firms and the university's characteristics data was coded using EXCEL. Then, information was analyzed using SPSS. Tables and graphs were prepared to illustrate the findings.

The statistical procedures are mainly done in two steps. In the first step, the null hypotheses were formulated for each of the research hypotheses. The following null hypotheses are presented:

NH1 - There is no correlation between the strength of the university's research capacity in specific technology fields to the technical needs of firms located in the associated university research park.
NH2 - There is no correlation between the number of faculty in specific technical fields at a university and the technical needs of firms located in the associated university research park.

NH3 - There is no correlation between the number of graduating students at a university and the technical needs of firms located in the associated university research park.

For the purposes of this research, the alpha level for statistical tests was set at .05. This indicates that the null hypothesis is rejected if the sample outcome was among the results that occurred no more than 5 percent. The statistical test was set in two-tailed test; the region of rejection was located at both left and right tails. The decision to locate the region of rejection in two tails was based on the hypotheses and the size of the sample. Two tailed tests are more stringent than one tailed test. This indicates that a result which is significant in two tailed is always significant in a one-tailed test. Likewise the variables are distributed according the normal distribution and the sample size is large enough to employ two-tailed tests (Lomax, 2001).

The second step, descriptive analysis was conducted. The descriptive analysis for variables used included percentages. Results were processed and displayed in tables and figures. On side, the information of descriptive analysis was presented. Correlation analysis was performed using a parametric test, the Pearson product-moment correlation coefficient. In this stage the first trial results were obtained using simple raw form. Later on, due to the nature of the research hypotheses, data was normalized to determine the strength of each university using the three variables of research capacity, human capital, and specialized labor pool across the six major
fields. In order to calculate universities' strength across the six sciences and
technology fields the data was normalized for each university using the percentage of
companies in a given field relative to all companies in a given park, percentage of
research funds, percentage of faculty and percentage of students in a given field
relative to the total at the university. This procedure captures the area of strength of
each university. Moreover it allows comparisons among the six scientific and
technological fields within a university. Likewise the analysis was more meaningful
because it helped to accept or reject the null hypotheses.
CHAPTER IV
ANALYSIS OF DATA

The universities' research expenditures, faculty, and graduating students in six technology fields do not correlate to the technology fields which tenant firms of university research parks engage in.

First, the agglomerate data summing all universities' research expenditures or faculty or graduating students is dislocated from the sum needs of all university research park tenants.

Second, the individual strengths of each university do not correlate with the needs of their tenants in their university research parks.

Third, a correlation is shown between the total research funding at a university and the total number of technology-based for-profit tenants in their university research park.

Finally, the data gathered provides further descriptive value to the general empirical understanding of university research parks that goes beyond addressing the hypothesis of this dissertation.

Correlation Analysis

Agglomerate Data - University Strengths and the Needs of Park Tenants

If 30 percent of a university's research funds physical sciences ought 30 percent of its park tenants be in the physical sciences? No. Federal research priorities, total job market outside of the park and the difference in research resource intensity for various fields are strong influencers that may be larger drivers than research park tenants.
Table 7

*Agglomerate Data Summing all Universities’ Research Expenditures, Faculty, Graduating Students and Companies.*

<table>
<thead>
<tr>
<th>Sciences</th>
<th>Companies</th>
<th>Research $</th>
<th>Faculty</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>29%</td>
<td>24%</td>
<td>18%</td>
<td>60%</td>
</tr>
<tr>
<td>Physical S.</td>
<td>13%</td>
<td>9%</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td>Environmental S.</td>
<td>5%</td>
<td>4%</td>
<td>4%</td>
<td>1%</td>
</tr>
<tr>
<td>Mathematical S.</td>
<td>0%</td>
<td>1%</td>
<td>6%</td>
<td>3%</td>
</tr>
<tr>
<td>Computer S.</td>
<td>29%</td>
<td>2%</td>
<td>3%</td>
<td>7%</td>
</tr>
<tr>
<td>Life Sciences</td>
<td>23%</td>
<td>60%</td>
<td>61%</td>
<td>26%</td>
</tr>
</tbody>
</table>

Table 7 exhibits the percentage of companies and universities’ research expenditure, faculty and graduating students in each of the six sciences and technology fields. The second column shows the average companies per fields. Third, fourth and fifth column list the average of research, faculty, and students respectively of the 19 universities. According to this table, the majority of companies in university research parks are in Engineering, Computer Science followed by Life Sciences respectively. Mansfield (1995) observes that universities’ research is relevant for some industries. The findings of his study show that universities are a major contributor to a firm’s innovations, especially in electronics, information processing, pharmaceutical, chemicals and petroleum industries. Similarly, Pavitt (1987) suggests that in specific fields such as pharmaceuticals, chemicals, biotechnology and electronics, there is a closer link with scientific research.
Although, universities in this study received 60 percent of their funding in the Life Sciences area, while only 23 percent of companies in their parks were Life Science oriented. This may reflect several forces. The expensive barriers to entry in Life Science businesses regulated by the Food and Drug Administration means that fewer companies can form relative to lower barrier to entry fields. At the same time, the infrastructure for Life Science research is substantially more expensive than information technology research, so the ratio of research dollars to start-up companies may not be the same between different fields. Additionally, the federal government’s research agenda strongly influences university research priorities.

Likewise the universities in the study received 60 percent of their funding in the Life Sciences, and they have 61 percent of faculty in the Life Sciences. This indicates that faculty is closely aligned with the research funding, and thus are not aligned with the number of companies in their parks. This strong association between numbers of faculty and research funding does show that universities can be strongly influenced by outside financial forces.

The universities in the study graduated 60 percent of students in the Engineering field. This indicates that students are not aligned with either research funding or the types of companies in the parks. This may reflect overall job market demand as opposed to just the opportunities within research parks. For example, very few park tenants were civil engineering firms, yet there is a very large job market for civil engineers and while some tenant firms were involved in chemical processes, these numbers are trivial compared to the total number of chemical corporations (chemical engineering jobs) in the world. It is also possible that the number of
graduating students may correlate to the number of employees in a given field in a research park, for instance, this study looked at numbers of tenant companies not numbers of employees in each field.

*Individual University’s Strengths and Numbers of Companies*

The percentage of research funding or faculty or students should not approximate the percentage of companies in their parks. But, cluster theory would predict that a university which has greater than the average of research funding or faculty or students in a given field, will display greater than the average number of tenant companies in that field. This was not the case in this study.

The relationship of each of the variables was examined in order to accept or reject the null hypotheses. The following null hypotheses are presented:

- NH1: There is not a correlation between the strength of the university’s research capacity in specific technology fields to the technical needs of firms located in the associated university research park.

- NH2: There is not a correlation between the number of faculty in specific technical fields at a university and the technical needs of firms located in the associated university research park.

- NH3: There is not a correlation between the number of graduating students at a university and the technical needs of firms located in the associated university research park.

Correlation analysis was done using the percentage of companies in a given field relative to all companies in a given park, percentage of research funds, percentage of faculty and percentage of students in a given field relative to the total at
the university (normalized) so as to determine the relative strength of each university.

The alpha level for statistical tests was set at .05. Table 9 exhibits the results of these correlations.

Table 8

**Correlation Coefficient between the Percentage of Universities' Research funds,**

**Faculty and Degrees Granted and the Percentage of their University Research Park**

*Companies in the Science and Technology Fields.*

<table>
<thead>
<tr>
<th>Companies</th>
<th>Engineering</th>
<th>Physical Sciences</th>
<th>Environmental</th>
<th>Math</th>
<th>Computer</th>
<th>Life Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Funding</td>
<td>0.264</td>
<td>0.140</td>
<td>0.575</td>
<td>0.060</td>
<td>-0.045</td>
<td>0.278</td>
</tr>
<tr>
<td>Faculty</td>
<td>0.117</td>
<td>-0.112</td>
<td>0.362</td>
<td>0.181</td>
<td>-0.249</td>
<td>-0.050</td>
</tr>
<tr>
<td>Degrees granted</td>
<td>0.219</td>
<td>-0.147</td>
<td>-0.197</td>
<td>-0.565</td>
<td>-0.025</td>
<td>0.292</td>
</tr>
</tbody>
</table>

Table 8 provides the correlation between the included variables. At the Research funding level, there is a significant correlation between a university’s research strength in the environmental sciences and the agglomeration of firms that draw directly from research in this field. However, for the rest of the science and technology fields, the findings do not show a correlation between the two variables. At the faculty level the data shows a lack of correlation. Similarly, at the degrees granted there is a lack of correlation. Even thought there is a significant correlation between a university’s strength in the mathematical science and the agglomeration of firms; the researcher has excluded from the analysis because there is only one
company whose technical needs are linked to university's strength in that field. The following figures provide a graphical representation of the correlations

Figure 2. Relationship between Engineering Companies and Research Funding in Engineering.

Figure 3. Relationship between Physical S. Companies and Research Funding in Physical S.

Figure 4. Relationship between Environmental S. Companies and Research Funding in Environmental S.

Figure 5. Relationship between Computer S. Companies and Research Funding in Computer S.

Figure 6. Relationship between Life S. Companies and Research Funding in Life S.

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Figures 2-6 illustrate the lack of correlations between the included variables. The lack of correlations between companies and research funding might indicate that the federal government’s research agenda strongly influences university research priorities. Often this research agenda is not directed at aligning universities research priorities with its park tenants. Likewise, this might indicate that the clustering around the universities’ assets of research is not the primary driver of technology-based companies located in related university research parks. Despite the emphasis on the current literature that suggests universities as a potential source of knowledge and research, and a significant factor in explaining the clustering of technology-based companies (Almeida & Kogut, 1999; Feldman, 1994; Jaffe, 1989; Jaffe et al., 1993; Porter, 1990; Varga, 1998).

Figures 7-11 show the lack of correlation between companies and faculty. The findings might indicate that a university’s faculty per se is insignificant when explaining the agglomeration of technology-based firms located in research parks. Despite the presumed advantages of university spillovers, the mechanisms by which knowledge is transferred are not well understood. Information flow is often attributed to the use of faculty as consultants (Audretsch & Stephan, 1996; Mansfield & Lee, 1996; Zucker & Darby, 1998). If geographic proximity is important to access and absorb knowledge spillovers, one expects a significant correlation, which indicates that expertise output from faculty serves as an explanation of the agglomeration of companies in university research parks. However, the figures 7-11 illustrate the lack of correlation.
Figure 7. Relationship between Engineering Companies and Faculty in Engineering.

Figure 8. Relationship between of Physical S. Companies and Faculty in Physical S.

Figure 9. Relationship between Environmental S. Companies and Faculty in Environmental S.

Figure 10. Relationship between Computer S. and Companies and Faculty in Computer S.

Figure 11. Relationship between Life S. Companies and Faculty in Life S.
Figure 12. Relationship between Engineering Companies and Degrees in Engineering.

Figure 13. Relationship between of Physical S. Companies and Degrees in Physical S.

Figure 14. Relationship between Environmental S. Companies and Degrees in Environmental S.

Figure 15. Relationship between Computer S. and Companies and Degrees in Computer S.

Figure 16. Relationship between Life S. Companies and Degrees in Life S.
Figures 12-16 illustrate the correlations between graduate students and companies. The lack of correlation between companies and graduate students might indicate that a specialized labor pool generated at the university per se it is insignificant when explaining the agglomeration of technology-based firms located in research parks. Besides it may reflect the high mobility of specialized, knowledge-based labor. Yet the presence of a pool of trained and highly qualified science and engineering graduates is considered another factor for explaining the agglomeration of technology-based companies in university research parks. The results do not support hypothesis H3. These results do not confirms studies on knowledge spillovers that suggest that the high level of human capital serves as a mechanism by which knowledge from university is transmitted to companies (Audretsch et al., 2005; Besson & Montgomery, 1993).

Table 9

|                    | Engineering | Physical Sciences | Environmental | Math  | Computer | Life Sciences |
|--------------------|-------------|-------------------|...............|-------|----------|---------------|
| Research Funding   | 0.114       | 0.124             | 0.553         | 0.058 | -0.105   | 0.351         |
| Faculty            | 0.06        | -0.213            | 0.158         | 0.181 | -0.410   | -0.055        |
| Degrees granted    | 0.137       | -0.141            | -0.114        | -0.565| -0.147   | 0.312         |

The relative strength of a university, measured by research funding, faculty, and degrees granted does not exhibit a convincing relationship with the clustering of
firms. The results presented in table 9 are similar to the results in table 8. Both tables show that there is not a significant correlation between a university's strength and the agglomeration of firms that draw directly from research in science and technology fields. Yet when all the firms, research centers, and organizations, are included the results are similar. Therefore, these findings fail to provide any significant relationship between universities and tenant firms. Likewise the results do not support the research hypotheses H1, H2 and H3.

**Total Research Funding Correlates to More Tenant Firms**

There is a weak correlation between the total R&D expenditures and the amount of tenants in a research park. This is not a significant correlation at the .05 level.

Table 10

<table>
<thead>
<tr>
<th>Correlations between the Total of Universities' Research Capacity and Total Research Park Tenants.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total of R&amp;D expenditures</td>
</tr>
<tr>
<td>Total of research park tenants</td>
</tr>
</tbody>
</table>

*Correlation is significant at the .05 level (2-tailed)*

Table 10 shows that there is a correlation between the total R&D expenditures in 2002 and the amount of tenants in the research parks. Notice that there is not a significant correlation at the .05 level. In fact, this finding seems to support the study of Audretsch et al. (2005). In their research, they conclude that the value of locating in close geographical proximity to a university depends upon the university's output.
The greater the knowledge output of a university, the greater the geographic proximity of firms to a related university.

![Figure 17. Research Funding and Number of Tenant Companies.](image)

While the total research funding and total number of companies yielded a weak correlation, a conclusion that total research funding results in more companies is held out more strongly in a few of the individual fields (Table 10).

The following table 12 indicates that Engineering research funding and faculty were strong predictors of the total number of engineering companies in the park, but not the percentage of engineering firms in the park. Similarly, physical science companies are correlated to total research funding in the physical sciences.

Table 11

*Correlation Coefficients between Science and Technology Fields and Technology-Based Companies.*

<table>
<thead>
<tr>
<th></th>
<th>Engineering</th>
<th>Physical Sciences</th>
<th>Environmental</th>
<th>Math</th>
<th>Computer</th>
<th>Life Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Funding</td>
<td>0.491</td>
<td>0.438</td>
<td>0.339</td>
<td>0.458</td>
<td>0.269</td>
<td>0.286</td>
</tr>
<tr>
<td>Faculty</td>
<td>0.537*</td>
<td>0.078**</td>
<td>0.123</td>
<td>0.483</td>
<td>0.147</td>
<td>0.075**</td>
</tr>
<tr>
<td>Degrees granted</td>
<td>0.219</td>
<td>0.207</td>
<td>-0.173</td>
<td>0.413</td>
<td>0.342</td>
<td>0.155</td>
</tr>
</tbody>
</table>

*Note.* *Correlation is significant at the .05 level (2-tailed)** **Correlation is below 0.01
Figure 18 illustrates the correlation between the total number of physical science companies and total amount of research funding in the physical sciences. Furthermore, figure 19 shows the correlations between the total number of engineering companies and the total number of faculty in this discipline.

Figure 18. Relationship between the Total of Physical Science Companies and Total Research Funding in the Physical Science.

Figure 19. Relationship between the Total Number of Engineering Companies and the Total Number of Faculty in Engineering.
In terms of the science and technology fields, the agglomeration of technology-based companies is significantly correlated with a university's faculty in engineering expenditures in engineering. This might indicates that the impact on the geographical proximity as the sources of knowledge cannot be explained as a simple and straightforward process, but rather this impact can be attributed to a complex process that depends on the type of knowledge and the mechanisms of knowledge transfer. The empirical studies suggest that firms tend to draw directly from universities through university's scientists, in particular, when the nature of the knowledge is tacit rather than codified. Engineering is one of those fields that depend on the constant face-to-face interaction between knowledge producers and knowledge exploiters. These findings corroborate with the literature on innovation that assumes that a university's research and expertise in engineering field are both crucial for the development and growth of high tech industries (Pavitt, 1987; Mansfield, 1995).

It is common sense to expect an increase in the expenditures of a university's research in departments that are linked to these types of industries (Feldman, 1994).

Descriptive Data

The data collected provides a rich descriptor of these mid-life parks that goes beyond just the fundamental research questions posed in this dissertation. It is provided here as empirical documentation and to a lesser extent to further support the findings from previous section. This section presents the descriptive analysis of the four variables. Special attention was paid to revealing the common properties of the distribution of these variables. Tables 12-15 exhibit the characteristics of firms, and university research data.
Table 12

*Characteristics of the Firm Data.*

<table>
<thead>
<tr>
<th>Agglomeration</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Sum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Firms</td>
<td>0</td>
<td>16</td>
<td>112</td>
<td>5.89</td>
</tr>
<tr>
<td>Physical Sciences Firms</td>
<td>0</td>
<td>11</td>
<td>50</td>
<td>2.63</td>
</tr>
<tr>
<td>Environmental Sciences Firms</td>
<td>0</td>
<td>4</td>
<td>18</td>
<td>.95</td>
</tr>
<tr>
<td>Mathematical Sciences Firms</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>.05</td>
</tr>
<tr>
<td>Computer Sciences Firms</td>
<td>0</td>
<td>27</td>
<td>112</td>
<td>5.89</td>
</tr>
<tr>
<td>Life Sciences Firms</td>
<td>0</td>
<td>14</td>
<td>89</td>
<td>4.68</td>
</tr>
</tbody>
</table>

*Note.* Data was collected from the panel of experts.

The sample of 504 firms generated high mean scores in engineering, computer sciences, and the life sciences.

Table 13

*Characteristics of the University R&D Data (R&D Expenditures in Thousands of US Dollars).*

<table>
<thead>
<tr>
<th>Research Capacity</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Sum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering R&amp;D</td>
<td>176</td>
<td>193,590</td>
<td>864,362</td>
<td>45,492.74</td>
</tr>
<tr>
<td>Physical Sciences R&amp;D</td>
<td>499</td>
<td>66,273</td>
<td>315,208</td>
<td>16,589.89</td>
</tr>
<tr>
<td>Environmental Sciences R&amp;D</td>
<td>414</td>
<td>35,314</td>
<td>150,528</td>
<td>7,922.53</td>
</tr>
<tr>
<td>Mathematical Sciences R&amp;D</td>
<td>178</td>
<td>10,816</td>
<td>34,967</td>
<td>1,840.37</td>
</tr>
<tr>
<td>Computer Sciences R&amp;D</td>
<td>205</td>
<td>23,403</td>
<td>68,274</td>
<td>3,593.37</td>
</tr>
<tr>
<td>Life Sciences R&amp;D</td>
<td>1,254</td>
<td>314,857</td>
<td>2,154,61</td>
<td>113,400.7</td>
</tr>
</tbody>
</table>

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Table 14

Characteristic of University Human Capital Data (Number of Degrees in the Science and Technology Fields).

<table>
<thead>
<tr>
<th>Specialized Labor</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Sum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Degrees</td>
<td>2</td>
<td>16,737</td>
<td>26,583</td>
<td>1,399.11</td>
</tr>
<tr>
<td>Physical Sciences Degrees</td>
<td>18</td>
<td>192</td>
<td>1,522</td>
<td>80.11</td>
</tr>
<tr>
<td>Environmental Sciences Degrees</td>
<td>0</td>
<td>164</td>
<td>668</td>
<td>35.16</td>
</tr>
<tr>
<td>Mathematical Sciences Degrees</td>
<td>21</td>
<td>162</td>
<td>1,301</td>
<td>68.47</td>
</tr>
<tr>
<td>Computer Sciences Degrees</td>
<td>41</td>
<td>486</td>
<td>3,096</td>
<td>162.95</td>
</tr>
<tr>
<td>Life Sciences Degrees</td>
<td>169</td>
<td>1,271</td>
<td>11,866</td>
<td>624.53</td>
</tr>
</tbody>
</table>

Table 15

Characteristics of the University Human Capital Data (Number of Faculty Members).

