

Universities and the Development of Industry Clusters



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Universities and the Development of Industry Clusters

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A Message from David A. Sampson, Assistant Secretary for Economic Development, U.S. Department of Commerce

The bottom-line of economic development today is about building prosperity – a high and rising standard of living. Productivity and productivity growth are the fundamental drivers of prosperity and innovation is the key driver of productivity. The focus of economic development should be on supporting innovation, increasing prosperity for American businesses and ensuring American workers have the skills to remain the most productive workforce in the world. Innovation will drive the growth of American industry by fostering new ideas, technologies and processes that lead to better jobs and higher wages – and as a result, a higher standard of living. America’s capacity to innovate will serve as its most critical element in sustaining economic growth.

The dominant reality of economic development today is that we live and operate in a worldwide economy. Worldwide commerce means that American businesses must operate and cooperate with countries around the world. Consequently, we must think regionally, avoid isolationist practices and build a strong economic platform for growth.

Over the course of its history, EDA has encouraged communities to harness the wealth of intellectual and technical resources of institutions of higher education to promote regional economic development. Universities can be a powerful force when they effectively serve the development needs of local communities. This research focuses on the key role universities can play in cluster-based economic development, establishes a foundation for a critical review of that role, and assesses the factors that are vital to successful university-industry cluster development.

David A. Sampson

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Executive Summary

Regional efforts to develop industry clusters increasingly include universities as central assets. Unfortunately, little is understood about how universities impact the development of regional industry clusters. Practice often precedes policy and such is the case with university- and cluster-based strategies. States and regions have jumped on the bandwagon before there is established knowledge of the costs and benefits of these approaches. This research establishes a foundation for a critical review of the role of the university in cluster development. It assesses both the factors of the university and the factors of the cluster that are vital to successful university-industry cluster development.

Universities that are highly engaged with regional industry clusters have diverse and complementary units that broadly address the needs of the cluster. Rather than a compartmentalized approach, engaged universities are sources of research and technology, but also address other aspects that affect cluster growth such as business, marketing, legal, and workforce issues. In order to have an impact on a regional industry cluster, the university must have a significant base of research aligned with the needs of that cluster. In the case of research and technology assets, size does matter. The university must have a large base of research and development in order to significantly impact a cluster, rather narrowly benefiting only a few firms. The university must also have expertise and resources in appropriate areas that align with the needs of the clusters in the region. Less important is the structure or processes of the technology transfer function. The key factors for universities, discussed in the findings are:

- Breadth of involvement
- Strong base of R&D
- Regional alignment

The characteristics of the cluster are as important as the characteristics of the university if there is to be any regional impact. Universities cannot defy the forces of the market. Established clusters with mature products and processes are less receptive to innovation, especially from universities and other external sources. Even if they are receptive, a cluster may lack the ability to absorb people and technology produced by the university. Clusters that are externally, rather than regionally, organized and oriented may even facilitate the diffusion of university-derived benefits outside the region. The university can produce the seeds of new firms and industries, but the region must offer a fertile climate for them to flourish. The key factors related to the industry cluster are its pattern of organization, market trends, and the life cycle stage of the industry or technology.

University-based cluster development is a difficult path that requires commitment, time and patience. The success of a university-based cluster initiative requires more than an active, engaged, high quality university. It is also necessary to have appropriate conditions within the regional industry clusters. Within a region, universities are best able to affect the growth of young, emerging clusters, but it takes a broad commitment of significant university resources across a variety of departments aligned with the needs of the cluster.

This report was prepared using a case study strategy. Quantitative data was collected for universities, metropolitan areas and counties in order to develop a sample frame for the selection of the cases. The literature review identified the criteria that for the selection of cases that represented conditions and outcomes. For each case, the project team collected a variety of secondary data, analysis and reports and conducted 15 to 20 interviews with university and regional representatives for each of the eight cases. The methodology is further explained in Appendix 1 – Case Selection Methodology. A summary of each of the cases is provided in the Case Profiles beginning on page 35.

Introduction

This research explored a set of regions and universities (cases) with different initial conditions and ultimately different outcomes (Table 1). Initial conditions related to geographic location, industrial composition, size, and innovation assets (including universities). The primary outcome is employment growth, but we also considered per capita income levels. We selected several different industry clusters from each region in order to have some overlap of clusters across regions.

Selecting only cases with known best practices or with ideal outcomes can identify common factors that might indicate a connection between the practice and the outcome, but it does not distinguish whether these factors and practices are also present in unsuccessful cases. The cross-case approach employed here addresses this problem. With this approach the factors that are unique to the desired outcome or undesired outcome are the most critical. Factors that are common in relation to the desired outcome, but are also associated with the undesired outcome will represent conditions that may be necessary, but not sufficient to impact the desired outcome.

Table 1: Case Taxonomy

<i>University is...</i>	<i>Economy is growing¹ ...</i>		
	Above US average	Close to US average	Below US average
Engaged	Ann Arbor (University of Michigan)	Morgantown (West Virginia University)	New River Valley (Virginia Tech) Allentown (Lehigh University)
Not engaged	Las Cruces (New Mexico State) Tallahassee (Florida State)	Waterloo-Cedar Falls (University of Northern Iowa)	Dayton (Wright State University)

These cases are snapshots and do not explore the full historical development of either the regional economies or the universities. Such history and tradition can be important in understanding current conditions. Furthermore, universities and regions are not monolithic; they are comprised of many parts. In reducing these complex entities for analysis, some elements are emphasized at the exclusion of others, and the complexity of the whole is oversimplified. This approach is particularly evident during discussions of

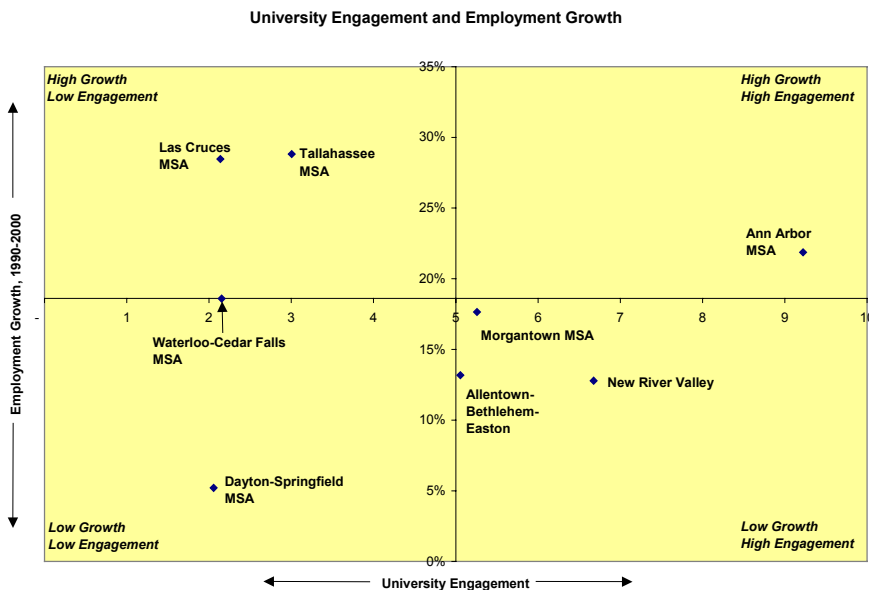
¹ The regions were categorized as “Above US Average” if the employment growth from 1990-2000 was more than two percentage points above the US average, and below if it was less than two percentage points below the US average.

how engaged or aligned universities are with local economies, especially when some university units or components are significantly involved with local industry and others are not.

The criteria used to select and evaluate cases are regional in scale and thus they blur significant achievements that may be achieved in a specific town, industry or firm. Using the criteria of regional employment growth, rather than cluster growth, establishes a higher standard of performance, but one that is more meaningful. It is a hollow victory to grow one industry cluster if the rest of the economy is in decline. If local successes are not having regional impact, they are not fully recognized in our analysis. The goal is to assess the impact of universities on regional clusters and economic development, not to denigrate local achievements.

After preliminary case analyses were conducted, refined criteria were developed to explore the level of university engagement. We also examined regional economic growth through a variety of measures and perspectives (Appendix 1 – Case Selection Methodology on page 95). This is presented in a simplified taxonomy in Table 1: Case Taxonomy. The taxonomy oversimplifies the complexities in these cases; the distinctions between them are better depicted in Figure 1.