<table>
<thead>
<tr>
<th>Human Capital</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Sum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Faculty</td>
<td>32</td>
<td>416</td>
<td>3,574</td>
<td>188.11</td>
</tr>
<tr>
<td>Physical Sciences Faculty</td>
<td>26</td>
<td>203</td>
<td>1,493</td>
<td>78.58</td>
</tr>
<tr>
<td>Environmental Sciences Faculty</td>
<td>11</td>
<td>96</td>
<td>836</td>
<td>44.00</td>
</tr>
<tr>
<td>Mathematical Sciences Faculty</td>
<td>18</td>
<td>127</td>
<td>1,128</td>
<td>59.37</td>
</tr>
<tr>
<td>Computer Sciences Faculty</td>
<td>17</td>
<td>77</td>
<td>646</td>
<td>34.00</td>
</tr>
<tr>
<td>Life Sciences Faculty</td>
<td>20</td>
<td>1,566</td>
<td>12,160</td>
<td>640.00</td>
</tr>
</tbody>
</table>

Tables 12-15 depict the descriptive statistics for the following independent variables: research capacity, human capital, and specialized labor. The sample of 19 universities generated a mean of 113,400.7 and 45,492.74 of R&D expenditures in the life sciences and engineering fields respectively. Similarly, the data of human capital generated a mean of 640 and 188 of scientists in the life science and engineering fields respectively. The data on specialized labor generated a mean of 1,399 and 625.
of degrees granted in engineering and life sciences fields. In terms of the university level, the data of the sample of 19 universities generated relatively high mean scores in the life sciences and engineering in each of the three variables. The mean reflects the skewed distribution of the data.

The following section describes the spatial distribution of research park firms. Figure 20 illustrates the geographical location of the sample of nineteen university research parks in the United States. The university research parks are located in seventeen states: Delaware, Iowa, Illinois (two research parks), Kentucky, Louisiana, Massachusetts, Missouri, Mississippi, North Carolina, New York, Ohio, Oregon, Pennsylvania, Texas, Utah, Virginia (two research parks), and Washington.

Figure 20. The Location of the 19 University Research Parks.
Table 16 shows the percentage of firms in the science and technology fields in university research parks. In the table, the maximum percent of firms is highlighted to indicate the strength of each university research park.

Table 16

*Percentage of Firms in the Fields of Science and Technology by University Research Parks.*

<table>
<thead>
<tr>
<th>University Research Parks</th>
<th>Engineering</th>
<th>Physical Sciences</th>
<th>Environmental Sciences</th>
<th>Mathematical Sciences</th>
<th>Computer Sciences</th>
<th>Life Sciences</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delaware Technology Park</td>
<td>23%</td>
<td>18%</td>
<td>3%</td>
<td>0%</td>
<td>22%</td>
<td>18%</td>
<td>15%</td>
</tr>
<tr>
<td>Quakadle Research Park</td>
<td>27%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>27%</td>
<td>7%</td>
<td>40%*</td>
</tr>
<tr>
<td>Northwestern University/Evanston Research Park</td>
<td>23%</td>
<td>11%</td>
<td>2%</td>
<td>0%</td>
<td>26%*</td>
<td>11%</td>
<td>26%*</td>
</tr>
<tr>
<td>University Park</td>
<td>8%</td>
<td>0%</td>
<td>8%</td>
<td>0%</td>
<td>8%</td>
<td>15%</td>
<td>62%*</td>
</tr>
<tr>
<td>Cold stream Research Campus</td>
<td>27%</td>
<td>4%</td>
<td>4%</td>
<td>0%</td>
<td>4%</td>
<td>19%</td>
<td>42%*</td>
</tr>
<tr>
<td>Louisiana Business and Technology Center</td>
<td>0%</td>
<td>17%</td>
<td>17%</td>
<td>0%</td>
<td>50%*</td>
<td>17%</td>
<td>0%</td>
</tr>
<tr>
<td>Biosquare at Boston University Medical Center</td>
<td>14%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>71%*</td>
<td>14%</td>
</tr>
<tr>
<td>Missouri Research Park</td>
<td>20%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>10%</td>
<td>15%</td>
<td>50%*</td>
</tr>
<tr>
<td>Mississippi Research and Technology Park</td>
<td>38%</td>
<td>23%</td>
<td>0%</td>
<td>0%</td>
<td>15%</td>
<td>0%</td>
<td>23%</td>
</tr>
<tr>
<td>Centennial Campus Cornell Business and Technology Park</td>
<td>19%</td>
<td>7%</td>
<td>7%</td>
<td>0%</td>
<td>22%</td>
<td>14%</td>
<td>32%*</td>
</tr>
<tr>
<td>Miami Valley Research Foundation</td>
<td>15%</td>
<td>13%</td>
<td>0%</td>
<td>0%</td>
<td>16%</td>
<td>23%</td>
<td>33%*</td>
</tr>
<tr>
<td>Riverfront Research Park</td>
<td>16%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>28%</td>
<td>0%</td>
<td>52%*</td>
</tr>
<tr>
<td>Innovation Park at Penn State</td>
<td>8%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>21%</td>
<td>21%</td>
<td>46%*</td>
</tr>
<tr>
<td>Texas Research Park Foundation</td>
<td>17%</td>
<td>6%</td>
<td>2%</td>
<td>2%</td>
<td>11%</td>
<td>9%</td>
<td>54%*</td>
</tr>
<tr>
<td>Utah State University Innovation Campus Fontaine Research Park</td>
<td>11%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>78%*</td>
<td>11%</td>
</tr>
<tr>
<td>Virginia Tech Corporate Research Center</td>
<td>14%</td>
<td>0%</td>
<td>3%</td>
<td>0%</td>
<td>10%</td>
<td>10%</td>
<td>62%*</td>
</tr>
<tr>
<td>Tri Cities science and Technology Park</td>
<td>21%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>38%</td>
<td>43%*</td>
</tr>
<tr>
<td>15%</td>
<td>6%</td>
<td>3%</td>
<td>0%</td>
<td>26%</td>
<td>8%</td>
<td>43%*</td>
<td></td>
</tr>
<tr>
<td>12%</td>
<td>9%</td>
<td>7%</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>73%*</td>
<td></td>
</tr>
</tbody>
</table>

*Note. * Strength of each university research park
Table 16 depicts some interesting pattern in the data. The majority of research parks have a high percentage of the tenants in the "other category". This might indicate that the majority of the university research parks in the sample attract firms that do not necessarily draw from a university's research base. However, there were two university research parks that had a high percent of firms in engineering; another had a high number of firms in the computer sciences, and also two other university research parks with a significant quantity of firms in the life sciences.

In terms of the characteristics of university research park firms, table 17 presents the percentage of firms in the science and technology fields. Firms were classified based on the National Science Foundation's classification of academic fields. Following this classification, firms were matched to these science and technology fields, as shown in table 17.

Table 17

<table>
<thead>
<tr>
<th>Science and Technology Fields</th>
<th>% Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>18%</td>
</tr>
<tr>
<td>Physical Sciences</td>
<td>8%</td>
</tr>
<tr>
<td>Environmental Sciences</td>
<td>3%</td>
</tr>
<tr>
<td>Mathematical Sciences</td>
<td>.1%</td>
</tr>
<tr>
<td>Computer Sciences</td>
<td>18%</td>
</tr>
<tr>
<td>Life Sciences</td>
<td>14%</td>
</tr>
<tr>
<td>Other- Firms that do not draw from university research based, and organizations</td>
<td>40%</td>
</tr>
</tbody>
</table>
According to table 17, sixty percent of firms located in research parks are firms whose core activities rely on research activities in the fields of engineering, physical science, life sciences, mathematical and computer sciences. It is important to notice that the number of technology-based firms (firms that are linked to a university’s research) is quite high.

Figure 21 illustrates the distribution of firms by categories. It is evident that each university research park attracts different types of firms. For example 40 percent of the firms seem to be involved with activities that not require the university research in science and technology fields. In terms of the science and technology fields, it seems that firms located in research parks are more likely to draw from research in engineering and computer sciences, followed by life sciences. On the other hand, there is small concentration of firms that draws information from research in the mathematical sciences.

Figure 21. Percentage of Research Park Firms in the Science and Technology Fields.
Figure 22 illustrates the percentage of the different types of firms by university research parks.

Figure 22. University Research Park Firms by Research Parks.

The distribution of firms is greater in some science and technology fields, particularly, in engineering, life sciences, and computer sciences. In terms of the other research park tenants, figure 22 shows the percentage of firms located in university research parks that do not rely necessarily on university research base, research centers or other organizations.
These firms and organizations provide support to technology-based firms in the clusters. Figure 23 shows that 48 percent of firms are in the category of other services, 23 percent in the category other organizations, 12 percent are in the category of research centers, followed by six percent in the category of financial and insurance firms. It is important to emphasize the presence of organizations, research centers as well as financial and service firms in research parks. As described in the literature, the presence of specific supporting organizations, not to mention financial and service firms is critical in the development of entrepreneurial activities, spin-off firms, overall firm performance, and consequently, cluster development. In these 19 university research parks, there is a clear evidence of presence of both supporting organizations and financial and service firms.

Characteristics of the universities were analyzed based on the three independent variables. University research strength was measured for each university
based on how R&D expenditures in science and technology fields are distributed at each university. To indicate the strength of each university in science and technology fields, the researcher then averaged the R&D across the fields within each university.

Table 18 indicates the percentages in each field for each university.

Table 18

Percentage of R&D Expenditures by Universities for the FY 2002.

<table>
<thead>
<tr>
<th>Universities</th>
<th>Engineering</th>
<th>Physical Sciences</th>
<th>Environmental Sciences</th>
<th>Mathematical Sciences</th>
<th>Computer Sciences</th>
<th>Life Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Delaware</td>
<td>40%*</td>
<td>17%</td>
<td>13%</td>
<td>1%</td>
<td>3%</td>
<td>27%</td>
</tr>
<tr>
<td>The University of Iowa</td>
<td>4%</td>
<td>7%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>88%*</td>
</tr>
<tr>
<td>Northwestern University</td>
<td>18%</td>
<td>9%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
<td>71%*</td>
</tr>
<tr>
<td>Southern Illinois University</td>
<td>39%*</td>
<td>7%</td>
<td>28%</td>
<td>5%</td>
<td>3%</td>
<td>18%</td>
</tr>
<tr>
<td>University of Kentucky</td>
<td>18%</td>
<td>4%</td>
<td>1%</td>
<td>0%</td>
<td>2%</td>
<td>74%*</td>
</tr>
<tr>
<td>Louisiana State University</td>
<td>16%</td>
<td>7%</td>
<td>13%</td>
<td>0%</td>
<td>1%</td>
<td>62%*</td>
</tr>
<tr>
<td>Boston University</td>
<td>12%</td>
<td>9%</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
<td>75%*</td>
</tr>
<tr>
<td>University of Missouri System</td>
<td>21%</td>
<td>5%</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
<td>71%*</td>
</tr>
<tr>
<td>Mississippi State University</td>
<td>37%</td>
<td>4%</td>
<td>5%</td>
<td>1%</td>
<td>2%</td>
<td>53%*</td>
</tr>
<tr>
<td>North Carolina State University</td>
<td>28%</td>
<td>7%</td>
<td>6%</td>
<td>4%</td>
<td>2%</td>
<td>53%*</td>
</tr>
<tr>
<td>Cornell University</td>
<td>65%*</td>
<td>4%</td>
<td>1%</td>
<td>1%</td>
<td>5%</td>
<td>67%*</td>
</tr>
<tr>
<td>Central State University</td>
<td>12%</td>
<td>14%</td>
<td>1%</td>
<td>1%</td>
<td>5%</td>
<td>24%</td>
</tr>
<tr>
<td>and University of Dayton</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Oregon</td>
<td>1%</td>
<td>27%</td>
<td>5%</td>
<td>2%</td>
<td>7%</td>
<td>59%*</td>
</tr>
<tr>
<td>The Pennsylvania State University</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Texas at San Antonio</td>
<td>43%*</td>
<td>13%</td>
<td>6%</td>
<td>2%</td>
<td>1%</td>
<td>36%</td>
</tr>
<tr>
<td>Utah State University</td>
<td>51%*</td>
<td>4%</td>
<td>9%</td>
<td>1%</td>
<td>1%</td>
<td>34%</td>
</tr>
<tr>
<td>University of Virginia</td>
<td>16%</td>
<td>8%</td>
<td>3%</td>
<td>0%</td>
<td>3%</td>
<td>70%*</td>
</tr>
<tr>
<td>Virginia Tech</td>
<td>39%</td>
<td>6%</td>
<td>6%</td>
<td>1%</td>
<td>2%</td>
<td>46%*</td>
</tr>
<tr>
<td>Washington State University</td>
<td>16%</td>
<td>9%</td>
<td>2%</td>
<td>1%</td>
<td>0%</td>
<td>72%*</td>
</tr>
</tbody>
</table>

Note. * Strength of each university in science and technology fields.

In terms of a university level, table 16 indicates that university research strength is quite high in the life sciences followed by engineering. All of the 19 universities show a low distribution in the mathematical sciences. According to the National Science Foundation (2004) medical sciences and biological research
accounted for the largest field shares of total academia R&D performance for the fiscal year of 2002.

In terms of the total R&D expenditures for the fiscal year of 2002, the sample of 19 universities shows approximately $4 billions in total research expenditures. The 19 universities capture 10 percent of the national total of research expenditures for the year 2002. The following figure illustrates the percentage of R&D expenditures by academic field.

Figure 24. Share of Academic R&D in the Science and Technology Fields in 2002.
According to figure 24, the percentages are distributed as follow: life sciences 60 percent, engineering 24 percent, physical sciences 9 percent, environmental sciences 4 percent, computer sciences 2 percent, and mathematical sciences 1 percent. These two pie charts (figure 24 and figure 25) depict the distribution of science and technology field's R&D expenditures from the sample of 19 university research parks and the total academic R&D expenditures in the science and technology fields in the U.S. for the fiscal year of 2002. Specific academic fields stand out within the research sample. The sample shows a higher concentration in engineering and the life sciences. For other fields, the sample is similar to the mathematical sciences.

Human capital is measured by the total number of university faculty. Studies on the development of technology-based industries demonstrate the importance of localized knowledge spillovers by building specific links between university scientists and firms (Audretsch & Stephan, 1996; Zucker & Darby, 1998). Knowledge
spillovers are central to Romer (1986) growth models; it is also considered a factor in
the cluster of firms. Empirical studies provide evidence that the relationship between
a university's scientists and firms explains observable technology transfers as well as
how knowledge spillover affect a firm's innovative capacity.

Table 19

Percentage of the Faculty Members in the Science and Technology Fields by Universities.

<table>
<thead>
<tr>
<th>Universities</th>
<th>Engineering</th>
<th>Physical Sciences</th>
<th>Environmental Sciences</th>
<th>Mathematical Sciences</th>
<th>Computer Sciences</th>
<th>Life Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Delaware</td>
<td>23%</td>
<td>12%</td>
<td>13%</td>
<td>8%</td>
<td>4%</td>
<td>40%</td>
</tr>
<tr>
<td>The University of Iowa</td>
<td>5%</td>
<td>4%</td>
<td>1%</td>
<td>3%</td>
<td>2%</td>
<td>86%</td>
</tr>
<tr>
<td>Northwestern University</td>
<td>15%</td>
<td>4%</td>
<td>1%</td>
<td>2%</td>
<td>1%</td>
<td>78%</td>
</tr>
<tr>
<td>Southern Illinois University</td>
<td>22%</td>
<td>23%</td>
<td>17%</td>
<td>12%</td>
<td>12%</td>
<td>14%</td>
</tr>
<tr>
<td>University of Kentucky</td>
<td>19%</td>
<td>11%</td>
<td>5%</td>
<td>9%</td>
<td>4%</td>
<td>53%</td>
</tr>
<tr>
<td>Louisiana State University</td>
<td>11%</td>
<td>6%</td>
<td>4%</td>
<td>4%</td>
<td>1%</td>
<td>73%</td>
</tr>
<tr>
<td>University of Missouri System</td>
<td>8%</td>
<td>5%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
<td>82%</td>
</tr>
<tr>
<td>Mississippi State University</td>
<td>24%</td>
<td>12%</td>
<td>2%</td>
<td>6%</td>
<td>4%</td>
<td>52%</td>
</tr>
<tr>
<td>University of North Carolina State</td>
<td>23%</td>
<td>5%</td>
<td>2%</td>
<td>4%</td>
<td>6%</td>
<td>58%</td>
</tr>
<tr>
<td>University</td>
<td>26%</td>
<td>7%</td>
<td>4%</td>
<td>9%</td>
<td>4%</td>
<td>52%</td>
</tr>
<tr>
<td>Cornell University</td>
<td>16%</td>
<td>7%</td>
<td>5%</td>
<td>5%</td>
<td>3%</td>
<td>65%</td>
</tr>
<tr>
<td>Central State University and</td>
<td>16%</td>
<td>8%</td>
<td>4%</td>
<td>6%</td>
<td>5%</td>
<td>61%</td>
</tr>
<tr>
<td>University of Dayton</td>
<td>12%</td>
<td>19%</td>
<td>20%</td>
<td>8%</td>
<td>5%</td>
<td>36%</td>
</tr>
<tr>
<td>University of Oregon</td>
<td>27%</td>
<td>9%</td>
<td>7%</td>
<td>9%</td>
<td>5%</td>
<td>42%</td>
</tr>
<tr>
<td>The Pennsylvania State University</td>
<td>32%</td>
<td>11%</td>
<td>7%</td>
<td>9%</td>
<td>10%</td>
<td>30%</td>
</tr>
<tr>
<td>University of Texas at San Antonio</td>
<td>23%</td>
<td>8%</td>
<td>16%</td>
<td>8%</td>
<td>5%</td>
<td>59%</td>
</tr>
<tr>
<td>Utah State University</td>
<td>18%</td>
<td>7%</td>
<td>3%</td>
<td>3%</td>
<td>2%</td>
<td>67%</td>
</tr>
<tr>
<td>University of Virginia</td>
<td>35%</td>
<td>8%</td>
<td>3%</td>
<td>11%</td>
<td>4%</td>
<td>39%</td>
</tr>
<tr>
<td>Virginia Tech</td>
<td>25%</td>
<td>12%</td>
<td>10%</td>
<td>10%</td>
<td>6%</td>
<td>36%</td>
</tr>
</tbody>
</table>

In terms of a university's strength based on human capital, table 19 shows quite a
higher distribution of scientists in the life sciences. Likewise in terms of science and
technology, figure 25 depicts the distribution of university faculty among the 19 universities

![Pie chart showing distribution of university faculty in Science and Technology fields in 2005]

Figure 26. Share of University Faculty in the Science and Technology Fields in 2005.

In figure 26, the percentage of faculty is distributed as follows: life sciences 61 percent, engineering 18 percent, physical sciences 8 percent, mathematical sciences 6 percent, environmental sciences 4 percent, and computer sciences 3 percent. The total of university faculty in the science and technology fields is 19,837.

Table 20 shows the percentage of degrees in science and technology granted at each of the universities in the study.
In terms of a university’s strength, Table 20 shows most universities have a majority of degrees granted in the life sciences followed by engineering.

In terms of the science and technology fields, Figure 26 illustrates the distribution of degrees granted at the sample set of 19 universities.

<table>
<thead>
<tr>
<th>Universities</th>
<th>Engineering</th>
<th>Physical Sciences</th>
<th>Environmental Sciences</th>
<th>Mathematical Sciences</th>
<th>Computer Sciences</th>
<th>Life Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Delaware</td>
<td>33%</td>
<td>7%</td>
<td>2%</td>
<td>5%</td>
<td>11%</td>
<td>43%</td>
</tr>
<tr>
<td>The University of Iowa</td>
<td>25%</td>
<td>5%</td>
<td>1%</td>
<td>7%</td>
<td>7%</td>
<td>56%</td>
</tr>
<tr>
<td>Northwestern university</td>
<td>46%</td>
<td>9%</td>
<td>0%</td>
<td>6%</td>
<td>10%</td>
<td>29%</td>
</tr>
<tr>
<td>Southern Illinois University</td>
<td>35%</td>
<td>4%</td>
<td>1%</td>
<td>4%</td>
<td>7%</td>
<td>49%</td>
</tr>
<tr>
<td>University of Kentucky</td>
<td>31%</td>
<td>3%</td>
<td>1%</td>
<td>5%</td>
<td>7%</td>
<td>54%</td>
</tr>
<tr>
<td>Louisiana State University</td>
<td>37%</td>
<td>2%</td>
<td>4%</td>
<td>4%</td>
<td>5%</td>
<td>48%</td>
</tr>
<tr>
<td>Boston University</td>
<td>21%</td>
<td>5%</td>
<td>1%</td>
<td>4%</td>
<td>14%</td>
<td>54%</td>
</tr>
<tr>
<td>University of Missouri System</td>
<td>24%</td>
<td>5%</td>
<td>2%</td>
<td>3%</td>
<td>12%</td>
<td>54%</td>
</tr>
<tr>
<td>Mississippi State University</td>
<td>42%</td>
<td>2%</td>
<td>16%</td>
<td>3%</td>
<td>6%</td>
<td>30%</td>
</tr>
<tr>
<td>North Carolina State University</td>
<td>49%</td>
<td>6%</td>
<td>1%</td>
<td>5%</td>
<td>11%</td>
<td>28%</td>
</tr>
<tr>
<td>Cornell University</td>
<td>40%</td>
<td>6%</td>
<td>2%</td>
<td>4%</td>
<td>9%</td>
<td>39%</td>
</tr>
<tr>
<td>Central State University and University of Dayton</td>
<td>56%</td>
<td>5%</td>
<td>4%</td>
<td>4%</td>
<td>8%</td>
<td>23%</td>
</tr>
<tr>
<td>University of Oregon</td>
<td>1%</td>
<td>25%</td>
<td>4%</td>
<td>6%</td>
<td>19%</td>
<td>45%</td>
</tr>
<tr>
<td>The Pennsylvania State University</td>
<td>89%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>3%</td>
<td>7%</td>
</tr>
<tr>
<td>University of Texas at San Antonio</td>
<td>27%</td>
<td>2%</td>
<td>2%</td>
<td>7%</td>
<td>14%</td>
<td>48%</td>
</tr>
<tr>
<td>Utah State University</td>
<td>40%</td>
<td>4%</td>
<td>1%</td>
<td>3%</td>
<td>20%</td>
<td>32%</td>
</tr>
<tr>
<td>University of Virginia</td>
<td>45%</td>
<td>15%</td>
<td>0%</td>
<td>3%</td>
<td>7%</td>
<td>30%</td>
</tr>
<tr>
<td>Virginia Tech</td>
<td>55%</td>
<td>3%</td>
<td>1%</td>
<td>5%</td>
<td>11%</td>
<td>24%</td>
</tr>
<tr>
<td>Washington State University</td>
<td>27%</td>
<td>4%</td>
<td>1%</td>
<td>4%</td>
<td>7%</td>
<td>56%</td>
</tr>
</tbody>
</table>
Figure 27. Share of Degrees in the Science and Technology Fields.

In figure 27, the percentage of degrees is distributed as follows: engineering sixty percent, life sciences twenty six percent, computer sciences six percent, physical sciences three percent, mathematical sciences three percent, and environmental sciences one percent. The 19 universities granted a total of 45,036 degrees in 2004.

Therefore, the characteristics of the firms and the universities are important for understanding the relationship between firms and university in research parks. Taking together, these findings provide a greater understanding of the role of universities in research parks. In terms of the strength of a university's research capacity, measured by R&D expenditures, faculty, and degrees granted in the science and technology fields, the findings do not provide a clear and convincing evidence of the university effect on the clustering of technology-based firms in research parks.
Yet, the findings suggest two additional insights: there is a correlation between the total R&D expenditures and the propensity of research park tenants, and there is a significant correlation between engineering and firms that rely on research in this particular field. These two additional observations support the intuition that local university effects might be substantial components of research park activities.

Increased university research expenditures are associated with the agglomeration of research park tenants and the probability of observing any cluster of firms that rely on engineering research in a research park is related to the degree of university research base in this particular field.

Overall, it is important to stress here that the common tendencies of the university variables do not necessarily mean that a university’s research base is a significant factor in the agglomeration patterns of research park firms. As the case with every analysis, the above findings need to be treated with caution. The lack of evidence to support the existence of measurable university effects on the clustering of firms suggests that the three variables might be exogenously determined by other factors. Thus other approaches are needed to determine the true role of university in research parks. The next chapter contains the main outcomes of the investigation as well as future implications.
CHAPTER V
SUMMARY AND CONCLUSIONS

Cluster theory predicts that technology-based companies will locate near universities to take advantage of technology transfer, knowledge spillover, and specialized labor (Audretsch et al., 2005; Feldman, 1994; Porter, 1990; Varga, 1998).

Empirical evidence shows that university research parks have not been an effective economic intervention (Appold, 2004; Massey et al., 1992; Shearmur & Dolorous, 2000; Westhead & Baststone, 1998). The findings of this study show that clustering around the universities' assets of research, faculty and students is not the primary driver of university research park tenants.

The implications of this study are explored, changes in policy are recommended and modifications to implementation are suggested. In addition, opportunities for future studies are explored.

Implications

The Common Interpretation of Cluster Theory and Technology-Based Firms

A sizable number of empirical studies has documented the essential role of universities in the development and growth of the two largest technology-based clusters, Silicon Valley and Route 128. The cluster success in these two regions has been attributed to the presence of two universities, Stanford University and the Massachusetts Institute of Technology (Saxenia, 1994). The literature suggests that the presence of a university or universities with advanced and highly recognized research in specific technological areas (Saxenia, 1994; Koh et al. 2005; Phillips & Yeung, 2003; Goldstein & Luger, 1991; Weber-Bleyle, 2003) is an essential
component for the success of such university research parks. Moreover, the empirical studies suggest that technology-based companies develop links with universities through supplier-customer relationship, specialized labor market and knowledge spillovers. Indeed, these three factors are considered relevant factors for the clustering of firms. These three variables fit well within the traditional functions of universities. Universities expand human capital through education and training, and generate knowledge, through basic and applied research (Castells & Hall, 1994; Malecki, 1991; Paytas et al., 2004; Porter, 1990).

In the case of university research parks, Porter’s cluster model predicts that the core competencies of the universities should to align with the technical and workforce needs of the companies located in the university research parks. The analysis fails to provide any significant relationship between universities and the technological needs of technology-based companies located in related university research parks. Being geographically near to a university in a particular strength in the fields of science and technology does not seem to correlate with the propensity of firms located in university research parks. Even though, the literature suggests that research parks facilitate the commercialization of a university’s research; the results cannot uphold such an assumption. One must expect a close relationship between the strength of a university in a given science and technology field and the applied technology of the research park firms nearby.

Instead these results are consistent with the studies of Appold (2004), Massey et al. (1992), Shearmur and Doloreux (2000), and Westhead and Baststone (1998). The authors suggest that research parks are real estate initiatives. Firms tend
to locate in a research park for the prestige of the location and not necessarily to promote the development of links with nearby universities and accelerate the clustering of technology-based firms. Appold (2004) argues that the ability of university research parks to shape the geography of innovation through local policy appears to be limited. Yet, most of cluster creation initiatives are driven by public sector intervention; there is a need to understand how universities impact the actual development of university research parks (Association of University Research Parks, 2003).

An interpretation of the findings is that the common understanding of cluster theory, university research parks and technology-based firms is wrong. It is possible that proximity to a university is an irrelevant factor to most (but not all) technology-based firms. Technology transfer, knowledge spillover and specialized labor could be imported to a region at an undifferentiated cost from obtaining them from within the region. Thus, other factors, such as quality of life (to attract the specialized labor), access to capital, financial incentives and the personal desires of the firms management may be the most significant drivers (Markusen et al., 1986; Malecki, 1986; Westhead & Baststone, 1998).

The theory cluster assumes that locating close to a knowledge source firm aids firms reducing their knowledge acquisition costs (Audretsch et al., 2005; Feldman, 1994; Porter, 1990). However, a technology-based firm may be as capable of licensing technology from a university on the other side of the world as in their own backyard. Most technology transfer occurs through the licensing of a patent. A firm anywhere in the world can access the patent databases, identify key patents and
negotiate with the university (or other entity) holding the patent. Proximity may play a factor in a firm's ability to license; however, without data to support this, one may postulate both positive and negative effects of proximity. For example, proximity may lead to stronger impressions by the patent holder regarding the quality of the potential licensee based on past experiences and bias the patent holder's decision to license.

Knowledge spillover may occur most frequently through publications in academic journals. While universities have greatly increased their patent rate, they still contribute only a small percentage of US patents each year (Gallini, 2002; Thursby & Thursby, 2002). Most universities release their intellectual property through publications in academic journals. Academic journals are equally available anywhere in the world in which information technology infrastructure is moderately sophisticated. While likely some knowledge does not spillover through publications, there is insufficient evidence to suggest that knowledge spillover from universities through methods not related to publishing is significant. This study does not contradict that knowledge spillover through anything other than publishing is trivial nor does it provide direct evidence supporting such a statement.

Specialized, knowledge-based labor is a large output of the university and a critical input for technology-based companies (Audretsch et al., 2005; Beeson & Montgomery, 1993; Castells & Hall, 1994; Feldman, 1994; Malecki, 1986; Porter, 1990; Zucker & Darby, 1998). The lack of correlation between university student output and the types of companies located in university research parks may reflect the high mobility of specialized, knowledge-based labor. In order to attract this
specialized, knowledge-based labor, employers need to create highly attractive work environments. University research parks with restrictive covenants would certainly meet the work environments needed to recruit key employees.

Thus, a university research park may be an attractive asset for technology-based firms to locate in, may offer financial incentives or other factors not directly related to knowledge spillover, technology transfer nor proximity of knowledge-based workforce. It is also possible that firms cluster near other firms that can provide knowledge spillover, an experienced knowledge-based workforce, supplier or customer relationships or other services. While this study has demonstrated that cluster theory is not being applied to the leveraging of the universities’ knowledge assets, it has not denied the possibility of other factors driving clustering.

Further data collection of the reasons that companies have located in the 19 studied parks, their relationships with other companies in the park and region and analysis of other clustering factors is needed to further understand the value of university research parks.

Likewise university research parks fail to implement clustering because of financial pressures. According to the Association of University Research Parks survey 2003, only about one third of university research parks are directly owned by the university with the rest being owned jointly or entirely by developers. Additionally, university research parks’ operations are often contracted to private developers (Clark, 2003; Goldstein & Luger, 1991). Therefore, the financial pressure to land lease property to anyone, regardless of their business model, is very high.
Even a university that owns and operates its park is under pressure to generate cash flow to offset the general costs associated with maintaining the park and salaries of employees involved in park operations. Universities may also be under other financial pressures that make liquidation of land holdings a priority.

Coupled with the financial pressures that universities and others involved in park operations may be under are the questionable financial values of restricting park tenants to only those that help form a cluster with a university. While the possibility for joint research funding, licensing to the company and intangibles that may lead to better student and faculty recruiting are often considered, there are no available studies of the value created for the university when a technology-based company locates near it.

There are significant financial pressures on universities to lease land and possibly little financial incentive to only lease it to firms with a specific technology base. Even if there are financial values to only leasing land to specific firms that form a cluster with a university, the lack of knowledge about these financial values makes senior administrative decision making challenging. Further work ought to be dedicated to studying the value to the university of technology-based companies that have strong relationships with that university and how proximity affects this value.

Universities fail to implement clustering because of structural and cultural issues. Physical distance between university facilities and those of tenant companies may range from several hundred feet to dozens of miles. As studies have shown, distance of only a few miles can greatly reduce the effectiveness of collaboration between universities and companies (Audretsch et al., 2005; Audretsch and Feldman,
Thus, the mere creation of a research park does not provide more effective knowledge spillover or technology transfer if the distance between the park and campus is substantial.

In addition to physical distance, cultural distance may also play a role. The needs of faculty to publish and companies to keep trade secrets are reasonably at odds with each other. There is a cultural barrier to faculty and companies working together (Slaughter, Archerd & Campbell, 2004; Siegel et al., 2003). Businesses and universities are not natural partners. Their cultures and their missions differ; the businesses' main goals are to make profit and build value for shareholders while universities traditional missions are to develop new knowledge and educate the next generation. Thus it also may be in the universities best interest to widely publish in academic journals in order to attract better faculty and students, especially at the graduate level.

The cultural differences include faculty publication pressures and extends into the inability (or even desirability) of university administration to specifically direct the research efforts of existing faculty. Academic freedom and managing creativity encourages the university administration to allow faculty to pursue any ethical research interest. This can make aligning university research efforts with those of tenant companies complicated.

Further minimizing the chances of successful clustering, the university administrator most able to influence the research and academic agenda often lacks the basic real estate management skills needed to drive the park. This often leads to division of responsibility and a coinciding difference in priorities.
Identifying these structural and cultural barriers would need to be done through surveys and analysis of specific interactions.

Clearly, Porter's concept is more synopses of accepted agglomeration phenomena rather than a new insight explaining the reason why firms group in a specific space. As Malmberg and Maskell (2002) and Martin and Sunley (2003) point out that Porter is successful in promoting the concept of competitiveness which appeals to politicians and policy makers, instead of providing a modeling framework that can be rigorously applied in practice; to some extent the cluster concept is a very generic and vague way of thing about regional economic development. Like any popular and heavily market idea, cluster can be an effective strategy but it is often misapplied or over-promoted as, for example, clusters are considered panaceas for economic growth and sustainability. In many cases clusters become empty promises.

There is the belief that bringing together some basic components: specialized labor pool, top academic institutions, venture capital and economic initiatives is sufficient to initiate a cluster. However, it may not be so simple.

The success of a university-based cluster initiative requires not only a large base of university research and development activities, but also appropriate conditions within the region. The characteristics of the clusters are just as important as the characteristics of the universities (Paytas et al., 2004). The establishment of a leading research focus area within a university cannot be considered as the sole factor for attracting technology-based firms or generating spin-off firms. In order to accelerate the development of technology-based clusters through research park, it is important to have a clear understanding of a university's research competences and
the ability of these institutions to facilitate the transfer of knowledge and technology more effectively to firms.

Policy Implications

University research parks focus only in attracting establishment alone is not likely to lead to production of innovation nor integrated or propulsive high-technology clusters. Explicit policies aiming to foment the link between university research park tenants and university must be established (Castells & Hall, 1994; Massey et al., 1992; Glasmeier, 1988). The efforts of many US states to advance local universities as a way to develop their high technology economic based have been widely recognized in the literature (Feller, 1984; Malecki, 1986). The findings of this research provide the following practical policies recommendations.

First of all, federal, state and local government policy and actions can influence clustering around university assets.

The research agenda set by the federal government is not directed at aligning universities research priorities with its park tenants. Specific programs that encourage corporate/university partnerships need to be expanded. For example, the National Science Foundation's Partnership for innovation (PFI) funds university/business projects without specific regard to the field of science. Expanding this program beyond the $100,000 grants that are typically awarded could spur interaction. Further requiring that all PFIs be granted only between universities and their park tenants can favor clustering.

Additionally, federal money used for university research parks should come with more strings attached by requiring that the university only lease to companies
with which it has a strong relationship. As many parks are built with congressional
ear-marks, it would also be fruitful to have congressional delegations more carefully
craft bill language to focus the marks more effectively. Such federal intervention and
specificity is preferred to the current policy which promotes competition between
private commercial parks and university research parks.

State policy has potential to greatly influence university research parks as
public universities fall under a range of regulations by their states. How public
universities use their land can be directly mandated by the legislature and governing
boards. These organizations could provide more stringent guidance to universities,
mandating their research parks maximize interaction and clustering. Such policies
would also reduce community strains between universities and private developers
from competing for projects.

Local governments often come under pressure to build roads and
infrastructure for university research parks. Additionally, local government sets
zoning and business ordinances which can regulate the types of businesses that locate
in the park. This provides local government with influence opportunity over the
university. Local government can minimize conflict between private developers and
university by insisting on the university to use covenant restricted to companies
having a direct relationship with the university. Thus, local policy can both help ease
competitive tensions in the community and maximize the clustering of firms with a
university. Further, congressional mark may request from the university ought to
include both part tenants and university needs.
Second universities must take a series of steps to encourage clustering. Management structure must reward executing leases with companies that have synergy with the university. A close look at who is responsible for recruiting and negotiating with companies is needed to ensure that the responsible people understand the value of the university research efforts.

Faculty should be encouraged to seek out and work with park tenants. This may be done by providing course release time for park tenant projects or consulting. Additionally, the university may provide matching grants when a faculty member gets funding related to a park tenant.

Hiring of new faculty ought to consider their synergy with the needs of park tenants. Opportunity to co-locate faculty with or near park tenant facilities should also be considered.

Moreover, technology transfer offices should give special consideration to licensors who locate in the park. Park tenant employees should be invited frequently to give guest lectures. A board of advisors should be created from the park tenants. Expanded internships for students should be explored. Importantly, all of these activities require high level coordination and leadership. The management of the parks must be more than just a real estate venture; it should be a highly coordinated effort that builds the capacity of the university and the park tenants.

Perhaps universities are already playing as large a role as the can in the clustering effect. It may be a more reasonable expectation that a university has close relations with only a small percentage of the park tenants. In such a model, the larger research park simply provides an economy of scale that allows the university to
develop these specialized relationships with only a few companies in a cost effective manner.

While there may not be many of these relationships, relative to the whole of the park tenants, they could be the most valuable of all the park tenants. One might envision that a university research park is mostly filled with low margin operations companies with no relation to a university and a couple of cutting edge, extraordinarily life changing businesses.

Third, research parks are not isolated to the USA and are being used globally as a method for economic intervention to increase national competitiveness. The issues faced in regions outside of the USA may provide additional considerations regarding policy and implementations of university research parks. A comparative analysis of Asian and European parks should yield a high value in assessing this and is a recommended follow-up to this study.

Limitations

Part of the strength of a study lies in the recognition of its limitations. These limitations provide guidelines for future research. First of all, the nature of the data used in the study set places limitations on the interpretation of the results to some extent. The National Science Foundation data at the university level are available for 2002; whereas, The National Education Statistics data are available for 2004. The optimal condition is to gather information from the same year. Furthermore, the direct mechanisms needed to establish the relationship between a university and nearby firms through the variables used in this study are not explicitly evaluated. As a result
further research studies should include a direct approach analysis of both universities and research park firms.

Second, this research focuses only on universities as a factor in explaining the clustering of research parks. In the future research studies should evaluate other regional factors that affect the location patterns of technology-based firms. These include quality of life, other technological infrastructures, access to communication linkages, and so on.

Third, the use of a panel of experts sets limitations in the interpretation of the results. Information regarding firms should be collected through a direct contact with a firm's scientists and administrators. As suggested by Cohen and Levinthal (1990) the capacity of a firm to exploit the knowledge produced at universities depends highly on the level of prior related knowledge already embedded in the firm. Thus, other data collection methods may be incorporated in future studies as way to expand empirical research in this area.

Conclusions

This study provided a new perspective on the role of research parks as economic interventions. It challenged the basic beliefs of most involved in the technology based economic development profession, raised questions about the role of the university in the economic development process and brought to light many important threads for future analysis of research parks.

The study increases the understanding of universities as a source of knowledge for a firm's innovative activities as well as the impact of university's assets on the development of industry clusters. Universities are the main sources of
new knowledge and specialized labor (Castells & Hall, 1994; Laursen & Salter, 2004; Paytas et al., 2004; Porter, 1990; Porter, 1998; Varga, 1998) thus, this study serves as guidance to university officials who are involved or may be involved in university research park initiatives. It provides a tool to analyze their resources and expertise in appropriate areas so as to align with the needs of the university research park firms. Also, it shed light on the relevant mechanisms transmitting knowledge spillovers from a university to university research park firms.