Figure 1: Case Taxonomy

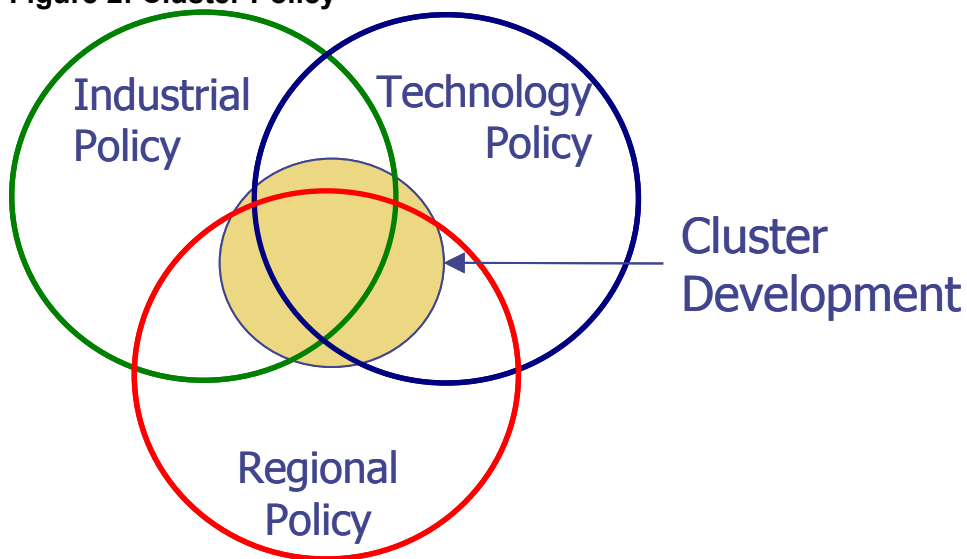


Findings

Universities are increasingly recognized as key partners in state and local development efforts, and in some instances are actively engaged in initiatives to promote cluster-based development. Cluster development occupies a shifting middle ground at the intersection of industrial, technology, and regional policy. Industrial policy seeks to

improve the performance of a specific sector of the economy.² Technology policy promotes the advancement and diffusion of knowledge and innovation, and in its pure form does not target individual firms.³ There is sufficient overlap between industrial and technology policy, so by and large they can be considered one in the same for most purposes. Regional policy aims to develop the economy or improve the socio-economic condition of geographically-targeted places. As it has been embodied in federal and state programs, technology-based economic development contains elements of all three of these policy domains. Cluster policy is a hybrid of these domains, over which no level of government has clear authority or responsibility (much like regional policy), which provides both opportunity and challenge.

Figure 2: Cluster Policy



Understanding the role of the university requires an appropriate framework. In what has become known as the cluster diamond, Michael Porter mapped four interactive dimensions that impact cluster competitiveness. These are factor conditions, demand conditions, firm strategy and rivalry, and supporting industries. The manner in which firms compete is key in productivity growth and essential to increasing the standard of living. With competition, the focus of firm strategy shifts to innovation rather than cost reduction by lowering labor costs.⁴ Market and growth oriented firms can push

² Michael Storper, "Competitiveness policy options: the technology-regions connection," *Growth and Change* 26 (Spring 1995): 285-308.

³ Storper 1995; and Michael H. Best, *The New Competitive Advantage: The Renewal of American Industry* (Oxford and New York: Oxford University Press, 2001).

⁴ Michael E. Porter, *On Competition*, Harvard Business Review Book Series (Boston: Harvard Business School Press, 1998).

innovation in a regional cluster, but there must also be sufficient local demand or sensitivity to external demand that provides innovation pull.

Cluster theory also describes how factors external to the firm impact competitiveness and innovation. It is not just the characteristics of firms that create a truly competitive cluster; there are regional factors external to the firm that matter as well. Universities are one such “regional factor” that impacts all of the dimensions of cluster competitiveness. On the one hand, universities are an asset that increases the quality of inputs and producers, by upgrading human capital and disseminating knowledge. Universities also promote economic diversity. In fact, the key role of the university is not so much to grow the economy, as it is to diversify it by generating new opportunities out of the old. The university is the creative side of economic destruction.

The cluster framework is important for examining the role of universities in cluster development and is critical to the design and understanding of this study. Universities are part of the fabric of relationships within a region. Without the context of the cluster, in which the university is one factor, there is the danger of magnifying the role of the university such that one can mistakenly link any observed effect to a university cause. Working within this framework helps to control for this bias and determine which aspects of the university matter most.

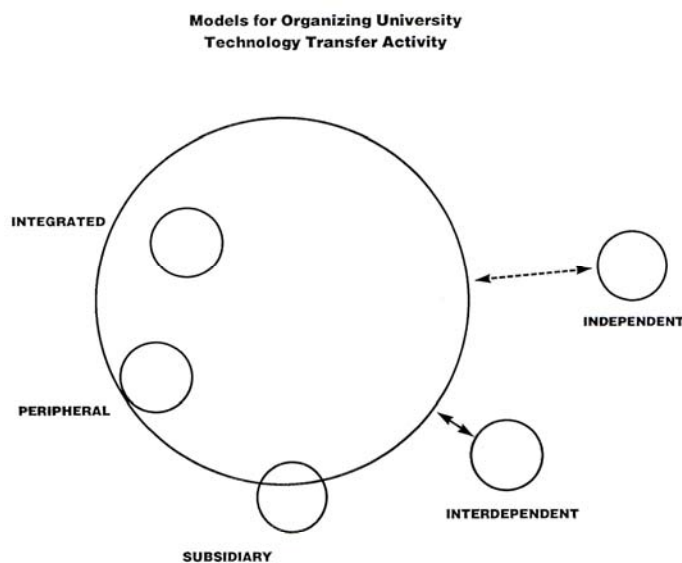
University Factors

There are three dimensions in which universities contribute to their local economies. The first is through purchasing and procurement activities. Numerous economic impact studies have demonstrated the significance of this role in terms of the job and income multipliers generated by these functions of the university. However, this does not represent an economic contribution that is unique to universities; the scale of these impacts may differ from other large institutions and employers but they are not substantively different. The second dimension is the traditional function of universities in expanding human capital through education and training. The impact of universities in this regard is equally well documented and generally agreed upon. The only problem is that when universities upgrade human capital they make it more mobile. People with more education are more likely to move longer distances such as to new states or metropolitan areas, and they do it more for work-related reasons.⁵ Unless the region has a healthy economy and job market, these graduates will leave. If regions want to maximize the human capital benefits provided by universities, then we have to consider the final aspect of how universities contribute to local economies. Related to their role in education and training, universities are creators of knowledge, sources of innovation and generators of economic development. It is this final role in which universities have the greatest potential to affect economic development.

⁵ Jason Schachter, *Why People Move: Exploring the March 2000 Current Population Survey*, U.S. Census Bureau, May 2001, 4.

One of the formalized linkages between universities and industry is the technology transfer process, which is the commercialization of technology created by university researchers. Technology transfer can be defined as “the transfer of the results of basic and applied research to design, development, production, and commercialization of new or improved products, services, or processes.”⁶ Technology transfer became more formalized as a university function in the late 1970s, and is becoming increasingly important at universities across the country, as a source of revenue, a stimulus to the regional economy, and a method of bringing research into practical use. While technology transfer used to consist mainly of patenting, it now includes licensing, research consortia, industrial extension (technical assistance) programs, industrial-liaison or affiliates programs, spin-off enterprises, research parks, start-up firm incubators, consultant services, and venture-capital funds.⁷ Tech transfer can also include the spread of knowledge through more informal means, such as meetings between academics and industry professionals.

Figure 3: Models for Organizing University Tech Transfer Activity



Source: Gary Matkin, “Spinning off in the U.S.,” OECD Workshop on Research-based Spin-offs, 8 December 1999; available from <http://www.oecd.org/dataoecd/48/17/2370995.ppt>; Internet; accessed 28 August 2003.

The structure of technology transfer operations varies from university to university. There are some basic characteristics that distinguish different organizational arrangements. The integrated organization is run by university faculty and is part of a university department. An integrated technology transfer office does not have its own

⁶ Gary Matkin, “Organizing University Economic Development: Lessons from Continuing Education and Tech Transfer,” in *The University’s Role in Economic Development: From Research to Outreach*. (Jossey-Bass, June 1997).

⁷ Matkin 1997, 32.

administrative space, and is sometimes considered to be a university entity. Non-faculty professionals run peripheral offices supervised by a member of the university's administration. Unlike the integrated office, the peripheral office has its own administrative space and staff. The subsidiary organization is a separate legal entity, usually a non-profit corporation, in which the university holds equity. The interdependent organization is also a separate legal entity, but the university does not hold equity. In the case of WARF, the Wisconsin Alumni Research Fund, the University of Wisconsin provides WARF with intellectual property rights in exchange for research funding. Independent organizations tend to have a contract or informal arrangement with the university, but the university does not have control and usually does not hold equity in the organization.⁸

Table 2: Tech Transfer in Case Study Universities

Organization of Tech Transfer	University	License Income ⁹	Industry R&D	Startups ¹⁰
Peripheral	Florida State University	34.7%	0.7%	5
Peripheral	Lehigh University	0.4%	24.2%	0
Peripheral	University of Northern Iowa	0.8%	0.9%	1
Peripheral	West Virginia University	0.1%	10.8%	1
Peripheral	Wright State University	0.7%	7.7%	0
Peripheral-Integrated	Univ. of Michigan	1.4%	6.9%	15
Subsidiary	New Mexico State University	0.0%	4.8%	0
Subsidiary	Virginia Tech	0.6%	7.4%	9

Note: Based on Matkin's (1999) framework, classification of universities by the authors data from AUTM.