University research parks are an important area of study because a large number of regions have established research parks as an economic development tools to promote economic growth. University research parks and their related institutions play a seminal role in the establishment of local technology-based industries in a number of scientific fields. Areas such as biotechnology, software, and so forth; benefit from university research. Yet, most of cluster creation initiatives are driven by public sector intervention; there is a need to understand how universities impact the actual development of research parks. This research study can shed light in how these initiatives should target areas of perceived market demand based on a university’s core competencies. In addition, this research will generate analytical results that can provide insights into the forces that contribute effectively to the development and growth of research parks; therefore, it will provide guidance to local and regional policymakers in designing their development strategies.
## APPENDIX A

### University Research Park Tenants

<table>
<thead>
<tr>
<th>University 1</th>
<th>AMDVCO, LLC</th>
<th>Blue Ocean Systems Corporation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AMDVCO, LLC</strong> provides comprehensive, quality technology solutions, human resources and management consulting to the Federal government and private sector. In addition to certification in one or more of our core competency areas, our expert consultants have a broad knowledge base that bridges our range of services.</td>
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<table>
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<tr>
<th>A Path To You</th>
<th>Avincis, Inc.</th>
<th>Blue Ocean Systems, LLC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A Path To You</strong> is a spiritual learning center that facilitates workshops for individuals and businesses. In business and in life, we want to be successful. We work with you to bring out the qualities within you and your employees that will assist you in creating a successful business and lead to a more fulfilling life.</td>
<td></td>
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<tr>
<td><strong>Avincis, Inc.</strong> traditionally offers high-quality services at competitive rates. Avincis strives to be the leader in providing high-quality, competitively priced services at a reasonable price.</td>
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<tr>
<th>ACS International Resources, Inc.</th>
<th>AviServe LLC</th>
<th>Breahwine Information Management Group</th>
</tr>
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<tbody>
<tr>
<td><strong>ACS International Resources, Inc.</strong> provides comprehensive, quality technology solutions, human resources and management consulting to the Federal government and private sector. In addition to certification in one or more of our core competency areas, our expert consultants have a broad knowledge base that bridges our range of services.</td>
<td></td>
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</tr>
<tr>
<td><strong>AviServe LLC</strong> is the premier provider of state-of-the-art technology solutions, human resources and management consulting to the Federal government and private sector. We strive to provide comprehensive, quality technology solutions, human resources and management consulting to the Federal government and private sector. In addition to certification in one or more of our core competency areas, our expert consultants have a broad knowledge base that bridges our range of services.</td>
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Renaissance Capital, LLC

- Provides comprehensive transaction advisory solutions under
  including fee structures.
- Assists in Private Credit, Senior Financing, and other
  financing structures.
- Provides capital to emerging growth companies.
- Offers debt and equity solutions to middle-market companies.
- Provides transaction advisory services across various industries.

Human Frequency, Inc.

- Circuits Engineering engages assistance through contract arrangements, offering
  manufacturing system consulting services and product process development.
- Offers technology and manufacturing solutions.
- Provides consulting services to enhance product performance.

Lucas Company, Inc.

- Creative Computing builds web applications to
  support business processes. Its style and approach
  is characterized by responsiveness and accuracy.
- Offers consulting services in the area of
  business process improvement and technology implementation.
- Provides web application development services.

Cancer Care Connection, Inc.

- Cancer Care Connection, an independent non-profit
  information program for people affected by cancer,
  provides telephone consultations by oncology
  social workers and nurses.
- Offers telephone and online support to patients,
  caregivers, and healthcare providers.
- Provides information and support services for
  people affected by cancer.

Cirrus Engineering

- Cirrus Engineering engages assistance through
  contract arrangements offering manufacturing
  system consulting services and product process development.
- Provides engineering services to enhance product performance.
- Offers consulting services in the area of business process improvement.

Creafive Computing

- Creative Computing builds web applications to
  support business processes. Its style and approach
  is characterized by responsiveness and accuracy.
- Offers consulting services in the area of business process improvement.
- Provides web application development services.

Cara Plastics, Inc.

- Cara Plastics develops and produces composite
  resins, adhesives, and composites for use in a range of industries from automotive
  to construction.
- Provides a wide range of composite resins and adhesives for various applications.
- Specializes in providing high-performance materials for the automotive industry.

CoastGKicz, LLC

- We specialize in assisting small and medium
  businesses in successfully navigating today's competitive technology markets.
- Provide cost-effective solutions to companies across industries.
- Offer consulting services to help companies
  navigate the ever-changing technology landscape.

Delaware Pain Initiative, Inc.

- Delaware Pain Initiative is the only statewide
  non-profit organization in Delaware whose
  mission it is to provide information and education
  on pain management and control.
- Offers educational programs and resources
  to increase awareness of pain-related issues.
- Provides resources and support to
  individuals and families affected by pain.
DX-CEEDS, Inc.

- DX-CEEDS is a non-profit entity.
- DX-CEEDS' mission is to develop strengthening relationships between mainstream and underserved communities through entrepreneurship and technology-economic development initiatives in a way that improves everyone's quality of life.

Entrepreneurial Spirit

- Entrepreneurial Spirit is a multimedia communications company connecting small business owners with consumers. We produce television and radio programs and a magazine. We offer a variety of advertising venues that enable business owners to inform the public about who they are and what they do.

InfoQuest Systems, Inc.

- A Platform Version with Multiple InfoQuest Systems customize your computer to create an environment that is unique to how you work, including software to control the behavior of your computer, the options you can choose for the display of front panel and keyboard, the options you can choose for the display of front panel and keyboard, and text options for your computer.
- In addition, InfoQuest systems InfoCare installs a self-monitoring (SM) system on a Windows-based computer, and provides training and ongoing support.

MacEnter, Inc.

- MacEnter, Inc. is a non-profit research organization (CRO) in technology and regulatory affairs. NCT specializes in genotyping screening (mutation assays), both GLP-compliant for regulatory submission and non GLP for product development.

MicroSelect, Inc.

- MicroSelect, Inc. is a nanotechnology company that develops and manufactures carbon nanotube devices for high-end, high volume applications.
- MicroSelect plans are to introduce a sensor produce the size of a postage stamp equipped with nano-scale sensors and communication electronics to provide real-time, continuous monitoring for the safety and quality of intake water distribution systems.
Oceana Systems, Inc.

- Oceana Beacon is a suite of geospatial tools for business and government use.
- Oceana Beacon provides high accuracy and security for military and civilian applications.
- The company is focused on technology and development.
- Design and prototyping of novel electrical and mechanical devices.
- Developing proprietary analysis methods and tools for enhanced analytical techniques.

Performance Consulting Group, Inc.

- PCC is a provider of information technology services, business process consulting, management consulting, and IT outsourcing.
- They provide solutions for-green projects, such as carbon reduction.
- They have expertise in cloud computing and data analytics.

Quantum Leap Innovations, Inc.

- Quantum Leap Innovations is a pioneer in the emerging field of smart grid technologies.
- They offer solutions to handle the complexities of the grid.
- They use advanced software to manage the grid and enhance efficiency.

Soma - Sandia Occupational Medicine Assessment, Inc.

- SOMA provides occupational medicine assessments.
- They have expertise in environmental and occupational medicine.
- They offer services for workplace health and safety.

Genentech, Inc.

- Genentech is a drug development company with a focus on developing innovative therapies for genetic diseases.
- They are committed to finding new ways to treat diseases.
- They have a strong focus on pharmacogenomics.

Quest Pharmaceutical Services, LLC

- Quest Pharmaceutical Services (QPS) is a full-service, good laboratory practice (GLP), and good clinical practice (GCP) compliant analytical laboratory, providing analytical support to the pharmaceutical industry.
- They have expertise in drug discovery, pharmaceutical development, and regulatory compliance.

Superior Pet Technologies, Inc.

- Superior Pet Technologies manufactures instruments for high-performance liquid chromatography, mass spectrometry, and other analytical applications.
- They have expertise in developing and producing high-quality products.

OrphagenX

- OrphagenX is a drug development company with a focus on developing innovative therapies for genetic diseases.
- They are committed to finding new ways to treat diseases.
- They have a strong focus on pharmacogenomics.

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Ultron Technologies, Inc.
- The Company has developed and patented a process for the production and encapsulation of nanoparticles for a variety of applications.

Y&M Technologies, Inc.
- Y&M Technologies has developed a patented process for the production and encapsulation of nanoparticles for a variety of applications.

ultron Technologies, Inc.
- Ultron Technologies has developed a patented process for the production and encapsulation of nanoparticles for a variety of applications.

DCANet
- DCANet is a division of Cullum Dynamics Inc. (CNI).
- DCANet provides internet services to the Delaware Technology Park and its tenants.

Kamen Dynamics, LLC
- Xenon produces high-quality web deliverables through alliances with the medical animation firm Animaedia and the interactive multimedia firm 2-Order.
- Lattix is an easy-to-use web-based communications application that allows users to spontaneously create and distribute personalized multimedia sales and educational messages.

Debary Small Business Development Center
- The Delaware Small Business Development Center (DSSDC) offers information, training seminars, and free counseling to every small business owner or potential entrepreneur in Delaware.

University 2
<table>
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<tr>
<th>Company Name</th>
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<tbody>
<tr>
<td>LMS CADSI</td>
<td>• Mechanical Simulator Software Development. CADSI is the supplier of the DADS multi-body motion simulation software and PolyFEM, a structural, modal, and thermal analysis tool based on p-element technology.</td>
</tr>
<tr>
<td>Stanley Environmental</td>
<td>• Environmental Engineering</td>
</tr>
<tr>
<td>Center for Biocatalysis &amp; Bioprocessing</td>
<td>• The Center for Biocatalysis &amp; Bioprocessing is a nationally prominent multidisciplinary research facility of faculty members and other researchers who worked with more than 60 companies over the past two years.</td>
</tr>
<tr>
<td>Breakthrough to Literacy, Inc.</td>
<td>• Educational Software and Program Development.</td>
</tr>
<tr>
<td>Pearson Educational Measurement</td>
<td>• As a pioneer and comprehensive provider of educational assessment products, services and solutions, PEM helps states and large school districts meet the requirements of education reform while understanding how to use testing and assessment to promote learning.</td>
</tr>
<tr>
<td>Fulbrite Medical Research Center</td>
<td>• Human Health and Medicine</td>
</tr>
<tr>
<td>Integrated DNA Technologies, Inc.</td>
<td>• Biotechnology for Genetic Research. Integrated DNA Technologies (IDT) has been a major force in advancing biotechnology research both as a leading supplier of custom oligonucleotides and as developers of innovative new biotechnologies.</td>
</tr>
<tr>
<td>Integrated DNA Technologies, Inc.</td>
<td>• Government Solutions and Division, Software Engineering &amp; Development.</td>
</tr>
<tr>
<td>National Advanced Driving Simulator Center</td>
<td>• The National Advanced Driving Simulator is an internationally unique and the most advanced simulator for conducting human-centered driving safety research in a high-fidelity and highly flexible computer-generated environment.</td>
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• The Center for Advanced Drug Development (CADD) offers risk protection services related to the production of clinical supplies and is a resource for growing the pharmaceutical industry in the State. The 2001 stand-alone, which completed 152 projects with CADD, included four companies from Israel, nine companies from surrounding Midwestern states, 18 companies from elsewhere in the USA, and one company from Europe.

300 facility
- 300 facility is a coproduction service provider (CSP) providing coproduction services for composites, carbon, composite, aerospace, marine, security, and medical sectors covering facility management and T procedures.
- 300 facility provides a comprehensive service package, which includes production and support management.
- 300 facility is a client in the Midwest and is a web business.
- 300 facility can be used for facility management and T repair, servicing, etc.

Channel Economics
• Channel Economics through our proven Channel Alignment methodology and sales support clients to set goals and standards for sales and display strategies.
• We leverage our deep expertise in marketing, sales, and customer support to create customized solutions to help our clients increase revenues, reduce the cost of doing business, and improve their customer experience.

Infuse and Disease in Extracellular Program Center
- Cell and Molecular Biology of Inflammation

Blast Bean LLC
- Blast Bean LLC is a strategic marketing and communications company affiliated with Dynamo. The online clients in New York, Denver, and bands are products, companies, and services
- Blast Bean LLC offers a range of services that add to the creation and growth of innovative brands. Our core values include efficient and effective marketing and communications solutions that deliver results and competitive edge.

College Butler
- College Butler offers counseling services to college students.

Design Factory International
- Designs and manufactures seasonal and home office products. Offices in Florida, Germany, and China.

BAU, Inc.
- BAU's core product, a design and prototype called (BAU), offers a comprehensive range of services to businesses and engineers. BAU's core product is design, developmental engineering, and manufacturing.
- BAU's core product is designed to develop, manufacture, and manufacture its parts, as well as product development for custom, design, and manufacturing.
- The company is offering equipment applied to design, engineering, and automation equipment.

University 3
Fluid Dynamics Studio

Fluid Dynamics Studio focuses on applying the principles of fluid dynamics to a wide range of applications and products. By utilizing the results of medical and physiological research, the company aims to expand its business by consulting services in order to improve patient care and minimize the involvement of environments. The company was founded in 2002.

JCL Biogas Inc.

JCL Biogas Inc. is a biogas company that offers anaerobic digestion services in the areas of the AgriFarm and industrial sectors. The company provides system designs and engineering services for anaerobic digestion, anaerobic filter systems, and biogas systems. JCL Biogas Inc. is also engaged in the development of anaerobic digestion processes and technologies.

MotiveQuest

MotiveQuest is a company that develops and produces software products and services to expand the functionality of enterprise systems. MotiveQuest's software products are designed to help customers improve the efficiency and effectiveness of their operations. The company's products are designed to be easy to use, and they include a comprehensive suite of tools and services for enterprise planning and reporting.

Knowledge Dynamics

Knowledge Dynamics is a software and services company that offers solutions for data mining, business intelligence, and analytics. The company's products are designed to help organizations make sense of large amounts of data, and they include a comprehensive suite of tools and services for data integration, data warehousing, and analytics.

Netguru

Netguru is a company that develops and produces software products and services to expand the functionality of enterprise systems. Netguru's software products are designed to help customers improve the efficiency and effectiveness of their operations. The company's products are designed to be easy to use, and they include a comprehensive suite of tools and services for enterprise planning and reporting.

Innomind

Innomind is a developer of business intelligence solutions and add-on software products to expand the functionality of leading enterprise systems. The company's software products are designed to help customers make sense of large amounts of data, and they include a comprehensive suite of tools and services for data integration, data warehousing, and analytics.

Mobility 24x7 Inc.

Mobility 24x7 Inc. is a company that develops and produces software products and services to expand the functionality of enterprise systems. Mobility 24x7 Inc.'s software products are designed to help customers improve the efficiency and effectiveness of their operations. The company's products are designed to be easy to use, and they include a comprehensive suite of tools and services for enterprise planning and reporting.

Neurosciences Technologies Inc.

Neurosciences Technologies Inc. is a company that develops and produces software products and services to expand the functionality of enterprise systems. Neurosciences Technologies Inc.'s software products are designed to help customers improve the efficiency and effectiveness of their operations. The company's products are designed to be easy to use, and they include a comprehensive suite of tools and services for enterprise planning and reporting.
<table>
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<th>Description</th>
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<tbody>
<tr>
<td><strong>Paradox Studios</strong></td>
<td>Creates high-end dynamic programming and interactive content for the Web and CD-ROM markets. Also provides other services ranging from graphics and video production to technical consulting.</td>
</tr>
<tr>
<td><strong>SourceLight Technologies</strong></td>
<td>Provides intelligent marketing solutions to retailers across multiple channels. The software suite enables customers to conduct transactions, access product information, personalized recommendations, order takes, and account information via interactive kiosks and the web.</td>
</tr>
<tr>
<td><strong>StarSpot Mediatworks, Inc.</strong></td>
<td>Developer and publisher of a network of high-quality vertical portals designed to make finding the best category-specific information on the web easy, fast, and enjoyable experience. The site has won more than 70 awards including &quot;Best of the Web&quot; from Fortune, &quot;Top 100 Website&quot; from PC Magazine, and &quot;Best of the Web 2002&quot; from U.S. News and World Report. Currently there are 14 sites in the network.</td>
</tr>
<tr>
<td><strong>PhiCom LLC</strong></td>
<td>A company specializing in hyper-targeted online advertising. Using the technology patented from Internet based profits streams, we send member's emails with free service and free return mail that deliver targeted messages in the form of electronic coupons, special promotions, and meaningful news or products of interest.</td>
</tr>
<tr>
<td><strong>SourceMtx</strong></td>
<td>Software consulting company providing mission critical solutions to global clients. Through unique software services including Oracle, SAP, and other methodologies, SourceMtx is able to provide the most cost effective high quality solutions. SourceMtx has experience in Healthcare, Financial Services, Life Sciences, and high tech industries.</td>
</tr>
<tr>
<td><strong>Venturcraft</strong></td>
<td>Business development firm that helps early stage companies to create and implement strategic business and marketing plans. Assists management in identifying, developing, and acquiring critical resources and capabilities.</td>
</tr>
<tr>
<td><strong>Secure Card International</strong></td>
<td>Secure Card International (SCI) developed a technology that utilizes a combination of唯敲, digital, and magnetic methods to prevent counterfeiting and is under international patent. SCI aims to receive high recognition from potential partners in the U.S. and will look to promote the technology in a wide range of applications. (Current Tethered Company)</td>
</tr>
<tr>
<td><strong>SpineHealth.com</strong></td>
<td>A leading spine portal supporting spine specialists through comprehensive patient education and targeted practice enhancement services. In-depth information to help patients understand and select appropriate treatment for back and neck pain and related conditions. This site is hosted by the National Institute of Health.</td>
</tr>
<tr>
<td><strong>Arc Technology Group</strong></td>
<td>Arc Technology Group is a web content, development and hosting firm. We provide content management, a comprehensive and enterprise application for fortune 500 and small businesses to facilitate marketing, online sales and data collection. Our design services include web and application graphics design as well as Flash design and development.</td>
</tr>
</tbody>
</table>
AudioCast

- AudioCast.net combines streaming media technology and database management to provide Internet business solutions. Under the "AVflyer" brand, AudioCast sells proprietary tools that allow customers to communicate and collaborate online.

Cyber Tech Applied Science, Inc.

- Optical non-destructive evaluation (NDE) of process control instruments for the biomedical and chemical industries. Specializes in holographic, interferometric and spectroscopic technologies.

Fusion Optics

- Fusion Optics is a manufacturer and distributor of products for the automotive and industrial sectors. The company offers a wide range of optical and mechanical components.

AudioSpark

- AudioSpark.com is a full-service Business Communication service that offers complete, cutting-edge solutions for all your communication needs.

Dye.technologies

- Dye.technologies offers a wide range of services, including but not limited to, laser technology, optical technology, and electronic technology.

GamesPark, Inc.

- GamesPark, Inc. is the world's leading operator of online chess services for local, national, and international chess organizations. The company offers a range of services for chess enthusiasts, including tournaments, training, and competitions.

Containerless Research Inc.

- Containerless Research Inc. is a technology company with specialized R&D capabilities in the field of nanotechnology. The company focuses on developing new technologies for the medical and pharmaceutical industries.

Franklin Partnership

- Franklin Partnership is a new consumer product line employing integration of mid-high technology.

Great West

- Great West offers development, manufacture, and sales of geophysical testing instrumentation.
<table>
<thead>
<tr>
<th><strong>Invarient Sensor Technologies</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Invariant Sensor Technologies develops, sells, and licenses non-linear signal processing software that can be attached to the &quot;front end&quot; of any standard speech recognition engine in order to make it more speaker independent and channel independent.</td>
</tr>
<tr>
<td>A second product line features software for accurate text-independent speaker identification.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Machine Bus Corporation (mBus)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A manufacturer of computer network hardware that can easily be integrated into customer environments.</td>
</tr>
<tr>
<td>Typical applications include mobile, automation, machine-to-machine communications, and remote control applications.</td>
</tr>
<tr>
<td>Machine Bus is a modular, software-driven network that can be configured with network and automation software.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th><strong>Pathmedia</strong></th>
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<tbody>
<tr>
<td>Pathmedia is a marketing and design studio dedicated to helping our clients brand and refine their message.</td>
</tr>
<tr>
<td>We work with them to develop a clear and creative message that will attract that plan to help them reach their goals.</td>
</tr>
<tr>
<td>Services offered include design planning, publication development, graphic design, and web-based communications.</td>
</tr>
</tbody>
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<thead>
<tr>
<th><strong>I2 Technologies</strong></th>
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<tbody>
<tr>
<td>I2 Technology develops the Nekokun (TM), a projection system displaying 240° overhead and computer images into free space (a real &amp; virtual).</td>
</tr>
<tr>
<td>The system can be configured with dual video sources (TV, VHS, computer images, etc.). The Nekokun is in addition a touch-screen - allowing a hand or finger for navigation and selection of free-space video.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Networked Robotics</strong></th>
</tr>
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<tbody>
<tr>
<td>Networked Robotics enables the real-time collection of diverse scientific raw data using TCP/IP.</td>
</tr>
<tr>
<td>Our first instrument type will be temperature devices such as refrigerators, incubators, incubators, and ovens.</td>
</tr>
<tr>
<td>We provide distributed temperatures throughout the Internet for these devices.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th><strong>Pixel Films</strong></th>
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</thead>
<tbody>
<tr>
<td>Pixel Films is the high quality, affordable solution for video tape or digital transfers to 35mm for the theater.</td>
</tr>
<tr>
<td>We output from 2K to video resolution at any aspect ratio available. We also scan 35mm original to files for effects, titles, or compositing.</td>
</tr>
</tbody>
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<thead>
<tr>
<th><strong>JACO</strong></th>
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<tbody>
<tr>
<td>Developers of advanced designs for recumbent bicycles.</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th><strong>NEXTChem</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>NEXTChem Process Analyzers provides a complete chemical measurement and process control solution.</td>
</tr>
<tr>
<td>The analyzers utilize wet chemistry measurements, not traditional conductivity control. The result is increased accuracy and reliability. All the analyzers are Ethernet friendly with Ethernet connectivity.</td>
</tr>
</tbody>
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<thead>
<tr>
<th><strong>Real Time Freight Services LLC</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Time Freight Services establishes and maintains private networks between shippers, distributors, or brokers and directly connects them to their sites across town in a real-time delivery.</td>
</tr>
<tr>
<td>The sophisticated software allows freight movers to communicate more efficiently and increase productivity, while eliminating their communication channels both internally and externally.</td>
</tr>
</tbody>
</table>
Stone Road Productions
- Professional, broadcast-quality multimedia production serving a Fortune 500 base.

Prol它的te SAONAI, broadcst-quality multimedia production serving a Fortune 500 base.

University #

Gateway Medical Research, Inc.
- Gateway Medical Research, Inc. is a Clinical Research Site, specializing in bioequivalence testing of generic drugs.

Hauser Group, Inc.
- The Hauser Group is a strategic public relations firm that works in partnership with our clients to help them communicate effectively and affordably with their targeted audiences.

Leadership Council Southwestern Illinois
- The Leadership Council Southwestern Illinois is a broad-based economic development corporation representing Madison and St. Clair counties in Illinois. Its membership consists of leaders in business, industry, labor, education and government sectors. The Leadership Council is a public-private partnership organized to encourage business investment in Southwestern Illinois.
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Com to-Ethanol Research Center</td>
<td>The National Com to-Ethanol Research Center (NCERC) conducts its own research, and research on behalf of private clients to improve the benefits of fuel ethanol production and use.</td>
</tr>
<tr>
<td>Company Name</td>
<td>Description</td>
</tr>
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<td>-------------</td>
</tr>
<tr>
<td><strong>E&amp;H Integrated Systems</strong></td>
<td>E&amp;H Integrated Systems is a leading supplier of cutting-edge telecommunications solutions in the Louisville area. It is focused on reducing customers' total telephone costs, with a unique approach to total business solutions and support.</td>
</tr>
<tr>
<td><strong>IBM Global Services</strong></td>
<td>IBM Global Services is one of IBM's strategic business units. IBM Global Services is known for its comprehensive range of services, including consulting, hardware, and software solutions. IBM Global Services provides end-to-end IT infrastructure and business process solutions to clients worldwide.</td>
</tr>
<tr>
<td><strong>Hydnight, Inc.</strong></td>
<td>Hydnight is a new technology process, or deoxygenated sodium hypochlorite, that is proposed to become a leading technology in producing diverse streams of high purity sodium hypochlorite. The target is the production of high-purity sodium hypochlorite, which is used in water treatment and many other applications.</td>
</tr>
<tr>
<td><strong>IDEXX Laboratories, Inc.</strong></td>
<td>IDEXX Laboratories is a leading developer and manufacturer of advanced diagnostic products and services for the animal health industry. IDEXX Laboratories offers a range of diagnostic tests to help veterinarians make faster and more accurate diagnoses, which can improve patient outcomes and overall health care.</td>
</tr>
<tr>
<td><strong>ImmunoTherapeutics Inc.</strong></td>
<td>ImmunoTherapeutics is a research and development company focused on developing novel immunotherapeutic treatments for cancer and other diseases. Their approach involves the use of engineered immune cells to specifically target and destroy cancer cells.</td>
</tr>
<tr>
<td><strong>Interlace, Inc.</strong></td>
<td>Interlace is a leading company in the development of new materials for use in various industries. Their technology is based on the use of ion exchange processes, which can be used to produce a wide range of materials with unique properties.</td>
</tr>
<tr>
<td><strong>ITC, Inc.</strong></td>
<td>ITC, Inc. is a leading company in the development of new materials for use in various industries. Their technology is based on the use of ion exchange processes, which can be used to produce a wide range of materials with unique properties.</td>
</tr>
</tbody>
</table>
First Tech Inc.
- First Tech is a leading provider of technology products and services.
- Offers a wide range of solutions to meet the needs of various industries.
- Provides innovative technologies for communications, energy, and transportation sectors.
- Secures a leadership position in the market with its robust product offerings.
- Continuously invests in research and development to stay ahead in the competitive landscape.

Second Inc.
- Second Inc. specializes in nanotechnology solutions.
- Engages in advanced research and development to drive innovation.
- Its cutting-edge technologies enable solutions for a range of industries, including healthcare, energy, and materials science.
- Committed to sustainability and responsible use of resources.

Tribus Flow Separations LLC
- Tribus Flow offers advanced separation technologies.
- Focuses on developing systems for efficient purification of various substances.
- On the forefront of technology advancements, Tribus Flow is poised to meet the challenges of the future.

Total Imaging Systems Inc.
- Total Imaging Systems is a leading provider of medical imaging solutions.
- Equipped with state-of-the-art technology, Total Imaging Systems offers top-tier imaging services.
- Continuously targets growth opportunities in the healthcare sector.

Strain Associates Inc.
- Strain Associates is a consulting firm with expertise in various sectors.
- Provides expert services in engineering, consulting, and technology development.
- Reputable for its high-quality solutions and excellence in client satisfaction.

R&K Research & Development Diagnostic Center
- R&K Research & Development Diagnostic Center focuses on developing advanced diagnostic tools.
- Committed to advancing healthcare through innovative research and development.
- Offers a platform for collaborative efforts in the medical research community.

RAAM Global Energy
- RAAM Global Energy is an independent energy company.
- Engaged in the exploration and production of oil and gas.
- Operating in areas with significant energy resources, RAAM Global Energy contributes to the global energy mix.

FuturConscious Mediation
- FuturConscious Mediation offers a range of services.
- Specializes in conflict resolution and mediation.
- Aims to bring about positive outcomes through its expert mediation services.

Veda Design LLC
- Veda Design offers design services.
- Combines architectural design with natural building materials.
- Dedicated to sustainability and creating spaces that enhance the environment.

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<table>
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<tr>
<th>University 6</th>
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<tbody>
<tr>
<td><strong>First Responder System &amp; Technology</strong></td>
</tr>
<tr>
<td>- FRONT designs and builds fully integrated data, GIS, navigation, and voice systems that are ported through innovative technology. The company's line of comprehensive software provides a unique integration of advanced software and hardware solutions.</td>
</tr>
<tr>
<td>- <strong>Industry</strong></td>
</tr>
<tr>
<td>- Product line includes products for the public safety, public health, and public service sectors.</td>
</tr>
<tr>
<td>Source: <a href="http://www.frontinc.com">www.frontinc.com</a></td>
</tr>
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<tr>
<th>University 7</th>
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<tbody>
<tr>
<td><strong>Environmental Technology</strong></td>
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<tr>
<td>- ASAT provides end-to-end services for the creation and delivery of products in the area of environmental protection.</td>
</tr>
<tr>
<td>- The company's products and services are used to achieve environmental sustainability.</td>
</tr>
<tr>
<td>Source: <a href="http://www.asatinc.com">www.asatinc.com</a></td>
</tr>
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<tr>
<th>Arabian Sea</th>
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<tr>
<td><strong>FPGA</strong></td>
</tr>
<tr>
<td>- This product line includes digital signal processing. Any image that can be digitized and digitized can be reproduced on a FPGA (field-programmable gate array) technology. These products are used to increase productivity and reduce costs.</td>
</tr>
<tr>
<td>Source: <a href="http://www.fpga.com">www.fpga.com</a></td>
</tr>
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<table>
<thead>
<tr>
<th>MassMedic</th>
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<tbody>
<tr>
<td><strong>The Massachusetts Medical Device Industry Council (MassMEDIC)</strong> is a voluntary trade association of medical device manufacturers and associated companies in the Commonwealth.</td>
</tr>
<tr>
<td>Source: <a href="http://www.massmedic.org">www.massmedic.org</a></td>
</tr>
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<tr>
<th>Lexicon USA</th>
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<tbody>
<tr>
<td><strong>First Responder System &amp; Technology</strong></td>
</tr>
<tr>
<td>- Combinatrix, Incorporated is a biopharmaceutical company focused on developing new medicines built from synergistic combinations of approved drugs.</td>
</tr>
<tr>
<td>Source: <a href="http://www.lexiconusa.com">www.lexiconusa.com</a></td>
</tr>
</tbody>
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**AdopoGenx**
- AdopoGenx, Inc. is a Boston-based biopharmaceutical company developing small molecule pharmaceuticals to treat obesity and its co-morbidities

**Central Relief Thread Die Company**
- Using the most advanced computer controlled robotic threading pole, CRT develops and produces high precision dies for cutting threaded metal parts for the aerospace and automotive industries.

**University of Massachusetts**

**Vaccinex Technologies, Inc.**
- Emerging threats of infectious diseases create a multibillion dollar vaccine market worldwide, and the Korean government budget is to date amounts US$ 417 million. In order to prevent the possible threat of pandemic influenza, the lab is developing the new vaccine against these emerging threats.

**A.G. Edwards**
- Financial Services & Investment Products
- Missouri Research Park is home to a state-of-the-art data center, housing computer systems that support corporate data processing and client Internet access activities.

**Digigraph, Inc.**
- A global producer of automated marking, coding and printing systems.
- Digigraph offers world-class marking and coding systems for pet food and product identification applications. Small-chord widths line jet inkjet printers. Digigraph provides product marking and printing systems and thermal transfer label printers.

**Resolvex Pharmaceuticals**
- RESOLVEX Pharmaceuticals is dedicated to the discovery and development of therapeutics for inflammatory diseases.

**AFB International**
- AFB is a worldwide leader in pet food palatability technology.
- We are dedicated to improving the health and well-being of companion animals worldwide through the delivery of superior products and services.

**Deep Creek Sanitary District**
- Deep Creek Sanitary District in an award-winning wastewater treatment district serving more than 27,000 residential and commercial customers.
<table>
<thead>
<tr>
<th>Federal Aviation Administration</th>
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</thead>
<tbody>
<tr>
<td>Home to the FAA's TRACON facility, the primary air-traffic-control facility of Lambert International Airport and all designated airspace in the St. Louis region.</td>
</tr>
<tr>
<td><a href="http://www.faa.gov">Link</a></td>
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<tr>
<th>Luxury Research, Inc.</th>
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<tbody>
<tr>
<td>Develops and manufactures reagents for diabetes research.</td>
</tr>
<tr>
<td><a href="http://www.luxuryresearch.com">Link</a></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Nardi Engineering, Inc.</th>
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<tbody>
<tr>
<td>A principal developer of superior quality dies for manufacturers in the pharmaceutical, storage battery and ceramic industries.</td>
</tr>
<tr>
<td><a href="http://www.nardiengineering.com">Link</a></td>
</tr>
</tbody>
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<thead>
<tr>
<th>Intechfin</th>
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<tbody>
<tr>
<td>A leading provider of fraud services and solutions for the mortgage industry. Intechfin develops fraud prevention and decision support tools to reduce risk, increase productivity and maximize loan quality.</td>
</tr>
<tr>
<td><a href="http://www.intechfin.com">Link</a></td>
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<table>
<thead>
<tr>
<th>Missouri Bluffs Golf Club</th>
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<tbody>
<tr>
<td><a href="http://www.missouri-bluffs.com/about">Link</a></td>
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<thead>
<tr>
<th>Nexstar</th>
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<tbody>
<tr>
<td>Neustar Financial Corp. provides outsourced client-branded mortgage services to banks, credit unions and diversified financial services companies.</td>
</tr>
<tr>
<td><a href="http://www.neustarfinancial.com">Link</a></td>
</tr>
</tbody>
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<thead>
<tr>
<th>Lincoln Diagnostic Services, Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consults, develops, analyzes, research, prototypes, manufactures, develops, maintains, manages and markets laboratory systems to automate and streamline the testing of blood, urine, and tissue samples in diagnostic and research laboratories.</td>
</tr>
<tr>
<td><a href="http://www.lincolndiagnostic.com">Link</a></td>
</tr>
</tbody>
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<thead>
<tr>
<th>National Weather Service</th>
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<tbody>
<tr>
<td>A regional forecasting center and Doppler radar research facility.</td>
</tr>
<tr>
<td><a href="http://www.nws.noaa.gov">Link</a></td>
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<tr>
<th>Novus International Research Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develops, manufactures, and markets animal feed supplements.</td>
</tr>
<tr>
<td><a href="http://www.novusinternational.com">Link</a></td>
</tr>
</tbody>
</table>
Warranty Corporation
- A designer, programmer and manufacturer of flat-panel display test systems and drive electronics for industrial operations.

University 9

Cypress Semiconductor
- Produces a wide range of semiconductors including programmable logic devices, memory, displays and networking ICs.

Wingate Ins Hotel

The High Performance Companies
- A designer, programmer and manufacturer of flat-panel display test systems and drive electronics for industrial operations.

HEVI Incorporated
- HEVI Incorporated and its divisions and subsidiaries utilize expertise in synthetic crystal materials growth, optical fabrication, electronics component manufacture, and more to create high-tech products for a wide range of applications and industries.

Zoltek Corporation
- Develops and produces high-quality carbon fibers used in the aerospace and automotive industry.
- Our mission as a company is to lead the commercialization of carbon fiber as a primary composite building material.

AlSIL
- AlSIL is a world-leading semiconductor company with a heritage in technology.
- The company designs, manufactures and markets high-performance semiconductors, including microprocessors, logic ICs, memory devices, and other semiconductor products.
- The company also offers a wide range of high-performance semiconductor components and subsystems for a variety of applications.

SemiSouth Semiconductor
- SemiSouth is a silicon carbide (SiC) based semiconductor company specializing in SiC materials and electrical components for high-power, high-efficiency, harsh-environment power management and conversion applications.
**Amplifier Devices, Inc.**

- A semiconductor company that develops, manufactures, and markets high-performance integrated circuits (ICs) used in signal-processing applications.
- The company has also developed a product group to provide general-purpose Surface Mount ICs (SMIC), which enable easy data-conversion and amplification.
- ADC has also become a major Signal Processing (DSP) supplier, providing both general-purpose and application-specific devices that combine analog and signal-processing capability in a single chip.

**CATLIN Engineers & Scientists**

- CATLIN Engineers and Scientists maintain a research and development collaboration network at NCSU’s Centennial Campus.
- The long-range goal is to enhance the North Carolina community’s ability to generate and evaluate new knowledge and validate the utility of scientific research from geographically diverse locations.
- Our other offices include collaborations in Structural and Civil Engineering, Chemical and Civil Engineering, and Mechanical Engineering.

**Catalyst Pharmaceuticals**

- Catalyst Pharmaceuticals is working to develop therapeutic agents from traditional medicinal sources. The lead product, a methylated derivative of nonhydroxyurea and (NGU), is currently undergoing evaluation as a therapeutic for the treatment of solid tumors.

**Baron Advanced Meteorological Systems (BAMS)**

- Baron Advanced Meteorological Systems is a team of scientists, mathematicians, and engineers dedicated to expanding the horizons of environmental computing.

**IPHI Solutions**

- National R&D applications center for utilities, fiber, textile, machinery, carpet and apparel industries.

**Global Warming Initiatives**

- Global Warming Initiatives (GWI) will assist businesses in reducing energy consumption and Environmental Performance into a Corporate Asset management plan.
- Wherever possible, the services of community colleges and two-year colleges will be utilized with the hope they will carry these initiatives into business communities as they move to other challenges in their lives.

**BioKreative, International, Inc.**

- BioKreative is an early-stage biotechnology company focused on the commercial development of enzymes for various agricultural and industrial applications.

**Eaton IP Infrastructure**

- Eaton is an IP network division developing advanced aggregation routers for new public IP networks.

**Governor’s Institute: Avoid & Substance Abuse, Inc.**

- The Governor’s Institute is a private nonprofit organization that began in 1985 to assist health professionals in addressing the health problems of substance use, abuse, and dependency in North Carolina.

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Glass/Smithline (GSI) is a world leading research based pharmaceutical company with a powerful combination of skills and resources that provides a platform for delivering strong growth in today's rapidly changing healthcare environment. GSI scientists located at NC State's Centennial Campus are engaged in developing and applying analysis technologies to maximize the value of data and drive the company.

Institute of Political Leadership

- The Institute of Political Leadership is a multi-purpose, non-profit, educational institution to prepare students to be leaders in today's world.
- The purpose of the Institute is to train and develop North Carolinians who may one day assume the role of a political leader.

Humanologix, Inc.

- Humanologix, Inc. is a VHb manufacturing facility specializing in antibody production. One of our primary product offerings is polyclonal antibodies, monoclonal antibodies, and proteins.
- Our secondary product line includes secondary antibodies used in both research as well as the in vitro diagnostics market. In addition, we provide custom manufacturing services to meet the customer's individual needs.

Integrated Financial Information, Inc.

- Develops applications and services to enable rapid and reliable deployment of existing strategic engineering assets into state-of-the-art POM and collaborative product commerce (CPC) applications.
- Our patented Legend technology allows legacy information to virtually any POM system.

Juniper Networks, Inc.

- Juniper Networks, Inc. delivers high-performance IP networking systems built by industry experts with broad experience in high-performance computer and Internet networking applications.

Jenkins, Wilson & Taylor

- Jenkins, Wilson & Taylor offers a full-service intellectual property law practice providing high-quality strategic business and services to clients with respect to patents, trademarks, and copyrights.

Knowledge Station Systems, Inc.

- Developers of internet-based networks to manage intellectual property. Providers of value-added services (e.g., systems maintenance, training) and value-added analysis (e.g., technology and commercialization, mergers).
The Land Trust Alliance is the national association of more than 1,200 land and water conservation organizations operating across America. LTA provides educational, training, public policy, and technical assistance to its member organizations.

Mage Web Development provides cost effective, reliable internet software applications to small businesses, designed specifically for internal distribution. Founded in 2000, the firm currently maintains more than 40 commercial web sites.

Natural Products and Glycochemistry (NPG) Research Institute, Inc.

- Organic chemistry research aiming to develop a carbohydrate-based anti-malaria vaccine under the sponsorship of the World Health Organization.

Pionic Technology LLC

- Pionic Technology focuses on setting up virtual network based on NGN (Next Generation Network) and 3G (Third generation) wireless network technologies.
- Pionic’s solutions, integrated voice, video and data services, will provide a unified platform for residential and enterprise customers.

Materials Analytical Services, Inc.

- MAS offers a full range of analytical and testing services to clients in the Environmental, Industrial Hygiene, Indoor Air Quality, Semiconductor and Materials arenas. Founded in 1979, MAS now has 5 offices serving clients throughout the world.
- Part of a network of analytical electron microscopy facilities used by company staff as well as NC State students and faculty.