While these frameworks can be used to organize and classify the technology transfer function at various universities, as well as to differentiate institutional approaches, very little research has been done on which organizational structure is most effective. Examining the case study universities, there is some variation in the technology-transfer activities of the engaged universities. Technology transfer activities at the case study universities were classified using Matkin's criteria and classifications.¹¹ The case study universities were distributed into one or more of three of Matkin's prototypes.

Of the case study universities, only Virginia Tech and New Mexico State follow the subsidiary model, while the others are peripheral organizations in Matkin's (1997) framework. New Mexico State University is similar to Virginia Tech in that it has a

⁸ Matkin 1997, 33-35.

⁹ Average license income 1998-2000 as a percent of average R&D expenditures as reported by AUTM.

¹⁰ Average industry R&D 1998-2000 as a percent of average R&D expenditures as reported by AUTM.

¹¹ Gary Matkin, "Spinning off in the U.S.", OECD Workshop on Research-based Spin-offs, 8 December 1999; available from <http://www.oecd.org/dataoecd/48/17/2370995.ppt>; Internet; accessed 28 August 2003.

nonprofit technology transfer corporation, but this has not resulted in higher levels of startups, industrial R&D or licensing income. Virginia Tech has performed well in terms of startups and industry R&D. The University of Michigan differs from the peripheral model somewhat as it operates through satellite technology transfer offices for the College of Engineering and the Medical School; it was therefore classified as a peripheral-integrated hybrid. This structure would seem to add a level of confusion for the community as well as faculty if the commercial product is based on interdisciplinary research that requires coordination across one or more of the offices. However, the University of Michigan has generated more startups than the other universities and is also strong in generating licensing income and industry R&D. Florida State's technology transfer function is organized as a university administrative office; it has been very successful in generating license income, primarily from its best-selling anti-cancer drug, Taxol, but has had less success in generating startups.

Universities have to respond to a variety of priorities not related to economic development. Chief among these is generally the academic mission. In the technology transfer domain, the obligations of the Bayh-Dole Act may encourage a university to license a technology rather than support a start-up. Furthermore, not all R&D is equally effective at generating spin-offs or other benefits that can be captured by a regional economy. Federally-sponsored research is geared toward national goals, whereas some industries, such as the life sciences, require more time and money to yield commercially viable ventures. This does not mean that technology transfer is unimportant, but that it has to be placed within a context of broad university engagement. It is possible that a pattern might emerge based on a study of all universities, their technology transfer structure and outcomes, but the evidence from the case studies is that the structure of the technology transfer office does not determine a university's performance in generating economic impact.

Research, policy and practice have focused too narrowly in terms of assessing the ability of the university to spur economic development. Much of the literature and policy debates regarding the role of universities in fueling economic development have focused on the formal processes of technology transfer and the role of the university as a generator of knowledge.¹² This focus has resulted in a misplaced emphasis and disregard for critical factors in leveraging university assets for growth. As these case studies demonstrate, the organization and operation of technology transfer does not explain differences in generating regional impact.

What makes an innovative university does not automatically make a high-impact university. From another perspective, what is good for the university does not always benefit the region, and vice versa. The challenge is how to achieve a mutual benefit for the university and the region, which requires a better understanding of the role played by universities. Universities are an excellent resource for transforming the economy through

¹² There is another domain of the literature that focuses on the economic impact of universities through their purchasing power and through upgrading workforce skills. While these are not trivial effects, they do not fundamentally transform the local economy and are not the focus of our concern.

the creation of new industries, but the ability of these industries to grow the region is related not to the character of the university, but to the character of the region, the state and of the industry itself. The three factors related to the university are:

- Breadth of involvement
- Strong base of R&D
- Regional alignment

Breadth of Involvement

An interesting model of university-based economic development portrays the university, industry, and government as being intertwined in a DNA-like formation. In this model, pioneered by Loydesdorff and Etzkowitz,¹³ the knowledge sector plays an important role: “three institutional spheres (public, private, and academic) that formerly operated at arms-length in laissez faire societies, are increasingly interwoven with a spiral pattern of linkages emerging at various stages on the innovation and industrial policy-making processes.”¹⁴ The authors describe two cycles that universities must go through in order to become more active players in the innovation process. The first includes making research a part of the academic mission, and the second involves taking on a role in regional economic development, both through research and teaching. Once these changes have taken place, the university has a new organizational structure with “mixed disciplinary departments, interdisciplinary centers, new disciplines, self-generation institution, [and] increased social space.”¹⁵ While industry and government remain independent, they also change in ways that make it easier for universities to become primary participants in the innovative process.

Universities are becoming increasingly entrepreneurial and engaged with business and industry. At this point, most research universities have created some kind of technology transfer program or industrial-liaison program to interact with the business sector.¹⁶ Economic development has become a more common focus in the mission statements of many universities. The Georgia Institute of Technology which is known for its focus on the local economy, states in its Strategic Plan: “Georgia Tech is a leading center for research and technological development that continually seeks opportunities to advance society and the global economic competitiveness of Georgia...”¹⁷ Purdue

¹³ L. Loydesdorff, and H. Etzkowitz, “The Triple Helix as a model for innovation studies,” *Science and Public Policy* (1998): 25.

¹⁴ Henry Etzkowitz, Gebhardt Webster, and B. Terra, “The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm,” *Research Policy* 29 (2000): 315.

¹⁵ Etzkowitz et al., 329.

¹⁶ Diane Rahm, *University-Industry R&D Collaboration in the United States, the United Kingdom, and Japan* (Dordrecht: Kluwer Academic Publishers, 2000): 45-46.

¹⁷ Louis Tornatzky, Paul Waugaman, and Denis Gray, *Innovation U.: New University Roles in a Knowledge Economy* (Raleigh: Southern Growth Policies Board, 2002).

University announces on its website that it is a “powerful resource for the economic development of Indiana.”¹⁸

Every university is engaged with its region or local community in multiple ways and assessing that involvement is a difficult task. Furthermore, universities are a collective of entities (schools, departments, centers and institutes) and individuals that are direct agents of interaction with the external world. Assessing the breadth of involvement across a university requires an aggregation of the involvement of all of these agents. What really distinguishes a university that is highly engaged is that the involvement of these units is broad and complementary, rather than compartmentalized. Universities need to address business and legal issues, workforce education, infrastructure, and industry relationships, as well as technology and R&D capacity, in order to yield regional benefits. The most engaged universities demonstrate these kinds of diverse, integrated commitments across administrative and academic units, including the schools of business, engineering, law, medicine, and public policy.

Lehigh University is highly engaged across the administrative, academic and research units. The President of Lehigh University has staked out an active role that is proclaimed on the website and maintains staff that handle federal, state, and community relations.¹⁹ Industry and community relations are not exclusive to this office, as the Office of Corporate and Foundation Relations, the Vice Provost for Research, and the Office of Government Relations are also active with regional industry and community groups. A variety of entities throughout the university provide support to local companies. The Manufacturers Resource Center works with manufacturing companies; the Musser Center for Entrepreneurship and the Small Business Development Center, both affiliated with the College of Business and Economics, mentor local entrepreneurs; and the Ben Franklin Technology Center, an independent nonprofit located on the Lehigh campus, supports technology-based economic development. There is also an incubator operated on the Lehigh campus that has achieved national recognition. Lehigh faculty and staff play leadership roles on boards and committees of all four of these organizations, as well as other community economic development organizations. Students are also able to support regional and urban economic development through the Lehigh CORPS.

West Virginia University has expanded its role in local economic development efforts in connection with the introduction of several new federal facilities. Existing programs in energy research have been supplemented by efforts in forensics and biometrics. The university, state and local development organizations are explicitly targeting areas where they can combine their joint resources to leverage federal investment. In part this degree of coordination is possible because WVU does not have to compete with any other research universities in the state. Therefore, the university is both a key contributor and beneficiary from strategies to develop technology, health

¹⁸ Tornatzky et al., 80.

¹⁹ “Economic Development Engine,” available from <http://www3.lehigh.edu/about/economicdevelopment.asp>; Internet; accessed 27 August 2003.

sciences and entrepreneurship. The university and several federal research centers are the anchors of the emerging I-79 High-Tech Corridor.

In addition to its many research centers developing new technologies, West Virginia has an EDA center, an Entrepreneurship Center at the College of Business and Economics, the Bureau of Business and Economic Research that monitors the local economy and the nationally recognized Regional Research Institute, as well as several other specialized business and economic policy centers. The Center for Entrepreneurial Studies and Development (CESD), affiliated with the College of Engineering provides services to local firms in the areas of training, operations and business development. CESD also serves as the champion or institutional home for several economic development initiatives including a regional entrepreneur's forum. There are few regional efforts that don't connect back to the university.

Virginia Tech has both breadth and depth of involvement with the community and local industry. Virginia Tech's resources include the office of Corporate and Foundation Relations, VT Connect, the Economic Development Assistance Center (EDAC), the Corporate Research Center, and the Office of Outreach and International Affairs that provides a variety of outreach and continuing education programs. Virginia Tech has more than a hundred research centers and institutes, many of which are regionally active. To access the expertise and resources of these centers, businesses and individuals can tap VT Connect or the Virginia Tech Expertise Database.