NOAA National Weather Service

- Provides hazardous weather warning information as well as local, regional, and national forecast for much of the Piedmont and Coastal Plain of North Carolina.
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BioLytix</td>
<td>Provides research, product development and manufacturing expertise to medical device, diagnostics, genomics and research companies.</td>
</tr>
<tr>
<td>Surya Technologies</td>
<td>Offers delivery, support, and customization of several applications — secure remote backup and disaster recovery, enterprise messaging, content management, and e-mail based helpdesk — to clients around the world.</td>
</tr>
<tr>
<td>Red Hat</td>
<td>A world leader in the design and production of networked computer systems and software, Red Hat provides enterprise class software and services to customers worldwide.</td>
</tr>
<tr>
<td>Surya Solutions</td>
<td>Offers specialized engineering services that can help industrial and commercial entities make the best use of their plant resources and their electrical supply.</td>
</tr>
<tr>
<td>Sciayr Communications</td>
<td>The SmartBits Division of Sprint Communications is the industry standard for network performance analysis for 10/100/1000 Gigabit Ethernet, ATM, Packet over SONET, Frame Relay, ADSL, Cable Modem, IP, QoS, VoIP, Routing, Multicast, and TCP/IP.</td>
</tr>
<tr>
<td>Techengage</td>
<td>A community-based non-profit organization founded to provide unemployed and under-employed technical professionals with an affordable opportunity to obtain the high quality training they need to be competitive in today's tough job market.</td>
</tr>
<tr>
<td>Biological products</td>
<td>Biological product development laboratory focusing on new drug discovery and development of new technologies for proven manufacturing.</td>
</tr>
<tr>
<td>Red Hat</td>
<td>A world leader in the design and production of networked computer systems and software, Red Hat provides enterprise class software and services to customers worldwide.</td>
</tr>
<tr>
<td>Surya Solutions</td>
<td>Offers specialized engineering services that can help industrial and commercial entities make the best use of their plant resources and their electrical supply.</td>
</tr>
<tr>
<td>Sciayr Communications</td>
<td>The SmartBits Division of Sprint Communications is the industry standard for network performance analysis for 10/100/1000 Gigabit Ethernet, ATM, Packet over SONET, Frame Relay, ADSL, Cable Modem, IP, QoS, VoIP, Routing, Multicast, and TCP/IP.</td>
</tr>
<tr>
<td>Techengage</td>
<td>A community-based non-profit organization founded to provide unemployed and under-employed technical professionals with an affordable opportunity to obtain the high quality training they need to be competitive in today's tough job market.</td>
</tr>
</tbody>
</table>
Telesyn is a network equipment maker delivering high-speed data services for communication providers, using the latest Ethernet technologies.

TransLoc develops innovative Passenger Information Systems for use by mass transit providers and their passengers. We are committed to helping riders save time, stay safe, and have more control over their schedules while enabling transit administrators to understand their fleets with unprecedented clarity.

Develops geographic Information Systems (GIS) software and applications.

WebAssign is the leading online Homework and Grading solution for the sciences and mathematics. WebAssign helps instructors motivate and engage students with frequent, customized assignments while eliminating the time-consuming pains of manual grading.

Conducts regional-scale integrated environmental assessments with the goal of providing scientific understanding of forest ecosystem trends.

Manages development systems, inc.

Business Management Consulting & Software solutions, process management & process engineering.

Research Organization R&D.
Biovitro, Inc.
- Biotechnology, manufacture and sell products for animal feed industry

CloudXUK
- World engineering software
- Autodesk builds infrastructure design and management software that helps you in every stage of your workflow.

BioNexus Ltd. - NutriSystems Inc., Inc.
- Nutritional, based biotech research and development
- BioNexus Ltd. is a company that identifies, develops and markets advanced nutritional supplement products designed to promote health and well-being.

Applied Pulsed Power, Inc.
- Applied Pulsed Power, Inc. (APP) designs and builds pulsed systems, including solid state switches, high power pulse generators, pulsed high magnetic field coils, high speed gas valves, plasma sources, and ion source systems. APP also performs contract R&D in pulsed power and plasma physics.
- Research & development of high peak power components and systems

Power and Systems, Inc.
- Computer software
- BSI is recognized as a world leader in developing on-line dynamic security assessment and control for energy management systems, voltage security assessment and preventive control, voltage security assessment and enhancement control, and continuation power flow (CPFLOW)

end

ATC
- Software and hardware products for computer security and software quality
- ATC-NY's research in information security has resulted in prototype systems and products addressing the protection of sensitive information, the detection of system vulnerabilities, and the analysis of system vulnerabilities.

RouteSpace
- Development of next generation optical devices
- BioOptics Corporation designs, develops, and manufactures nonlinearly integrated optoelectronic components based on indium phosphide and other semiconductor materials.

Lend Lease
- Construction management
- Bovis Land Lease is one of the world's leading companies in the project management and construction services industry
Medcat office

- Develop and manufacture optical micro-electromechanical (MEMS) devices.
- Celent Networks is a leading provider of carrier-grade photonic switching systems and software that help service providers scale their networks for expanding bandwidth demands and deliver new wavelength services.
- Microencapsulation R&D. Delayed release of pharmaceuticals. The company specializes in microencapsulating both inorganic and organic materials often using well materials that are patented by CSI. These capsules can be delivered in either dry isolated microcapsule or syrup form in sizes ranging from 5-500 microns in diameter.
- Advance research findings at Cornell University
- Real estate asset management & development for Cornell University.

Convergent Care Health

- Manufacturer of integrated systems for the food service and security industry.
- The CBGRC Group is the world's leading provider of foodservice management software solutions, campus and cashless card systems, housing and judicial process management solutions, and access control/elecronic security systems.
- Leading national demographics and marketing information firm.
- Claritas is a marketing information resources company dedicated to helping companies engaged in consumer and business-to-business marketing. We are dedicated to maximizing our clients' profitability with targeted and measurable marketing programs and enterprise-wide technology solutions.

Community Systems Institute, Inc.

- Tech support for volunteer water quality monitoring, including testing, training and QA/QC.

Tech support for volunteer water quality monitoring, including testing, training and QA/QC.
CREATIVE Multimedia
- Multimedia and design computer applications
- Multimedia Services
- Communications and Consultancy

DataBound Solutions, Inc.
- Custom software and database development
- DataBound Solutions brings together consulting, education, and support services to help our customers and partners maximize the benefits of their investment in technology

Student Express
- Overnight mail service and distribution center

GREAT NEW YORK UNIVERSITY: President's Office
- An Association of college presidents and their campuses

DataWays Lab
- Testing/Research & development
- We are a world-class testing facility with expertise in plastics, rubber, food, ceramics, and metals. Our JesterTool™ provide design analysts with the unparalleled convenience of "load & go" material models for over a dozen CAE programs. We find solutions to your unique testing needs.

New York State Senate
- Creates cell and organ-level computer models used to simulate the clinical performance of drugs.
- Uses algorithms to identify compound simulation models that help pharmaceutical companies improve the quality of their drug candidates.
- Leading the company's multi-disciplinary approach are scientists specializing in neuroscience, computer science, mathematics, genetics, chemical engineering and physics.

H & L Agritech, Inc.
- Research and development - bio-compatible plant disease control
- H & L Agritech, Inc. provides research, development and production of environmentally safe, broad spectrum four fungicides for curative control of powdery mildew, black spot and other plant diseases

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Hanger Orthopedic Group, Inc.

- Hanger Orthopedic Group, Inc. is the world's premier provider of orthotic and prosthetic services and products, offering the most advanced technology, clinically differentiated programs and unsurpassed customer service.

MateriMity, Inc.

- MateriMity® meets products to manage material and macro molecular crystallography communities. MateriMity manufactures and distributes products for x-ray crystallography.

NITEQ Inc.

- NITEQ has been founded to develop and manufacture products for the small molecule and macromolecular crystallography communities. NITEQ manufactures and distributes products for x-ray crystallography.

MiTegen Inc.

- MiTegen has been founded to develop and manufacture products for the small molecule and macromolecular crystallography communities. MiTegen manufactures and distributes products for x-ray crystallography.

OPTIGEN, a service company established to provide DNA based diagnoses and information about inherited diseases of purebred dogs.

Video and Film Production Service

- Video and Film Production Service is a service company established to provide DNA based diagnoses and information about inherited diseases of purebred dogs.

OP'TGEN is a service company established to provide DNA based diagnoses and information about inherited diseases of purebred dogs.

- Our strength and focus is on applying concepts and technologies from physics and related fields to address the practical problems faced by our friends and collaborators in the structural biology community.

MiTegen Laboratories Ltd.

- MiTegen Laboratories Ltd provides products for the rapid orientation of single crystals with the back-reflection Laue method.

- Video and Film Production Service is a full service video and film production company based in New York. In addition to our complete videography and non-linear editing services, we offer creative approaches to developing effective visual communications.

- Index Laue patterns from the M3M.110 real time filmless x-ray detector equipped with rotation orientation stages or from Polaroid TM photographs.
The Executive Group
- Developer of IT-enabled business processes
- Our people have experience analyzing client enterprise problems and translating findings into Information Technology (IT)-enabled, efficient business solutions

Miami Valley Research Park
- Owner/developer of Miami Valley Research Park

Northern Ohio Transportation Services
- Develop traffic management and traveler information systems

Deklin Ventures, Inc.
- High-speed digital printers

Northwest Consulting Services, Inc.
- Avionics engineering

Ohio Business Connection
- The Ohio Business Connection (OBC) is dedicated to helping your small businesses grow

LIR
- Engineering and architectural services
  - Architecture
  - Civil Engineering
  - Electrical Engineering
  - Environmental Engineering
  - Environmental Sciences
  - Safety Engineering
  - Structural Engineering
  - Surveying

Selling Growth Systems and Information Technology Group
- Information management systems

Ottenbacher Group, Inc.
- Specialized Nursing Care Services

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<table>
<thead>
<tr>
<th>Reynolds and Reynolds, Inc.</th>
<th>S&amp;K Technologies, Inc.</th>
<th>APC Accounts</th>
<th>BELLs</th>
<th>Reynolds and Reynolds, Inc.</th>
<th>BELLs</th>
<th>Fletcher, Eaton, Inc.</th>
<th>BELLs</th>
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<tr>
<td>■ Integrated information management solutions.</td>
<td>■ S&amp;K Technologies specializes in providing end-to-end, mission critical information technology solutions for government agencies and private-sector clients.</td>
<td>■  The company develops a variety of proprietary software used in the clinical field. It develops software that manages and builds databases among physicians, pharmacies that needs coordinating at physician education, training, and service. including integrated systems for patient and financial information management, and for the complex legal and financial administration of the healthcare industry.</td>
<td>■ BELLs produces and distributes Dow Jones Business English (DJE), a dynamic online English learning program based on current Dow Jones content and individualized learning technology. The pedagogic framework for DowBE was created by a team of experts in teaching English as a Second Language from the UO.</td>
<td>■ Integrated information management solutions.</td>
<td>■ Business consulting</td>
<td>■ Integrated information management solutions.</td>
<td>■ University of Pennsylvania Health System</td>
</tr>
<tr>
<td>■ Robust-Guides fresh approach to program management consulting helps our clients drive projects to completion effectively and efficiently.</td>
<td>■ Business consulting</td>
<td>■ Ultrasonic sensor development</td>
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<td>■ Business consulting</td>
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<td>■ Supporting all models of Telemechanique and Idec PLC sensors, the SCC is an invaluable resource for plant operators, specifying engineers and OEMs.</td>
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<td>■ center on Teaching and Learning (CTL) is a community of education scholars whose mission is to conduct, translate, and disseminate research focused on solutions to practical problems in schools.</td>
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The Computational Intelligence Research Laboratory

- CIR is a UO research institute composed of top scientists conducting research in the field of artificial intelligence.

Human Subjects Compliance

- Human Subjects Compliance assumes the responsibility to ensure that state and federal guidelines are met for the protection of the rights and welfare of human subjects who participate in research and other activity projects conducted by faculty, staff, and students at the UO.

Language Learning Solutions

- Language Learning Solutions is the world leader in the delivery of Web-based second language assessments, with unparalleled experience measuring reading, writing, listening, and speaking proficiencies in classroom settings.

Electrical Geodesics

- EGI, a company which started in the Research Park, licenses technology from the UO. It designs, produces, and sells electrophysiological recording equipment and related software, and employs undergraduates, graduate students, and postdoctoral fellows, serving as a training ground in the field of cognitive neuroscience.

Marker Gene Technologies

- EGI, a company which started in the Research Park, licenses technology from the UO. It designs, produces, and sells electrophysiological recording equipment and related software, and employs undergraduates, graduate students, and postdoctoral fellows, serving as a training ground in the field of cognitive neuroscience.

Health Policy Research Northwest

- HPRRN is an independent not-for-profit source of information useful for health policy decision makers and performs studies assessing healthcare needs and access to healthcare resources.

Lone Individual Practice Association

- LIPPA is an exclusive physician organization that strives to foster through physician leadership, a cooperative environment in which participating physicians can provide and improve community access to high quality cost-effective medical care for Oregon Health Plan patients.

MitoSciences

- MitoSciences, a spin-off from the UO's Monoclonal Antibody Facility specializing in mitochondrial structure and function, has licensed through the UO over 50 unique monoclonal antibodies against mitochondrial proteins.
Neurometrics Center
- NIC brings advanced informatics to brain research. In the near term, NIC will demonstrate the capability of creating a high-resolution finite element model of human head tissues, which will be used in the analysis of brain function by integrating information from EEG and MRI sources.

Office of Research Services and Administration
- ORSA provides assistance to UC faculty, staff, and administration in support of extramural funding in support of their research, instructional programs, and public services projects.

SeQuential Biofuels
- SeQuential Biofuels is Oregon's largest biofuels marketing and distribution company. Biodiesel is a cleaner burning diesel fuel alternative that is produced domestically from renewable materials.

Pacific Institutes for Research
- PIR conducts educational research in several key domains: early literacy, early numeracy, social behavioral systems, substance abuse, prevention, and positive school-wide behavioral programs.

Technology Transfer
- Technology Transfer helps university inventors successfully make the transition from academia to the commercial marketplace.

Oregon Research Institute
- ORI is internationally known as a leader in the conduct of socially relevant research.

Technical Assistance and Consulting Services/Western Regional Resource Center
- TRC provides technical assistance to state education and technical agencies to support and improve the design, implementation, and assessment of educational and technical programs and practices which will result in quality programs and services to children with disabilities and their families. It offers consultation, technical assistance, training, product development and information services, excluding research.

University of Oregon
- UO
Achroo

- Global enterprise company providing advanced computational fluid engineering solutions
- CO abode in the leading global provider of laser spectrum engineering simulation (CAE) solutions for fluid flow, heat transfer and stress. STAR-CD and STAR-CCM+ provide the world's most comprehensive CAE solutions, with the STAR-CD product as easy to use, CAE married from the start to the full spectrum of CAE software, backed by 25 years of advancement experience in CAE technology.

Rutter, Cullen, Clements & Zimmer, P.C.

- Law Firm

University Metallurgy Laboratory, Inc.


First Quality Enterprises, Inc.

- The First Quality family of companies includes First Quality Products, First Quality Noowovens and First Quality Hygienic. The company employs over 770 people, with more than 700 in PA.
- The State College office is responsible for finance, cash management, payroll and corporate human resources for all the affiliates.

Behavioral Endocrinology Lab (PSU)

- PSU Research and testing laboratory

E-commerce & Business Industry of Centre County

- The E-commerce & Business Industry of Centre County is a non-profit corporation dedicated to serving & advocating for the business community. It represents the interests of over 700 members from all over Centre County.

CEDA Corporation

- Advanced Information Technology Solutions for Geospatial Applications
1. Robert Kimber & Associates

- Robert Kimber & Associates is a full-service architecture and engineering company based in Williamsport, PA, with 15 regional offices including State College.
- Professional services provided by the company include architecture, civil and environmental engineering, telecommunications and technology consulting, transportation design, and mapping/GIS mapping.

2. The Penn State Justice & Safety Institute

- The Penn State Justice & Safety Institute was formed in 1971 to meet the professional development needs of law enforcement and public safety professionals.

3. Indigo Biosciences LLC

- Indigo Biosciences LLC is a contract research organization specializing in pharmaceutical, nutraceutical and toxicology screening services, custom assay development, and the creation of innovative products for high-throughput screening applications.

4. Intellectual Property Office (PSU)

- Promotes commercialization of inventions and discoveries arising from University research through licensing agreements and other arrangements.

5. Management Development Programs and Services (PSU)

- Penn State Management Development offers:
  - Public Programs: Register today for one of our open enrollment courses.
  - Custom Programs: Let us design a program that meets your organization's exact needs.
  - Services: Assessments Services, Corporate Education and Technology, Technology Group

6. Industrial Research Office (PSU)

- The Industrial Research Office matches faculty expertise and technical capabilities to a company's needs and determines where Penn State resources might prove most beneficial.

7. Materials Research Institute

- The Materials Research Institute is an interdisciplinary research and education center that fosters collaboration among faculty and students from across the College of Engineering. The Institute's mission is to advance materials science and engineering for the benefit of society through research, education, and technology transfer.
- The Institute is located in the Materials Research Building (MRB) and houses several research laboratories, including the National Charcoalization Laboratory (NCL), a National Center for Electron Microscopy (NCEM), and the Pennsylvania Supercomputer System (PSS).
<table>
<thead>
<tr>
<th>Company</th>
<th>Description</th>
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<tbody>
<tr>
<td>Fidicservice &amp; Environmental Consulting Firm</td>
<td>Full service engineering and environmental consulting firm.</td>
</tr>
<tr>
<td>Microelectronics Inc.</td>
<td>MSN Technologies Inc. specializes in the development and commercialization of piezoelectric actuators and transducers.</td>
</tr>
<tr>
<td>NanoHortions Inc.</td>
<td>NanoHorizons is an engineering company focusing on the development and production of products utilizing state-of-the-art nanotechnology for the fields of biotechnology and nanoelectronics.</td>
</tr>
<tr>
<td>Office of Sponsored Programs (NSU)</td>
<td>The Office of Sponsored Programs (OSP) is established to assist faculty in obtaining external funding to support their creative and scholarly activities.</td>
</tr>
<tr>
<td>Penn State Conference and Institutes</td>
<td>Responsible for the development, management, and coordination of educational conferences, intensive institutes, workshops, short courses, and seminars both on and off-campus.</td>
</tr>
<tr>
<td>Paradise Dynamics LLC</td>
<td>Manufacturer of Satellite Communication Equipment.</td>
</tr>
</tbody>
</table>
Penn State Public Broadcasting (PSPB)
- WPSU TV/FM: Quality radio and television programming as well as other educational and creative services.

QuantumBio, Inc.
- Software design and development services.
- QuantumBio's CHAMPAC software and data content is based on technology developed between 1996 and the present in the Department of Chemistry at the Pennsylvania State University in the labs of Dr. Kenneth M. Went, Jr., an international leader in the field of computational chemistry for drug discovery.

Pennsylvania Technical Assistance Program (PENNATP, PSU)
- Helps Pennsylvania business and industry improve their competitiveness by providing free scientific and technological assistance and information to help resolve specific technical questions or problems that can be addressed within a limited amount of time.

Real Time Embedded Technologies, Inc.
- Manufacturer of microcomputer data acquisition interface boards and single board computers.

SoftRock, LLC (a PennCom Company)
- SoftRock, headquartered in Menlo Park, CA, is one of the world's leading manufacturers of frequency and timing control components used in electronic products.

Qbic Diagnostics, Inc.
- The Qbic systems deliver the technology that leads the way in point-of-care hematology testing.

Research Commercialization Office (PSU)
- Helps with creation of spin-off companies from University research.

Schoharie.com
- A comprehensive and fully customizable online service that provides Internet, intranet, and extranet services to high schools.
<table>
<thead>
<tr>
<th>SerTech Corporation</th>
<th>Small Business Development Center (SBDC)</th>
<th>SBDC offers free business consulting for Centre and Mifflin counties.</th>
<th>TIAA-CREF</th>
<th>TIAA-CREF is a national financial services organization and the leading provider of retirement services to more than 3.2 million participants in the academic, research, medical and cultural fields at over 10,000 institutions nationwide.</th>
</tr>
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<tr>
<td>Shaw Environmental &amp; Infrastructure, Inc.</td>
<td>Shaw Environmental &amp; Infrastructure, Inc. (Shaw E&amp;I) is one of the nation's largest full service contractors, provides innovative solutions for environmental and infrastructure projects worldwide. Clients include the commercial industry, institutions, and federal government. Programs are supported throughout all phases of a project, from planning and permitting through design, construction, operation, demolition, remediation and redevelopment.</td>
<td>Developer and marketer of genetic analysis software.</td>
<td>SOHO Genies, Inc.</td>
<td>SOHO Genies, Inc. provides custom genetic analysis software.</td>
</tr>
<tr>
<td>Sercomposites (USA), LLC</td>
<td>SRU</td>
<td>SRU is a leading manufacturer of advanced composite materials for aerospace, defense, and industrial applications. Services include design, fabrication, testing, and quality control.</td>
<td>West Arc Computer</td>
<td>West Arc Computer provides high-quality computing services to academic groups. Our mission is to bring the best practices of the software industry to academic computing projects.</td>
</tr>
</tbody>
</table>
Biogenesis, Inc.
- Biogenesis is a biotechnology company that develops, manufactures, and sells biological research reagents to scientists studying breast cancer.

Biorex, Inc.
- Biorex, Inc. was designed to meet a new and increasing demand by the pharmaceutical industry for reliable molecular data during clinical trials.

GEX Systems, Inc.
- GEX Systems is a biotechnology company that develops and manufactures research reagents to scientists studying breast cancer.

BIOMEDICAL ENTERPRISES
- Biomedical Enterprises is a company that is engaged in orthopedic and dental implant research.

GENZYME (formerly BEX ONSCOLOGY)
- Genzyme is a drug development company that has a central manufacturing laboratory facility located in the Texas Research Park. This facility produces pharmaceutical grade bulk, non-sterile compounds under cGMP conditions.

MISSION TECHNOLOGIES, INC.
- Mission Technologies Inc is an aerospace company that specializes in the design of unmanned aerial vehicles (UAVs).

THE COOPERATION AND RESEARCH DEVELOPMENT
- The Cancer Therapy and Research Center's Institute for Drug Development is an organization that focuses exclusively on the discovery and development of new therapies for the treatment of cancer patients.

OncoVista
- OncoVista is a privately held pharmaceutical company dedicated to the discovery and development of innovative, safe and efficacious treatments for cancer and other life-threatening diseases.

SOUTHWEST ONCOLOGY GROUP
- Southwest Oncology Group is one of the largest of the National Cancer Institute-supported cancer clinical trials cooperative groups in the United States.

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<table>
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<tr>
<th>University of Tennessee Institute for Biotechnology</th>
<th>Avaneek, Inc.</th>
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<tbody>
<tr>
<td>An organization that performs research focusing on molecular pathogenesis of cancer, heredity links to obesity and other diseases.</td>
<td>Engineering and sales consulting for Asian electronics manufacturing company, and ATR manufacturing.</td>
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<tr>
<th>Enprotech Corporation</th>
<th>Artisan Studios Inc.</th>
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<tr>
<td>Primary businesses are design and consulting services in areas of Signal Processing (hardware &amp; software), Radio Frequency hardware design (from HF to S-band), Embedded Systems (hardware &amp; software), IP Core Design.</td>
<td>Artisan Studios Inc. provides clients with all aspects of design, from traditional print media to website and multimedia/video productions.</td>
</tr>
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<tr>
<th>Aerospace Precision Imaging - USU RF</th>
<th>Convergys Training Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>A unit of the Utah State University Research Foundation</td>
<td>In our pursuit of seeking new talent, we have a team-based approach to recruiting tomorrow's leaders off of today's college campuses.</td>
</tr>
<tr>
<td>A non-profit research corporation owned by Utah State University.</td>
<td>We have built strong strategic partnerships with 15 target schools that, in addition to being nationally recognized, are also geographically representative of the 40+ Convergys U.S. locations.</td>
</tr>
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<tr>
<th>Texas Research Park Foundation</th>
<th>Convergys Customer Contact Center</th>
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<tr>
<td>Texas Research Park Foundation</td>
<td>Convergys provides inbound customer care to Direct TV.</td>
</tr>
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Artisan Studios Inc. provides clients with all aspects of design, from traditional print media to website and multimedia/video productions.
Karthl'Ax I X-vcIopnit-nf
• EartftaCtevetopnirttoMOTtfrorHnentai
wmedto&on company offerag fungal toms
toeremedtoliaa technology.
• The com pany concentrated Its efforts on the
developm ent 01
detd procedure* for application at
wito ati«to«»meewo<t3kirefiainfl
eootarrtA atod son TNs tactaotegy has proven amenable to the degradation of a w ide variety ot
contaninante, Inotooina parades, tertxortoe, woood proaervetivce, axptoaiuea, potycycic arom atic
hydrocarbon*. PC B ». eyaiade, dyat.

Immuno Labs
• Immuno Labs is an innovative life science
company. With over 20 years of combined
experience in the scientific industry we are
dedicated to providing quality products for
use in cancer detection and infectious
diseases.
• In addition we provide a variety of OEM
contract services including sterile and non-
sterile liquid manufacturing, custom
packaging and drop shipping services.

Information Connections
• Information Connections partners with the
USU innovation Campus Smart Sites.
Provides outsourcing services and corporate
training to national and international
companies.

Information Alliance
• Information Alliance is a market research firm
experienced in quality data collection,
providing primary research and technical
support to consultants, full service market
research firms, Fortune 500 companies, and
government entities.

Letterpress Software
• Letterpress Software develops cost effective
Internet and CD-ROM based instructional
software for training on product lines,
equipment systems, setup and maintenance
procedures, software applications, and
custom training needs.

Ladew Transit Services, Inc.
• Ladew is an innovator in personalized
transportation services.
• Ladew works with government organizations
to develop and implement better ways to
provide public transportation within the United
States.

Letterpress Software
• Letters is an innovator in personalized
transportation services.
• Letters works with government organizations
to develop and implement better ways to
provide public transportation within the United
States.

YsriChoice, Inc.
• YsriChoice, Inc provides state of the art,
browser-based records management, and
dispatch software to military, campus, city
and county law enforcement agencies across
the United States.
• YsriChoice offers over 15 years of
experience producing, designing, and
implementing quality software solutions for
law enforcement agencies.

Ladew Transit Services, Inc.
• Ladew is an innovator in personalized
transportation services.
• Ladew works with government organizations
to develop and implement better ways to
provide public transportation within the United
States.

ICAO combines university, business,
industry, and government experience, while
providing office space, laboratories, and other
tenant services to create a stimulating
environment for dynamic partnerships and
growth between USU regional and global
communities.

Information Connections
• Information Connections partners with the
USU innovation Campus Smart Sites.
Provides outsourcing services and corporate
training to national and international
companies.

Integra Learning, Inc.
• Integra Learning, Inc. publishes educational software for
home educators, parents, libraries, and
schools.

Information Connections
• Information Connections partners with the
USU innovation Campus Smart Sites.
Provides outsourcing services and corporate
training to national and international
companies.

Information Connections
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Provides outsourcing services and corporate
training to national and international
companies.
**MicroProbes, LP**
- develops instruments and methodologies for the detection of microbial contaminants and toxic proteins in air, water, food, animal tissue, and mail systems, etc.

**Space Dynamics Laboratory**
- applies basic research to the technology challenges presented in the military and science arenas. SDL has developed revolutionary solutions that are changing the way the world collects and uses data, and continues to lead the way in the development of sensors and supporting technologies.

**Trio Systems**
- Trio Systems is a dynamic professional search firm specializing in the successful placement of both software and hardware engineers with growing Bay area companies. From great icons in the industry to hot pre-IPO companies operating in stealth mode.

**Utah State Regional Resource Center**
- develops and distributes educational material for the disadvantaged.

**Spectrum Research Technologies**
- develops software and hardware solutions for the defense and aerospace industries.

**Technology Communication Office**
- Responsible for managing the commercial aspects of technology licensing at Utah State University.

**Utah Division of Water Rights**
- The Utah Division of Water Rights is an agency of the Utah State Government within the Department of Natural Resources. Records, information, and forms for regulatory activities administered by the agency.
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<tr>
<td>West Words, Inc.</td>
<td>West Words, Inc. is a full-service textbook composition company supplying project management, editorial services, copyediting and production services to the major educational publishers in the U.S. and Canada.</td>
</tr>
<tr>
<td>MicroAire Surgical Instruments</td>
<td>R&amp;D and headquarters facility for surgical instruments manufacturer.</td>
</tr>
<tr>
<td>Southern Health</td>
<td>Headquarters for Coverity-owned health maintenance organization (HMC).</td>
</tr>
<tr>
<td>World Savings</td>
<td>World Savings is a call center dedicated to portfolio retention for home mortgages and real estate loans.</td>
</tr>
<tr>
<td>Carlisle Industries (Motion Control)</td>
<td>R&amp;D and sales facility for industrial brake pad manufacturer.</td>
</tr>
<tr>
<td>ANGEL Technology</td>
<td>U.S. headquarters for international consulting firm. Management and Ventures company focusing on the commercialization of technology and the development of technology-based industry.</td>
</tr>
<tr>
<td>PRA International, Inc.</td>
<td>University 17</td>
</tr>
<tr>
<td>Memorial Institute</td>
<td>Battelle is a global science and technology enterprise that develops and commercializes technology and manages opportunities for customers.</td>
</tr>
</tbody>
</table>
Innovative Solutions, Inc.
- R&D and HQ facility - supplier of purification, separation systems and consumables for the pharmaceutical, biopharmaceutical and specialty chemical industries - leader in the field of Liquid Chromatography products and services.

Athena Innovative Solutions, Inc.
- Regional office for contract research organization in national security, technology, and policy arenas.

Padron's Home & Deli
- A well-known food service organization in Charlottesville & Richmond.

Adenosine Therapeutics
- R&D and HQ facility for biotechnology company focusing on novel pharmaceutical products that target adenosine receptor subtypes.

Northrop Grumman
- A global aerospace and defense company and the world's largest shipbuilder.

Pineapple Pharmaceuticals
- R&D and HQ facility for pharmaceutical products.
- Small biotechnology company operating primarily in the market for researched and tested biologically active compounds of proven medicinal value.

TIAA-CREF
- A financial services provider offering pension services to many UVA employees.

Accelco Corporation
- Accelco Corporation develops software and provides tech support services.

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Aeroprobe Corporation is a manufacturing company, its strength lies in its ability to develop and market scientific and engineering equipment to measure, monitor and control air speed and direction. Many of its products have already been designed, built and tested, and most have been manufactured.

Aerosoft was incorporated in 1988 to develop, license, market, and support software for computational fluid dynamics (CFD) applications, utilizing novel algorithms which expand the capabilities of its users.

Asia Venture Partners, Inc. was established as US Corporation in the year of 2001 for the purpose of technology industry development and investment in Asia and the USA. Asia Venture Partners provides venture capital to high-tech companies.

AVD, LLC specializes in aircraft design consulting and creation, and dissemination and maintenance of open-source aircraft analysis and design software.

AVP provides design and software support for U.S. Government agencies and aerospace companies—both military and commercial sectors.
<table>
<thead>
<tr>
<th>Biological Monitoring, Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Biological Monitoring, Inc. provides consultation, site services, and water quality monitoring technology to water, waste water, and chemical manufacturing clients. Performs environmental risk assessments.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BioNet Technologies, Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- BioNet Technologies, Inc. offers a variety of Internet and network services including hosting and design, e-commerce and database solutions, server co-location consulting, and dedicated bandwidth.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BizNet Systems, Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- BizNet Systems, Inc. integrates different sources of business information into real-time, intuitive business intelligence solutions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Computer Resource Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Computer Resource Team services including consulting training, design and applications development.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DesignPayment.com</th>
</tr>
</thead>
<tbody>
<tr>
<td>- DesignPayment.com develops online payment solutions for organizations, non-profits, and political parties.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Travegrol Temporary Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Travegrol Temporary Projects offers a variety of temporary staffing solutions, including IT, technical, and administrative professionals.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wyly Engineering, Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Wyly Engineering, Inc. develops Internet-based software applications.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wyly Copy and Shipping Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Wyly Copy and Shipping Center operates a copy and shipping center permitting Virginia Tech Corporate Research Center tenants to have maximum discounts.</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DiatflX System, Inc.</td>
<td>Provides IT services and solutions to design and develop business applications, e-commerce sites, computer networks, Business Process Optimization, Business Intelligence, Data Warehousing and EWM.</td>
</tr>
<tr>
<td>Everest Systems, Inc.</td>
<td>Provides data warehousing and business intelligence solutions for enterprise applications.</td>
</tr>
<tr>
<td>Exemptum</td>
<td>Specializes in creating interactive demonstrations that deliver your product message. For marketing, sales, training, and customer support, we develop engaging, high-impact demonstrations that bring true value to your organization.</td>
</tr>
<tr>
<td>Digital Bazaar</td>
<td>Creates web services that revolutionize the way digital content is bought and sold online.</td>
</tr>
<tr>
<td>Everest Software, Inc.</td>
<td>Develops software that empowers wholesale/distributor/companies to view and manage every function of their business more effectively by allowing them to track their business operations online and offline, from storefront to the back office.</td>
</tr>
<tr>
<td>First National Bank</td>
<td>Provides full-service banking specializing in small business financing and government-assisted loan programs.</td>
</tr>
<tr>
<td>Enrgence Corporation</td>
<td>Provides information technology services for data warehousing and business intelligence solutions for enterprise applications.</td>
</tr>
<tr>
<td>Evreptics, Inc.</td>
<td>Develops and sells document management, fingerprint management, and image processing systems.</td>
</tr>
<tr>
<td>G.J. Hopkins</td>
<td>Designs and installs mechanical and electrical systems providing 24-hour preventative and emergency service.</td>
</tr>
</tbody>
</table>
G3 Systems Inc.
- G3 Systems, Inc. specializes in interactive media design, educational and training content creation, website design and hosting.
- Commerce 3D modeling, rendering and animation, visual simulations, network planning and design and info systems integration.

Intercast International Inc.
- Intercast International, Inc. develops, manufactures, and distributes content solutions.

Intecons Inc.
- Intecons, Inc. develops network storage systems.

Tmographics Inc.
- Tmographics uses XML for user interfaces and other software problems.

Intrexon Corporation
- Intrexon Corporation manufactures genetic material.

Meadowbrook & Hersey Inc.
- Provides engineering and architectural design, surveying, and software development services.
- Services include:
  - Mechanical Engineering
  - Planting/Tree Protection Engineering
  - Electrical Engineering
  - Telecommunications/Systems Engineering
  - Web Site Project Construction Management
  - Commissioning
  - Planning

Intricon for Critical Technologies Inc.
- Manages the research program for a major Virginia Tech research institute.

Intricon Inc.
- Intricon, Inc. performs research and development of electronic components.
Kcoon, Inc.
- develops products that help organizations deal, discover, explore, track, and reward their employees, creating a vibrant, high-performing culture with objectives.
- For Kcoon, it's a choice and a commitment among vendors. Kcoon leads the way in innovative and development strategies. It's about making a tangible impact on developing innovative solutions that solve real business problems.

Luna Technologies Inc.
- researches, develops, and manufactures fiber optic products.

Martech, Inc.
- MapTech, Inc. hydrological & water quality monitoring & modeling, GIS applications, precision agriculture, environmental training, GPS applications, & laboratory. Features one of only 2 commercial water quality labs in the nation.

NanoCom Corporation
- performs legal work relative to software for the banking industry.

Lumen Intellectual Property, LLP
- provides intellectual property legal services.

MapTech, Inc.
- MapTech, Inc. hydrological & water quality monitoring & modeling, GIS applications, precision agriculture, environmental training, GPS applications, & laboratory. Features one of only 2 commercial water quality labs in the nation.

MapTech, Inc.
- performs computer consulting on security, networking, Linux, HP UNIX systems.

National Weather Service
- provides full weather forecasts, warnings and statements for a 40-county area.
The Network Dynamics and Simulation Science Laboratory is pursuing an advanced research and development program for interaction-based modeling, simulation, and associated analysis, experimental design, and decision support tools for understanding large biological, information, social, and technological systems.

New City Media provides web development specializing in custom interactive design. Regional and national leading companies rely on our usability design, technology, and project management excellence.

New River Pharmaceuticals Inc. (NRPH) is a specialty pharmaceutical company focused on developing novel pharmaceuticals that are safer and improved versions of widely-prescribed drugs in large and growing markets. We are developing new molecular entities that are derivatives of public domain actives using our proprietary Camerwave™ technology.

Open Tech Inc.
- Open Tech, Inc. provides consulting services for software development specializing in Virtual Reality and open source software.

Orbit Inc.
- Orbit, Inc. provides consulting services for geographic information systems.

Phoenix Integration Inc.
- Phoenix Integration, Inc. provides software that allows manufacturing companies to integrate and automate numerous software tools, remote locations, and different computing platforms into a cohesive environment for systems design.

New Tech Solutions Incorporated
- PSI conducts forensic analyses and physical testing of plastics, polymers, resins, coatings, fibers and fabrics, forams, and items for industry, government, and attorneys.
Prime Photonics LLC
Prime Photonics LLC develops and markets fiber optic sensor systems for harsh environments. Our primary focus is the commercialization of industrial grade fiber optic sensor systems and instrumentation for harsh environments specializing in those with extreme temperature or pressure, high electromagnetic interference, and/or corrosive conditions.

PyGon specializes in information security, network administration, system integration and web application development.

Rapid Response Inc.
Rapid Response Inc. commercializes therapies that can treat and cure serious human diseases through regenerative medicine, namely, the replacement of cells, tissue, and organs.

Rivivicor Inc.
Rivivicor Inc. commercializes therapies that can treat and cure serious human diseases through regenerative medicine, namely, the replacement of cells, tissue, and organs.

Revivicor Inc.
Revivicor Inc. commercializes therapies that can treat and cure serious human diseases through regenerative medicine, namely, the replacement of cells, tissue, and organs.

RJK Technologies LLC
RJK Technologies LLC develops avionics systems and software. RJK Technologies LLC is a software engineering and systems integration firm that specializes in developing, integrating, testing, and supporting mission critical software.

Rapid Research
Rapid Research is a certified federal small business that is focused on R&D, product development, and manufacturing of sensor systems for harsh environments as well as R&D programs that develop unique solutions to unmet needs of our federal and commercial customers.

Rapid Response Inc.
Rapid Response Inc. commercializes therapies that can treat and cure serious human diseases through regenerative medicine, namely, the replacement of cells, tissue, and organs.

Schned Medical Solutions LLC
Schned Medical Solutions LLC develops software solutions for the healthcare market.
Software Licensing Corporation

- Provides high-quality restaurant and catering service at the CRC.

- We have specialized in developing terminal emulation software for 17 years.
- We were one of the first companies to offer terminal emulation under Windows, and one of the first to support PC to host connections over the Internet. We continue to offer state-of-the-art solutions such as Java applets with SSL encryption.

Technology Licensing Office

- Offers a range of legal services to start-up corporations, including corporate, patent, licensing, trademark, joint venture, and VC expertise.

- Provides public library services at the CRC.

- Provides high-quality restaurant and catering service at the CRC.

- TECHLAB, Inc. develops, manufactures, and distributes rapid on-site disease detection systems in the areas of oncology, hematology, immunoassay, and respiratory disease and parasitology.
- TECHLAB is a highly responsive full service medical product design, medical device manufacturing and regulatory filing company with FDA registrations. Our expertise is recognized with the formulation, testing and packaging of diagnostic products. The company offers clean room and non-clean room services for Class I and II products.

- TECHLAB is a New York State service provider to domestic and international companies. The company offers clean room and non-clean room services for Class I and II products.

- TECHLAB is a laboratory within the Research Department of the Graduate School of Engineering at Virginia Tech's mission of outreach and service through technology transfer and economic development.

- The Public Library at CRC

- Provides public library services at the CRC.