The university's outreach activities are both extensive and unique. Continuing education programs at the university reach as many as 8,000 people annually, nearly 5% of the regional population. One of the unique aspects of outreach is Virginia Tech's Center for Organizational and Technological Advancement (COTA). Since 1994 COTA has connected the university to Virginia organizations and individuals. COTA provides small grants for fellowships that "...focus university resources on specific realworld problems and areas where university expertise can make a distinct contribution."²⁰

An important element of Virginia Tech's engagement with business and the community is the EDAC, which is funded by the Economic Development Administration. The EDAC provides technical assistance throughout southwest Virginia's planning districts. Virginia Tech's efforts support a variety of industries, including automotives, aeronautics, polymers, and biotechnology. The university has helped transition parts of Virginia from tobacco and textiles to new industries. There are community-oriented efforts as well, such as the Blacksburg Electronic Village, the construction of a modern conference center and the renovation the Hotel Roanoke.

The engineering and business schools at the University of Michigan work extensively with the automotive and information technology industries. Research is distributed throughout the university and nearly every academic unit conducts research. The university recently made a \$100 million investment in the Life Sciences Institute to

²⁰ Virginia Tech Outreach and International Affairs, "What is COTA?", available from <http://www.cota.vt.edu/content/what.html>; Internet; accessed 3 November 2003.

bring an interdisciplinary perspective to life sciences research. The university is active in regional economic development planning, particularly with the Michigan Economic Development Corporation and the Washtenaw Development Council. Collaboration between the university and state government resulted in the Life Sciences Corridor and the Michigan Universities Commercialization Initiative. The business school holds symposia for area businesses. The Wolverine Venture Fund can help find funding for startups or make a direct investment. The Institute of Labor and Industrial Relations provides economic and labor market outlook reports. The Center for Local, State, and Urban Policy examines problems facing states, cities and metropolitan regions. The Program for Research on the Information Economy is focused on the economics of information and information systems. The Institute for Social Research, affiliated with the Ford School of Policy, is one of the oldest and largest policy research centers in the nation.

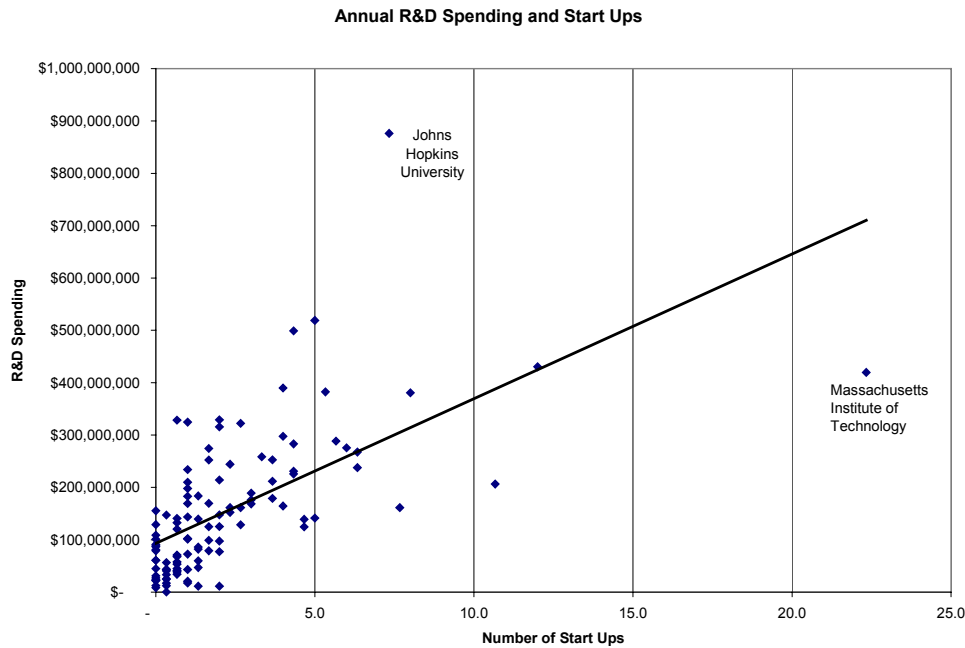
Strong Base of Research

Regional development interests often encourage universities to do more to create new commercial enterprises, but research about the influence of universities on the formation of new companies has been mixed. Bania, Eberts, and Fogarty have found mixed evidence for the role of the university in the creation of new firms. They studied the relationship between university research and development and the birth of new firms (classifying firms by SIC code), and only found a significant relationship in Electrical and Electronic Engineering.²¹ However, because their data was from 1976-78, it is possible that if they used more recent data they would draw different conclusions. Many researchers have written about the importance of MIT in the creation of new firms around Route 128 in Boston, as well as Stanford's role in Silicon Valley's technology start-ups.

The Association of University Technology Managers tracks a number of indicators of technology transfer activities, one of which is startups. The AUTM Survey documented that in 2000, 454 new startups were reported by universities responding to their survey, up from 344 in 1999.²² The average startup rate for all universities from 1998 – 2000 was one per \$69 million in R&D expenditures, but there is no significant correlation between R&D spending and the generation of startups, particularly if the outliers are removed (Figure 4). The relationship between startups and research is a skewed distribution. Only four universities in the U.S. were able to spin-off more than ten firms annually, and all of them spent nearly a half billion dollars in annual R&D. Few universities with annual R&D expenditures of less than \$100 million generate more than one or two spin-offs annually.

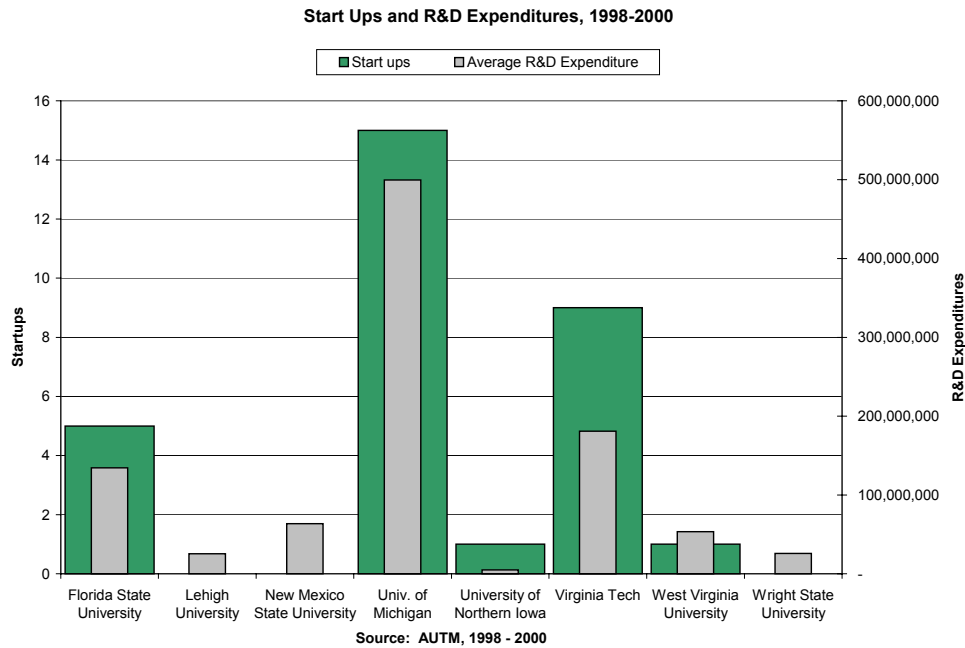
²¹ Neil Bania, Randall Eberts, and Michael Fogarty, "Universities and the Startup of New Companies: Can we generalize from route 128 and Silicon Valley?" *The Review of Economics and Statistics* 75 issue 4 (November, 1993).

²² Association of University Technology Managers, "AUTM Licensing Survey: 2001," edited by Lori Pressman, Chair.

Figure 4: Annual R&D Spending and Start Ups

Source: AUTM data 1998, 1999, 2000.

This relationship holds true for the case study universities as well (Figure 5). A large R&D base is necessary but not sufficient to generate economic impact. Without a large R&D base, even highly engaged universities are not able to exert enough impact to make a difference in a small economy. Lehigh University is highly engaged in the regional economy and regional activities, and it is a world leader in several technology areas, but with its small size the positive spillovers from the university can be overpowered by other events. For example, in 2003 Agere Systems, a maker of communications networking products, announced a shift in market focus and manufacturing operations, moving some of the manufacturing out of the region. (See the Lehigh profile on page 57). The decision by Agere was not made on the basis of university R&D or even on regional characteristics, but on industry conditions and competitive pressures. The consolidation of administrative and research personnel in the Allentown headquarters mitigates, but does not replace the loss of manufacturing jobs. Agere is a major anchor, but the region maintains several thousand jobs in this cluster. The uncertainties around Agere may turn out to be only a temporary psychological setback but the situation illustrates the limits of *university leverage* on a cluster.

Figure 5: Start Ups and R&D Expenditures, 1998-2000

Regional Alignment

If a large R&D base is not sufficient for generating regional industry clusters, then what does matter? The alignment of university assets, skills and expertise with regional industry clusters maximizes the regional benefit. Some regions may have a substantial research presence, but companies in the surrounding region are not able to absorb the resulting technology. In these cases innovation is more likely to flow out of the region. It is also a matter of how the geography of university impact aligns with the boundaries of the region and local industry clusters. If the boundaries of the industry cluster overflow the regional boundaries, the impact of the university will be dispersed.

The case study universities and regions were compared on the basis of their cluster concentration and research intensity. Cluster concentration was examined using data from the Harvard Business School's Cluster Mapping Project. For each region, the location quotients for cluster employment provide an estimate of the concentration of employment in the region relative to the total cluster employment in the U.S.²³ A value greater than one indicates that the region's share of employment in an industry exceeds the national share. Research intensity was measured for each university based on how the cluster-related academic R&D expenditures per cluster employee in the region varied from the national average. Using these two measures creates four possibilities of alignment between the university and the cluster, each of which suggests a different

²³ A location quotient compares the share of cluster employment in a region with the national share. The formula for calculating the values is: $\text{Location Quotient} = (\text{Cluster Employment in Region} / \text{Total Employment in Region}) / (\text{Cluster Employment in Nation} / \text{Total Employment in Nation})$.

strategic need (Table 3). University-Cluster examples from the case studies illustrating these alignment options are presented below.

Table 3: University-Cluster Alignment

		Research Intensity	
		Low	High
Cluster Concentration	High	Cluster is dominant <i>Strategy: Focus on building R&D</i>	University & cluster are aligned <i>Strategy: Focus on efficiency and transfer</i>
	Low	Limited foundation <i>Strategy: Focus on nothing or everything</i>	University is dominant <i>Strategy: Focus on cluster development</i>

The University of Michigan exemplifies alignment of R&D activity and cluster specialization in several of Ann Arbor's clusters, particularly in information technology (IT) and the life sciences. The university's research intensity in the information technology cluster is just above the national average, but the university is actively engaged with the cluster in several areas. A group of University of Michigan professors helped to initiate the IT cluster strategy, referred to as the Ann Arbor IT Zone. These professors aimed to emulate the success of Palo Alto, California, by coordinating industry, government, and academia in developing an IT industry.²⁴ They believed Ann Arbor had the resources to begin such a cluster, and formed the IT Zone in response, creating "a partnership of the University of Michigan, businesses and local government to stimulate and grow the IT industry in the area".²⁵ The IT Zone holds networking sessions for executives, brings together people working in information technology, and works to bring new IT companies to Ann Arbor. Through the Wolverine Venture Fund and the Zell-Lurie Institute, the business school has extensive interaction with IT companies in the region. The fund works with other venture capitalists in the region and also invests its own funds in companies after conducting due-diligence tests. The Zell-Lurie Institute holds symposia twice a year, showcasing the development of new technologies while bringing together entrepreneurs and venture investors.

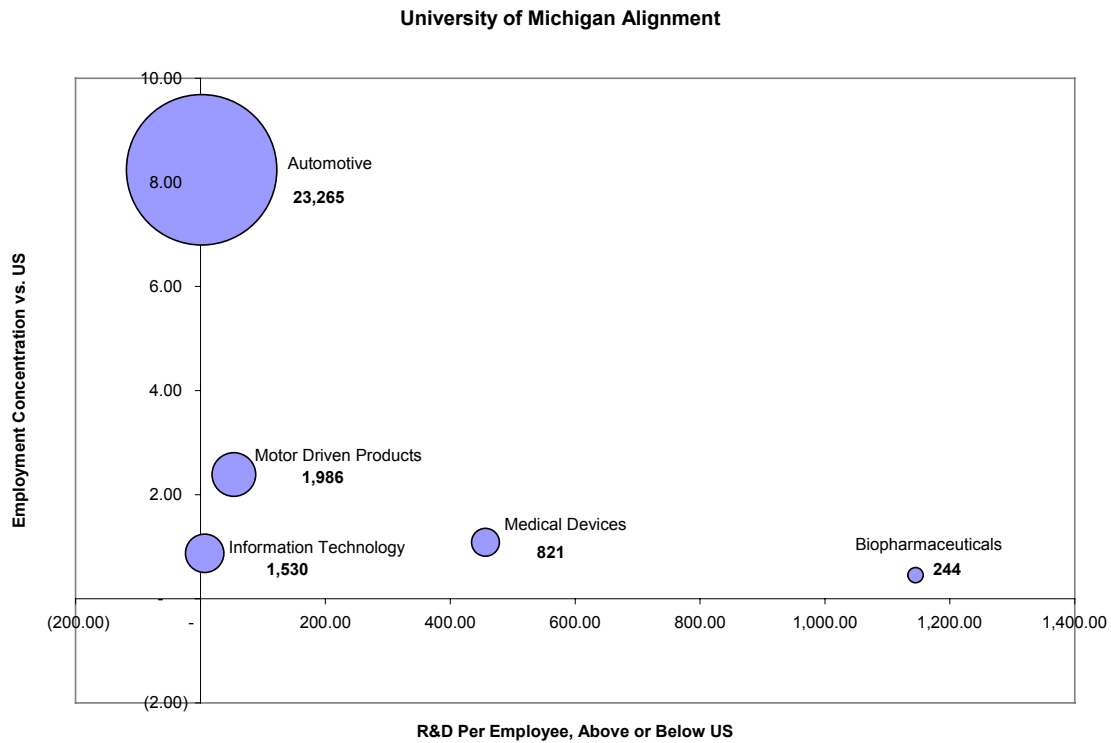
Ann Arbor's IT cluster is still relatively small and the region is only slightly more specialized than the nation in IT, but regional development efforts in Ann Arbor have concentrated on growing the IT industry in recent years. The Michigan Economic Development Council, a public-private partnership that serves as the state's economic development arm, is also an active participant in the IT strategy. It has a variety of supporting initiatives, including industry parks, an angel investor network, workforce training funds, the Michigan Council for IT Executives, and property tax abatements. On a local level, the Washtenaw Development Council is an active participant and incubated the Ann Arbor IT Zone/Business Accelerator. The Accelerator helps IT companies

²⁴ Ann Arbor IT Zone, "Mission and History," available from <http://www.annarboritzone.org/history.asp>; Internet; accessed 27 August 2003.

²⁵ Washtenaw Development Council, "Technology Rankings," available from <http://www.wdc-econdev.com/rankings.html>; Internet; accessed 27 August 2003.

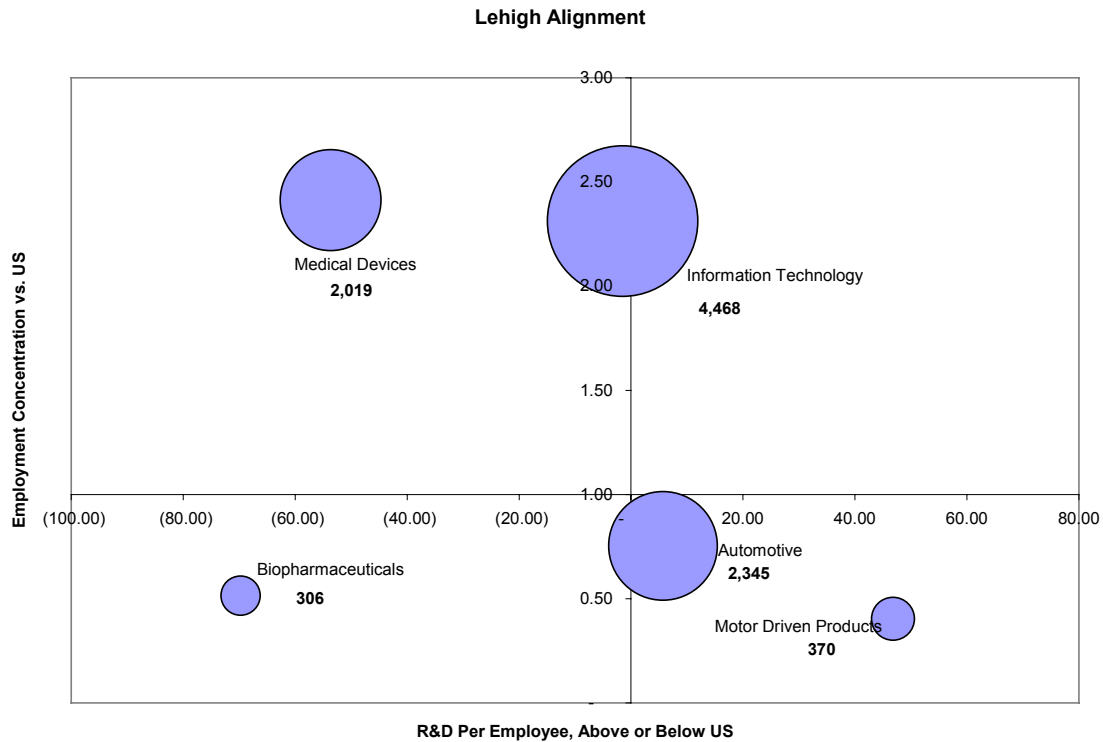
relocate to Ann Arbor/Ypsilanti. The Washtenaw Council also tracks the IT industry in the region; in 1995 they conducted a survey of the IT industry in the region and found 200 firms with 3,500 employees; by 2000 these numbers had increased to 1,000 companies with 20,000 employees.²⁶

Figure 6: University of Michigan Alignment



Source: National Science Foundation, R&D Expenditures at Universities and Colleges, by Science and Engineering Field: FY 2001 (Table B-39), and Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School (cluster data for 2001).