- Virginia College of Osteopathic Medicine

- Trains medical students and performs research related to osteopathic medicine.
<table>
<thead>
<tr>
<th>Virginia Tech Intellectual Properties, Inc.</th>
<th>Virginia Tech System, Inc.</th>
<th>VT Corporate Research Center</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supports the instructional, research, and public programs of Virginia Tech.</strong></td>
<td>VT provides and manages intellectual development and technology transfer services to support the advancement of Virginia Tech's mission and goals. The mission of Virginia Tech is to educate the leaders and innovators of the future, to engage in transformative research, and to serve society through partnerships and outreach.</td>
<td>VT manages the facilities and programs of the Virginia Tech Corporate Research Center.</td>
</tr>
<tr>
<td><strong>Virginia Tech System, Inc.</strong></td>
<td><strong>VT Corporate Research Center</strong></td>
<td><strong>VT System, Inc.</strong></td>
</tr>
<tr>
<td>VT develops and manages software related to tobacco use prevention for youth.</td>
<td>VT develops system engineering software (CORE) that facilitates collaborative research at Virginia Tech related to biomedical and health sciences.</td>
<td>VT develops and supports software for document imaging and electronic document delivery.</td>
</tr>
<tr>
<td><strong>VT System, Inc.</strong></td>
<td><strong>VT Corporate Research Center</strong></td>
<td><strong>VT Intellectual Properties, Inc.</strong></td>
</tr>
<tr>
<td>VT offers assistance through R&amp;D, outreach, and education to industrial clients involved in the engineering, manufacturing, and marketing of forest products.</td>
<td>VT was established in 1985 as a university affiliated, nonprofit, private corporation. VTIP handles, protects, and licenses technologies developed by the faculty, staff, and students at Virginia Tech. These technologies include new varieties of plants, transgenic technologies, microelectronics, fiber optics, wireless communications, coal technologies, software and more.</td>
<td>VT develops and supports software for document imaging and electronic document delivery.</td>
</tr>
<tr>
<td>Company</td>
<td>Description</td>
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</tr>
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</tr>
<tr>
<td>VTLS Inc.</td>
<td>develops innovative technological solutions to transportation problems.</td>
<td></td>
</tr>
<tr>
<td>Webmail Inc.</td>
<td>provides managed email and virtual hosting with integrated anti-spam, anti-virus and other email security services to thousands of small businesses and private user resellers throughout the world.</td>
<td></td>
</tr>
<tr>
<td>WPI</td>
<td>VTLS Inc. focuses on providing innovative and practical solutions to environmentally, energy and management challenges. WPI provides dynamic information technology tools for small and mid-sized businesses. WPI's highly trained team of experts combines technical know how with business and management skills to deliver comprehensive solutions. Our engineers, consultants, environmental experts, financial analysts, and sales staff provide support in administration, planning, and expert communications. WPI designs the best mix of services to achieve creative and cost-effective answers.</td>
<td></td>
</tr>
<tr>
<td>WPI</td>
<td>provides information technology services to Virginia Tech.</td>
<td></td>
</tr>
<tr>
<td>WPI</td>
<td>provides information technology services to Virginia Tech.</td>
<td></td>
</tr>
<tr>
<td>WPI</td>
<td>distributes corporate gifts, gemstone world globes, exercise balls, promotional gifts, gems and collectibles through online trade shows.</td>
<td></td>
</tr>
<tr>
<td>WPI</td>
<td>provides legal services.</td>
<td></td>
</tr>
<tr>
<td>WPI</td>
<td>provides legal services.</td>
<td></td>
</tr>
<tr>
<td>University 19</td>
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</tr>
</tbody>
</table>
Airhortu-  

Ovemigra delivery

Over 20 sizes of self-storage units starting at $9.95/month. Outside storage (including covered) for boats and RVs.

APEL provides opportunities for efficient and effective business startup and development. Entrepreneurs, engineers, scientists, and businesspeople developing new businesses, as well as university staff, will all have access to the facility.

Bonneville Power Administration

The Bonneville Power Administration, headquartered in Portland, Oregon, is a federal agency under the U.S. Department of Energy.

Bechtel National, Inc.

Bonneville Power Administration

Anheuser-Busch

Developers, designers, and manufacturers of nuclear fuel and services for electric utilities operating commercial light water reactors throughout the U.S., Europe, and the Far East.

Dyno Specialty Foods

Specializing in hot and spicy foods

Garlic Catering

WIN 2011-15

We are your Catering Professionals with unlimited catering capabilities, specializing in Pacific Northwest Cuisine from the simple to the spectacular. Please contact us when we may assist in serving your guests.

Applied Process Engineering Laboratories

APEL provides opportunities for efficient and effective business startup and development. Entrepreneurs, engineers, scientists, and businessmen developing new businesses, as well as university staff, will all have access to the facility.

Bechtel National, Inc.

Bechtel National, Inc. is designing, building, and commissioning a vast complex of treatment plants to convert dangerous waste into stable glass.

CURRENT ENVIRONMENTAL SOLUTIONS

Rapid in-place remediation of soil and groundwater using innovative and cost-effective thermal treatment.
Consulting firm specializing in occupational and environmental radiation protection, radiation waste management, regulatory compliance, radiation dose and risk assessment, and National Environmental Policy Act implementation, including preparation of EISs and EAs.

- Serving breakfast, espresso, freshly baked pastries and lunch.

- Energy Northwest is a valued public energy resource for the Northwest and provides electricity, at cost, to public utilities and municipalities in the Northwest.

- Provide government and commercial waste management services including transportation logistics, engineering, environmental monitoring and investigations, well services, sampling and mobile laboratories, generator services support, and integrated post management.

- FE&C is a company with expertise in high-quality environmental remediation and construction projects for the public sector.

- Innovatek creates innovative solutions for health, safety, and energy applications using advanced materials and chemical processing technologies. The company has two primary business areas: 1) chemical safety and defense; and 2) micro fuel processing.
International Health Metals, LLC
- Titanium melting facility.

Pacific EcoSolutions
- A nuclear waste processing facility providing comprehensive low level waste and mixed low level waste processing services to commercial and government clients.

PLC & Plus Control Systems
- PLC automation & control systems, real-time data acquisition & monitoring, test & measurement systems, design, documentation, analysis, and reporting. Microsoft Visual Basic, C and C++ programming.

Jason Associates
- Risk assessment, technology transfer, safety, environmental, and project management consulting. Jason Associates is a certified SDB.

Pacific Northwest National Laboratory
- Battelle operates DOE’s Pacific Northwest National Laboratory, a multiprogram, national laboratory. By advancing science and putting technology to work, Battelle is meeting national challenges in the environment, health, energy, national security, and technology deployment.

Richard Skydive
- Instruction for skydiving.

Northwest Technical Glass
- Scientific glassblowing and manufacture of glass laboratory products.

Pacific Food Ingredients Co.
- Manufacturer of food grade potato starch.

Science Applications International Corporation
- SAIC has a broad range of experience in environmental concerns, health and safety issues, quality assurance, training, and engineering applications. We have Licensed Professional Engineers and Certified Health Physicists and Industrial Hygienists.
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSI (Safety Test Laboratories, Raffles)</td>
<td>The provider of the world’s most comprehensive range of environmental testing and program compliance support.</td>
</tr>
<tr>
<td>Total Energy Management, Inc.</td>
<td>Complete HVAC design and installation, process control design and fabrication, U.L. 508 control panels, complete system integration.</td>
</tr>
<tr>
<td>USA Ventures, Inc.</td>
<td>UFA Ventures is an innovative and full-service soil, rock, and materials testing laboratory. It provides ODE, other government agencies, academia, and industry, with the services necessary for cost-effective environmental restoration and waste management operations.</td>
</tr>
</tbody>
</table>
| Soma Systems, Inc. | Radiation dosimetry
The Soma Precision Point® Dosimeter is a revolutionary new product for high-dose dosimetry capable of using LiF-based optically stimulated luminescence (OSL) for doses from 0.3 to 200 kGy. |
| TEC-CITIES ENTERPRISE CENTER | TEC provides coaching and mentoring to small businesses. TEC operates two business facilities and provides office and bay space, administrative support and shared services. TEC offers financing options including Microloans, Micro-Equity. |
| Vista Engineering Technologies, L.L.C. | Provides environmental engineering for tanks and pipelines. |
| Surgical Implant Generation Network (SIGN) | Non-profit corporation dedicated to creating equality of fracture care throughout the world. |
| The City’s SCT Park Avenue | The Park Association’s mission is to inform developers, business leaders, and entrepreneurs of the Park’s potential. |
| Good Learning Systems, Inc. | Computer-based training in the following areas: safety, employment law, all medical. |
Manufacturing of custom powder metal parts.
## APPENDIX B

### Classification of Companies

**High-technology or knowledge-intensive Companies**

<table>
<thead>
<tr>
<th>Company ID #:___________</th>
</tr>
</thead>
</table>

### A. ENGINEERING

<table>
<thead>
<tr>
<th>Field</th>
<th>Disciplines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aeronautical &amp; Astronautical</td>
<td>Aerospace, Aeronautical, and Astronautical Engineering (also aerodynamics)</td>
</tr>
<tr>
<td>2. Bioengineering/ Biomedical Engineering</td>
<td>Bioengineering and Biomedical Engineering</td>
</tr>
<tr>
<td>3. Chemical</td>
<td>Wood Science Chemical Engineering Petroleum Engineering Polymer/ Plastics Engineering</td>
</tr>
<tr>
<td>4. Civil</td>
<td>Architecture Architecture Engineering Civil Eng. Environmental/ Environmental Health Engineering (also geotechnical, hydraulic, hydrologic, sanitary and environmental, structural transportation)</td>
</tr>
</tbody>
</table>

### B. PHYSICAL SCIENCES

<table>
<thead>
<tr>
<th>Field</th>
<th>Disciplines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Astronomy</td>
<td>Astronomy Astrophysics (also Gamma-ray, neutrino, optical and radio, X-ray)</td>
</tr>
<tr>
<td>2. Chemistry</td>
<td>Chemistry (also analytic, inorganic, organic, organo-metallic, pharmaceutical, physical, polymer sciences (except biochemistry)</td>
</tr>
<tr>
<td>3. Physics</td>
<td>Physics (also acoustics, atomic/molecular, chemical, condensed matter, Elementary particles, nuclear structure, optics, plasma, theoretical/ mathematical)</td>
</tr>
<tr>
<td>4. Other</td>
<td>Physical Sciences, General Miscellaneous Physical Sciences, Other Physical Science, other</td>
</tr>
</tbody>
</table>

### C. ENVIRONMENTAL SCIENCES

<table>
<thead>
<tr>
<th>Field</th>
<th>Disciplines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Atmospheric</td>
<td>Atmospheric Sciences and Meteorology (also aeronomy, extraterrestrial atmospheres, solar, weather modification)</td>
</tr>
<tr>
<td>2. Earth Sciences</td>
<td>Surveying Geological and Related Sciences Earth &amp; Planetary Sciences Cartography (Also engineering geophysics, general geology, geodesy and gravity, geomagnetism, hydrology, inorganic, isotopic, lab geophysics, organic geochemistry, paleomagnetism, physical geography, seismology)</td>
</tr>
<tr>
<td>3. Oceanography</td>
<td>Marine/ Aquatic Biology Oceanography</td>
</tr>
<tr>
<td>4. Other</td>
<td>(Multidisciplinary projects with Earth, Atmospheric, and Ocean Sciences)</td>
</tr>
<tr>
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</tr>
</tbody>
</table>

### D. MATHEMATICAL SCIENCES

<table>
<thead>
<tr>
<th>1. Mathematical Sciences</th>
<th>Mathematical, General Applied Mathematics Operations Research Mathematical Statistics Mathematical, Other Math/Computer Sciences (also algebra, analysis, foundations and logic, geometry, numerical analysis, topology)</th>
</tr>
</thead>
</table>

### E. COMPUTER SCIENCES

<table>
<thead>
<tr>
<th>1. Computer Sciences</th>
<th>Computer and Information Science, General Management Information Systems (also design, development, and application of computer capabilities to data storage and manipulation, information science)</th>
</tr>
</thead>
</table>

### F. LIFE SCIENCES

<table>
<thead>
<tr>
<th>1. Agricultural</th>
<th>Agricultural Production Aquaculture International Agriculture Agriculture Sciences Plant Sciences Soil Science Renewable Natural Resources Landscape Architecture</th>
</tr>
</thead>
</table>

#### 2. Biological

<table>
<thead>
<tr>
<th>2. Biological</th>
<th>Foods and Nutrition Studies Biology, General Biochemistry Biophysics Botany Cell and Molecular Biology Anatomy Ecology Nutritional Sciences Parasitology Toxicology Genetics Biometrics Biostatistics Misc. Bio. Specializations, other Zoology Entomology Pathology Pharmacology Physiology Biolog./Life Science Other Medical Anatomy Medical Biochemistry Medical Immunology Medical Microbiology Medical Pathology Medical Physiology Medical Toxicology Epidemiology</th>
</tr>
</thead>
</table>

#### 3. Medical

<table>
<thead>
<tr>
<th>3. Medical</th>
<th>Neurosciences Radiation Biology/Radiobiol. Dentistry Medicine, General Med. Basic Sciences, Other Nursing Psychiatry Optometry Osteopathic Med. Mental Health Pharmacy Podiatry Public Health Veterinary Medicine</th>
</tr>
</thead>
</table>

#### 4. Other

<table>
<thead>
<tr>
<th>4. Other</th>
<th>Gerontology Communication Disorders Sciences and Services Health and Medical Administrative Services Health and Medical Laboratory Techn. Nursing technologies Occupational Therapy Physical Therapy Rehab/Therapeutic Services Health Professions and Related Services, Other</th>
</tr>
</thead>
</table>

### G. OTHER

<table>
<thead>
<tr>
<th>1. Financial and Insurance Services</th>
<th>Commercial Banking Services Retail Banking Services Investment Services</th>
</tr>
</thead>
</table>

#### 2. Accommodation and Food Services

<table>
<thead>
<tr>
<th>2. Accommodation and Food Services</th>
<th>Hotels Restaurants Cafeterias Catering Other</th>
</tr>
</thead>
</table>

#### 3. Retail Services

<table>
<thead>
<tr>
<th>3. Retail Services</th>
<th>Computer and Software Stores Supermarkets and Other Grocery Stores Clothing Stores Motor Vehicle Dealers Other</th>
</tr>
</thead>
</table>

#### 4. Real Estate and Leasing Services

<table>
<thead>
<tr>
<th>4. Real Estate and Leasing Services</th>
<th>Real Estate and Rental and Leasing</th>
</tr>
</thead>
</table>

#### 5. Other Services

<table>
<thead>
<tr>
<th>5. Other Services</th>
<th>Other</th>
</tr>
</thead>
</table>

#### 6. Research Centers

<table>
<thead>
<tr>
<th>6. Research Centers</th>
<th>Private Research Center Government Research Center Other</th>
</tr>
</thead>
</table>

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# APPENDIX C

National Science Foundation’s Classification

<table>
<thead>
<tr>
<th>NSF Categories</th>
<th>NCES Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. ENGINEERING</strong></td>
<td></td>
</tr>
<tr>
<td>1. Aeronautical &amp; Astronautical</td>
<td>Aerospace, Aeronautical, and Astronautical Engineering</td>
</tr>
<tr>
<td></td>
<td>(also aerodynamics)</td>
</tr>
<tr>
<td>2. Bioengineering/ Biomedical Engineering</td>
<td>Bioengineering and Biomedical Engineering</td>
</tr>
<tr>
<td>3. Chemical</td>
<td>Wood Science</td>
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<tr>
<td></td>
<td>Chemical Engineering</td>
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<tr>
<td></td>
<td>Petroleum Engineering</td>
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<tr>
<td></td>
<td>Polymer/ Plastics Engineering</td>
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<tr>
<td>4. Civil</td>
<td>Architecture</td>
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<tr>
<td></td>
<td>Architecture Engineering</td>
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<tr>
<td></td>
<td>Civil Eng.</td>
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<tr>
<td></td>
<td>Environmental/ Environmental Health Engineering</td>
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<tr>
<td></td>
<td>(also geotechnical, hydraulic, hydrologic, sanitary and environmental, structural transportation)</td>
</tr>
<tr>
<td>5. Electrical</td>
<td>Computer Engineering</td>
</tr>
<tr>
<td></td>
<td>Electrical, Electronics and Communications Eng.</td>
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<tr>
<td></td>
<td>Mechanical Engineering</td>
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<tr>
<td></td>
<td>Geological Eng.</td>
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<tr>
<td></td>
<td>Geophysical Eng.</td>
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<tr>
<td></td>
<td>Materials Eng.</td>
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<tr>
<td></td>
<td>Mining &amp; Mineral</td>
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<tr>
<td>8. Other</td>
<td>Engineering General</td>
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<tr>
<td></td>
<td>Agriculture Eng.</td>
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<tr>
<td></td>
<td>Engineering Physics</td>
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<tr>
<td></td>
<td>Engineering Science</td>
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<tr>
<td></td>
<td>Industrial/ Manufacturing Eng.</td>
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<tr>
<td></td>
<td>Naval Architecture and Marine Eng.</td>
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<tr>
<td></td>
<td>Nuclear Eng.</td>
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<td></td>
<td>Ocean Eng.</td>
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<tr>
<td></td>
<td>Systems Eng.</td>
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<tr>
<td></td>
<td>Engineering Design</td>
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<tr>
<td></td>
<td>Eng./Industrial Management</td>
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<tr>
<td></td>
<td>System Science and Theory</td>
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<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td><strong>B. PHYSICAL SCIENCES</strong></td>
<td></td>
</tr>
<tr>
<td>1. Astronomy</td>
<td>Astronomy</td>
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<tr>
<td></td>
<td>Astrophysics</td>
</tr>
<tr>
<td></td>
<td>(also Gamma-ray, neutrino, optical and radio, X-ray)</td>
</tr>
<tr>
<td>2. Chemistry</td>
<td>Chemistry (also analytic, inorganic, organic, organo-metallic, pharmaceutical, physical, polymer sciences <strong>except biochemistry</strong>)</td>
</tr>
<tr>
<td>3. Physics</td>
<td>Physics (also acoustics, atomic/molecular, chemical, condensed matter,</td>
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<td>Elementary particles, nuclear structure, optics, plasma, theoretical/mathematic)</td>
</tr>
<tr>
<td>4. Other</td>
<td>Physical Sciences, General</td>
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<tr>
<td></td>
<td>Miscellaneous Physical Sciences, Other</td>
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<tr>
<td></td>
<td>Physical Science, other</td>
</tr>
<tr>
<td><strong>C. ENVIRONMENTAL SCIENCES</strong></td>
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</tr>
<tr>
<td>1. Atmospheric</td>
<td>Atmospheric Sciences and Meteorology</td>
</tr>
<tr>
<td></td>
<td>(also aeronomy, extraterrestrial atmospheres, solar, weather modification)</td>
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<tr>
<td>2. Earth Sciences</td>
<td>Surveying</td>
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<tr>
<td></td>
<td>Geological and Related Sciences</td>
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<tr>
<td></td>
<td>Earth &amp; Planetary Sciences</td>
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<tr>
<td></td>
<td>Cartography</td>
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<tr>
<td></td>
<td>(Also engineering geophysics, general geology, geodesy and gravity, geomagnetism, hydrology, inorganic, isotopic, lab geophysics, organic geochemistry, paleomagnetism, physical geography, seismology)</td>
</tr>
<tr>
<td>3. Oceanography</td>
<td>Marine/ Aquatic Biology</td>
</tr>
<tr>
<td></td>
<td>Oceanography</td>
</tr>
<tr>
<td>4. Other</td>
<td>(Multidisciplinary projects with Earth, Atmospheric, and Ocean Sciences)</td>
</tr>
<tr>
<td>D. MATHEMATICAL SCIENCES</td>
<td></td>
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<tr>
<td>---------------------------</td>
<td></td>
</tr>
</tbody>
</table>
| **1. Mathematical Sciences** | Mathematical, General  Applied Mathematics  Operations Research  
Mathematical Statistics  Mathematical, Other  Math/ Computer Sciences  
(also algebra, analysis, foundations and logic, geometry, numerical analysis, topology) |

<table>
<thead>
<tr>
<th>E. COMPUTER SCIENCES</th>
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</thead>
</table>
(also design, development, and application of computer capabilities to data storage and manipulation, information science) |

<table>
<thead>
<tr>
<th>F. LIFE SCIENCES</th>
</tr>
</thead>
</table>
| **1. Agricultural** | Agricultural Production  Aquaculture  International Agriculture  
Agriculture Sciences  Plant Sciences  Soil Science  
Renewable Natural Resources  Landscape Architecture |
| **2. Biological** | Foods and Nutrition Studies  Biology, General  Biochemistry  Biophysics  
Botany  Cell and Molecular Biology  Anatomy  Ecology  
Nutritional Sciences  Parasitology  Toxicology  Genetics  
Biometrics  Biostatistics  Misc. Bio. Specializations, other  
Zoology  Entomology  Pathology  Pharmacology  
Physiology  Biolog./Life Science Other  Medical Anatomy  
Medical Biochemistry  Medical Immunology  Medical Microbiology  
Medical Pathology  Medical Physiology  Medical Toxicology  
Epidemiology |
| **3. Medical** | Neurosciences  Radiation Biology/Radiobiol.  Dentistry  Medicine, General  
Med. Basic Sciences, Other  Nursing Psychiatry  Optometry  Osteopathic Med.  
Mental Health  Pharmacy  Podiatry  Public Health  
Veterinary Medicine |
| **4. Other** | Gerontology  Communication Disorders  Sciences and Services  
Health and Medical Administrative Services  Health and Medical Laboratory Techn.  
Nursing technologies  Occupational Therapy  Physical Therapy  
Rehab./Therapeutic Services  Health Professions and Related Services, Other |

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REFERENCES


Harris, R. G. (2001). The Knowledge-Based Economy: Intellectual Origins and