²⁶ Washtenaw Development Council, "Technology Rankings," available from <http://www.wdc-econdev.com/rankings.html>; Internet; accessed 27 August 2003.

Figure 7: Lehigh Alignment

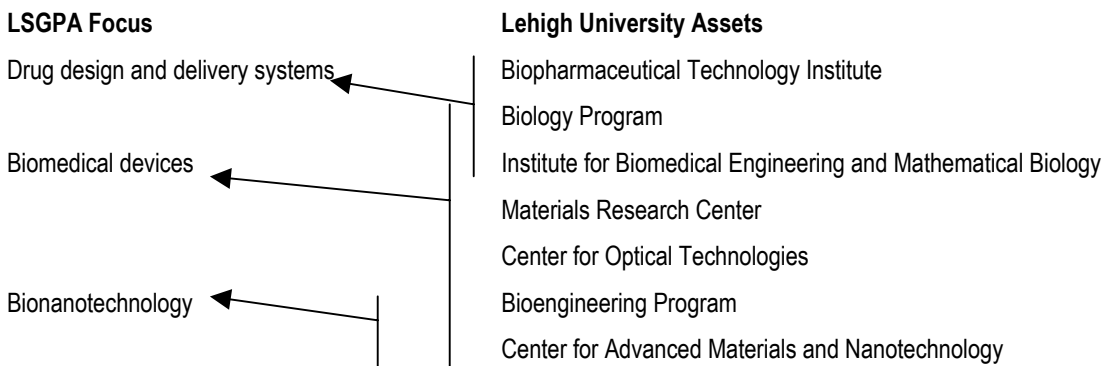
Source: National Science Foundation, R&D Expenditures at Universities and Colleges, by Science and Engineering Field: FY 2001 (Table B-39), and Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School (cluster data for 2001).

Lehigh University and the Lehigh Valley region provide a range of examples with clusters in every quadrant. The Lehigh Valley, like much of Pennsylvania has pursued a deliberate strategy of diversifying the economy to avoid over-dependence on any one sector. As a reflection of this approach, there are five emerging clusters targeted by regional development groups with potential university synergy. These clusters tend to pay above-average wages, require technology or knowledge-based skills and have the potential for high-growth. The emerging clusters are chemical and allied products, health-related companies, technology intensive manufacturing/service companies, engineering management and business consulting firms, and financial and insurance services. These clusters are broadly defined, making it difficult to assess the university's impact, or to compare the clusters across regions.

The analysis here focuses on biopharmaceuticals and medical devices, which are often considered together as part of the life sciences cluster. The life sciences cluster is an emerging cluster in the Lehigh Valley, however, medical devices is a larger and growing presence in the region than biopharmaceuticals. In biopharmaceuticals, the region faces the challenge of growing the cluster and increasing university R&D. In medical devices the cluster is more established in the region. According to the Cluster Mapping Project at the Harvard Business School's Institute for Strategy and

Competitiveness, between 1990 and 2001 medical devices was the fifth largest job producer among all traded clusters in the region.²⁷ OraSure, the creator of an oral HIV test, and a client of the Ben Franklin incubator, is one of the region's most successful spin-outs; it is now the 147th largest employer. B. Braun, a manufacturer of disposable surgical and medical supplies, is the 19th largest employer in the Lehigh Valley.²⁸ The challenge for the medical devices cluster in the region and its alignment with Lehigh is to enhance the university's R&D in that area. This should be helped by the National Science Foundation's recent award of \$1.38 million to Lehigh University to enhance its bioengineering program.

Promoting the growth of the life sciences cluster is the role of the Life Sciences Greenhouse of Central Pennsylvania (LSGPA), whose mission is to enhance and translate life sciences innovation into economic development in central Pennsylvania. The LSGPA has identified three areas of regional significance that have strong synergies with the expertise and resources of Lehigh:



Lehigh is one of seven university participants in the LSGPA and brings a number of high quality resources into the initiative. Lehigh's Center for Optical Technologies is a national leader in optics research, and has attracted commercial activity to the region. Demonstrating the cross-disciplinary nature of Lehigh, much of this optics research has applications in the life sciences field. Lehigh's Biopharmaceutical Technology Institute focuses on the improvement of processes in biotechnology and in pharmaceuticals. The university participants include:

- Bucknell University
- Dickinson College
- Pennsylvania State University

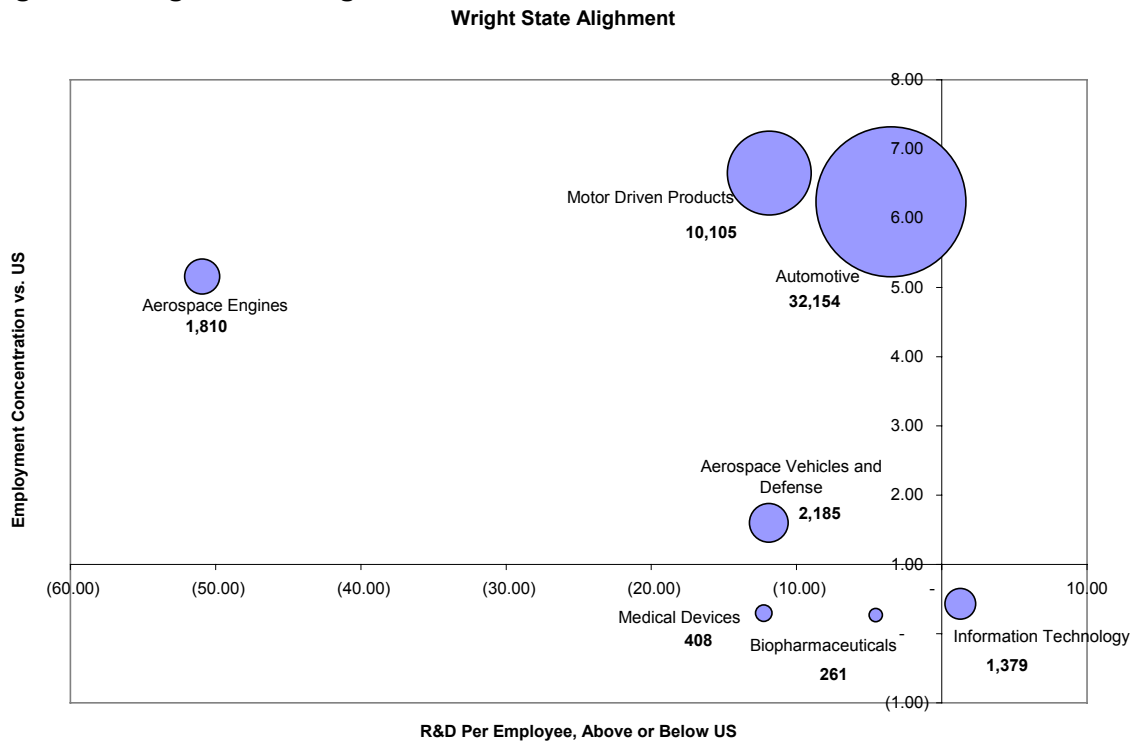
²⁷ Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School. Traded clusters sell products across different economic areas.

²⁸ Lehigh Valley Economic Development Corporation, "Estimated Local Employment at Lehigh Valley Employers (9/23/2003)", available from http://www.lehighvalley.org/assets/pdfs/econ/Employ_largest.pdf; Internet; accessed 13 October 2003.

- Juniata College
- Lehigh University
- Messiah College
- Shippensburg University

The LSGPA has a \$10 million gap fund where early stage firms can get up to \$350,000 for marketing, business development or building a management team. The LSGPA’s Technology Development Fund provides up to \$100,000 of convertible debt for one year, with the goal of moving technology toward commercialization. These funds can be used for prototype, proof of concept and commercial feasibility. The LSGPA is encouraging small-business university collaboration, both explicitly in its guidelines, but also in requirements for matching funds and the ability to meet federal standards for life sciences research that often favor the involvement of established firms or universities. The LSGPA strategy and programs are designed to address the critical needs of the life sciences cluster, building both industry resources as well as enhancing research assets.

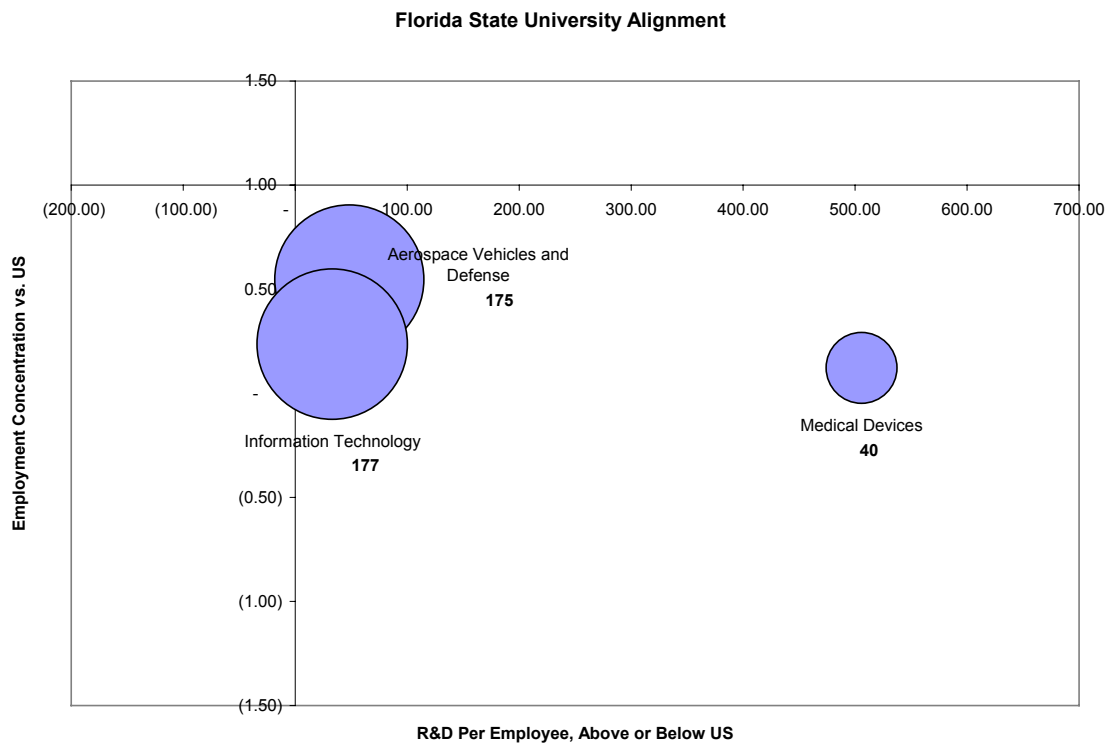
Figure 8: Wright State Alignment



Source: National Science Foundation, R&D Expenditures at Universities and Colleges, by Science and Engineering Field: FY 2001 (Table B-39), and Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School (cluster data for 2001).

Wright State University’s alignment with various segments of the Dayton economy presents an interesting example of cluster-university interaction. The R&D intensity at Wright State is below the national average with several of the largest clusters, due in part to the size and concentration of these clusters in the Dayton region. Dayton has a diversified economy, although many of the clusters support the two most dominant industries – automotive and aerospace. In fact, even these sectors may be converging. In a recent announcement, Delphi Automotive Systems and the Air Force Research Lab at Wright-Patterson Air Force Base (WPAFB) are collaborating to implement Brake-by-Wire technology in passenger vehicles. Much of the R&D to support this sector is conducted not by Wright State or other universities in the region, but by the Air Force Research Lab. Wright-Patterson Air Force Base is the economic anchor in aerospace, technology and manufacturing, conducting several billion dollars of research annually. Wright State has positioned itself to complement the cluster and not duplicate the specialties of other local institutions. The best example of this may be Wright State’s program in aerospace medicine that combines the resources of the medical school in a unique way with the aerospace cluster.

Figure 9: Florida State University Alignment



Source: National Science Foundation, R&D Expenditures at Universities and Colleges, by Science and Engineering Field: FY 2001 (Table B-39), and Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School (cluster data for 2001).

Florida State's research assets engage a broad range of industries. The university has several assets with expertise in materials science that cut across three emerging clusters – aerospace, information technology and medical devices (Figure 9). Florida State University, in partnership with Florida A&M University and Leon County has been working to attract businesses to the region; Innovation Park was created more than 20 years ago as a University-Industry research park. It currently houses the National Science Foundation's National High Magnetic Field Laboratory and research centers associated with FSU and Florida A&M University. Another research park, spearheaded by Florida State University, is modeled on the University of North Carolina's Centennial Park.²⁹

Table 4: Sample FSU Cluster Assets

	Medical Devices	Information Technology	Aerospace
Advanced Mechanics & Materials Laboratory			•
Center for Biomedical & Toxicological Research and Waste Management	•		
Florida Advanced Center for Composite Technologies (FAC2T)	•	•	•
Information Use Management and Policy Institute		•	
Materials Research and Technology, Center for (MARTECH)		•	
Molecular Biophysics, Institute of	•		
National High Magnetic Field Laboratory		•	•
Pepper Institute on Aging	•		
Sensory Research Institute	•		

Florida State is above the US average for research intensity in medical devices, information technology and aerospace although the clusters employ few people in the region. There are numerous research assets for growing the IT cluster in the region, not just at Florida State, but also at Florida A&M University. The Supercomputer Computations Research Institute and the National High Magnetic Field Laboratory are critical assets, but the region's industry base may be too small to benefit from these assets. There are three IT firms that have made the Inc. 500 list, but none of these firms has more than 200 employees: Mainline Information Systems, an IBM reseller; ATG Technologies, a provider of voice mail and paging services; and Advanced Systems Design, computer consulting services. In order to attract and grow firms there are tax and training incentives of up to \$5,000 per new job paying more than 115% of the average private sector wage in the Tallahassee area.

Florida State University exemplifies the case of the high-quality research university that has no local industry to absorb its research. There are only 134

²⁹ Melanie Yeager, "FSU Eyes Proposed Research Park", *The Tallahassee Democrat*, 12 June 2002 [journal online] <http://www.tallahassee.com/mld/democrat/3449621.htm>; Internet; accessed 4 September 2003

technology firms in the Tallahassee region and most of those are very small. The Tallahassee economy is also diversified. Of the four clusters that are relatively concentrated in the region – communications equipment, business services, printing and publishing, and furniture, none is significantly more concentrated in Tallahassee than it is nationally.³⁰ Tallahassee is a state capital; therefore much of the metropolitan economy is oriented to government services. With the exception of communications equipment, the clusters in which the region specializes are not clusters that benefit from university research.

Table 5: Technology Firms in Tallahassee

Number of Employees	Number of Firms
Less than 10	79
11 to 50	40
51 to 100	10
101+	5
TOTAL	134

Source: Florida State University. High Technology Business List: Tallahassee Region. October 2003.

Cluster Factors

The university dimension is only half of the equation for successful university-industry clusters. The other dimension is the nature and organization of the cluster. Clusters vary based on their life cycle and industry structure as well as their specific pattern of organization in different regions. A cluster may be organized and operate very differently from one region to another. Because cluster organization is critical to the ability of a university to impact cluster dynamics and growth, a review of these dynamics is in order.

There are several explanations for the de-concentration of production that affects cluster growth and decline. These explanations center on either location factors or externalities from the concentration of production (diseconomies of agglomeration). Favoring the de-concentration of production is the need to locate near expanding external markets or to access a dispersed, international labor force. Congestion and high land rents also counteract degree of concentration.³¹ The difficulty with these explanations is that it is difficult to identify the thresholds when location or agglomeration factors become negative.

The product life cycle offers an alternative explanation for the de-concentration of production that affects regional clusters. Product life cycle theory examines the role of

³⁰ Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School

³¹ Paul Krugman, "What's new about the new economic geography?" *Oxford Review of Economic Policy* V14 2 1998: 7-17.

technological progress from invention to decline in firms or products. Products pass through four phases in the life cycle - invention, growth, maturity, and decline. Each phase is characterized by its own growth trajectory, market structure, factor input, competitive environment, business size, and locational features. The theory emphasizes the growing importance of cost reduction and standardization of products and production processes, and the declining importance of R&D and production flexibility in the mature phase of a product. To remain competitive, firms often shift production from the location of innovation to lower-cost locations (domestic and foreign) to take advantage of lower land, labor, and/or resource costs.³²

Audretsch and Feldman extended the product life cycle beyond the question of “who innovates” and “how much innovation takes place” by adding a geographic component describing how regional industry concentrations form as a result of innovation. Controlling for the geographic concentration of production, and using industry R&D, university R&D, and the share of the labor force accounted for by skilled workers as three measures of innovation, they found that production tends to be more “geographically concentrated where new economic knowledge plays an important role,” and is “shaped by the stage of the industry life cycle.” Innovative activity clusters during the innovation and growth stages, and disperses during maturity and decline.³³

Some regions also lose the ability to absorb innovation. As a disruptive new technology is introduced, established clusters in older cities and regions may initially be reluctant to abandon established technology and production methods more profitable than adopting new technology. As new technology becomes more competitive, however, the cities and regions adopting new technologies are able to overtake those that aren't.³⁴ The steel industry and the competition between integrated production facilities and newer mini-mills have been offered as an example to illustrate this process.

In established regions, cluster institutions can also become victim of lock-in. Research labs, as well as educational and financial institutions, can become captive to existing customers and ways of doing things. Institutions used to serving a dominant industry may be unresponsive to changes in that industry or even ignore industries and opportunities presented by new innovations.³⁵ While regions may find it difficult to unlearn tried-and-true ways of business, competition may play a role in preventing regional lock-in.³⁶ Certain structures, such as oligopolies, may prevent a region from competing its way out of lock-in.³⁷

³² Rolf Sternberg, “Regional Growth Theories and High-Tech Regions,” *International Journal of Urban and Regional Research* 20 (September 1996): 518-38.

³³ David B. Audretsch and Maryann P. Feldman, “Innovative Clusters and the Industry Life Cycle,” *Review of Industrial Organization* 11 no.2 (1996).

³⁴ Elise S. Brezis and Paul Krugman, “Technology and the Life Cycle of Cities,” *Journal of Economic Growth* 2 no.4 (1997): 369.

³⁵ Peter Maskell, “Towards a knowledge based theory of the geographical cluster,” *Industrial and Corporate Change* 10 (December 2001): 921-943; Chinitz, 1961.

³⁶ Anders Malmberg and Peter Maskell, “The elusive concept of localization economies: towards a knowledge-based theory of spatial clustering,” *Environment and Planning* 34 n3 (March 2002): 429-229;

Regions do not have to wait for economic restructuring to alter their economy. They can prepare by seeding new industries to complement or even replace existing ones. Michigan remains heavily reliant on the automotive sector, but it is preparing for a future that may radically alter that industry. Michigan's NextEnergy initiative is dedicated to developing fuel cell technology that could be incorporated into automobiles, or become a new industry in its own right. Ann Arbor is also working to diversify and develop the regional economy to avoid reliance on one critical industry. Michigan, and Ann Arbor in particular, are focused on life sciences and information technology. Through the year 2000, these efforts have kept the Ann Arbor economy in balance, with strong gains in some sectors offsetting the declines in a few others.

Clusters are also organized and structured differently across regions. How a cluster is structured within a particular region helps to determine the ability of a university to impact the cluster in ways that generate regional benefit. There are four basic cluster development patterns, each of which has different implications for regional growth and development.³⁸

- Networked (Industrial Districts)
- Hub and Spoke
- Satellite (Branch Plant)
- Institutional (State-Anchored)

Examples of each of these four clusters were identified in our case study regions. In some cases a cluster does not fit easily into one category or another, or it may shift over time. For example, the information technology cluster in the Lehigh Valley has the characteristics of both a networked cluster and a hub and spoke cluster. In software, the region is more like a networked cluster with many small firms, but in hardware it is more like a hub and spoke cluster.

David B. Audretsch, "Agglomeration and the Location of Innovative Activity," *Oxford Review of Economic Policy* 14 n2 (Summer 1998): 18-29.

³⁷ Walter Adams and Hans Mueller, "The Structure of American Industry" in *The Steel Industry* (McMillan Publishing Co., 1990): 72-100.

³⁸ Ann Markusen, "Sticky places in slippery space: A typology of industrial districts," *Economic Geography* 72 n3 (July 1996): 293-313.

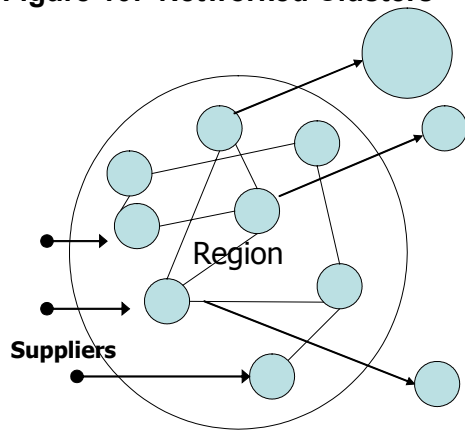
Table 6: Cluster Typology and Cases

	Networked (Industrial Districts)	Hub & Spoke	Satellite (Branch Plant)	Institutional (State-Anchored)
Aerospace Engines & Aerospace Vehicles and Defense				Las Cruces Dayton
Automotive & Motor Driven Products		Ann Arbor Lehigh Valley	New River Valley	
Information Technology	Ann Arbor Dayton Lehigh Valley	Lehigh Valley		Dayton
Biopharmaceuticals & Medical Devices	Ann Arbor Morgantown Lehigh Valley			Morgantown

Networked Cluster (Industrial Districts)

The prototype is the networked cluster that is composed of networks of small firms in the same or related industries able to rapidly adapt to changing markets and differentiated demand through collaboration and the use of new technologies. Firms in a networked cluster enjoy advantages not available to firms elsewhere, including access to local knowledge and labor markets, low transportation and transaction costs, cultures of flexibility, trust, and cooperation, and available local infrastructure supporting specialized sales, service, and supplier networks. Three frequently cited examples of the networked cluster include Silicon Valley, Boston (Route 128), and northern Italy.³⁹

Figure 10: Networked Clusters



Source: Adapted from Markusen 1996.

³⁹ Markusen, 1996

Michigan is a state with an emerging life sciences cluster, and Ann Arbor is an anchor of that cluster. Michigan has a mixture of small and large firms in life sciences, with most of the larger firms clustered in Western Michigan and the smaller firms in Southeastern Michigan.⁴⁰ Beyond the region's impressive research assets, anchored by the University of Michigan, there is a diverse base of firms across several life science sectors. The life sciences cluster in Ann Arbor is not organized around any one entity or even one product or technology area. Rather it is a diverse sector that spans pharmaceuticals, biomedical devices, surgical instruments, medical imaging, diagnostics and therapies. Parke-Davis, maker of Lipitor, was located in the region before Pfizer acquired it and established the Pfizer Global Research and Development facility in the region. Both the University of Michigan and Pfizer/Parke-Davis have been important sources of startup firms for the region's life science cluster.

Ann Arbor's efforts to develop the life sciences industry benefit from strong state involvement. The Michigan Life Sciences Corridor is a statewide initiative conceived in 1999 that has broad participation across the state. The University of Michigan is a main participant in the strategy. In addition to providing lab space to companies and training graduates to work in life sciences firms across the state, the University assists with regional infrastructure to support firms. Part of the Corridor strategy involves five labs in Michigan, which provide a variety of services for particular types of life sciences companies. These labs provide small business with access to costly equipment they could not afford on their own. Two of these five labs (Proteomics and Bioinformatics) are at the University of Michigan. The President of the University of Michigan also serves on the Board of the Life sciences Steering Committee at the MEDC.

The university also works with regional economic development organizations in support of life sciences initiatives. Michbio, a trade association devoted to growing the life sciences industry, is located in Ann Arbor. Michbio supports life sciences research and commercialization on a variety of levels, including workforce development initiatives, networking events, and provider services for members. The University of Michigan has been an active partner since the founding of Michbio, providing space for companies on its campus and helping to attract life sciences firms to the region. The Washtenaw Development Council and the University worked together to bring Pfizer's \$250 million R&D plant to Ann Arbor, a major triumph for life sciences in the Ann Arbor region. The university has also invested heavily into the life sciences initiative and set up the Life Sciences Institute on campus with the hope of creating corporate partnerships and promoting commercialization of research. The university has been able to have a large impact both because the cluster is small and innovation-dependent, where the university can exert the most influence.

Dayton's information technology cluster has aspects of both a networked cluster and an institutional cluster. Wright Patterson Air Force Base is a source of contracts and research producer in information technology, but the IT cluster as a whole is not

⁴⁰ Catherine D. Freiman, "Ready for the Next Leap Forward: A Competitive Assessment and Strategic Plan to Develop Michigan's Life Sciences Industry," Michigan Economic Development Corporation, 2003.

dependent on contract work from the base or its laboratory. Major firms, such as LexisNexis, Reynolds & Reynolds and the Uniform Code Council, balance the influence of WPAFB in the cluster. Most IT firms in the Dayton area have five or fewer employees and are not dependent on WPAFB or the major firms.

In fact, one regional program, the I-Zone, is focused on creating a supportive climate for innovation in Dayton. The I-Zone's Pillar program is a unique effort designed to help small technology firms sell goods and services to large regional firms. This is an explicit effort to build more linkages between firms within the cluster that should strengthen the network of IT firms. The Greater Dayton IT Alliance, another networking resource, is a 200 member trade association that provides a variety of member benefits and programs and supports the Dayton-Metro Internet Exchange (D-MIX), a local peering point to increase the IT connectivity in the community.

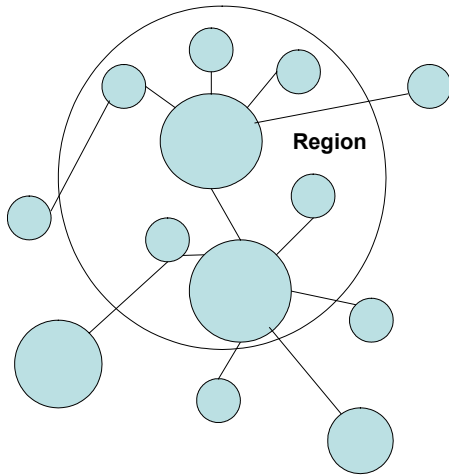
Relative to the size of the cluster, Wright State has intensive research assets supporting information technology. Wright State University, the Dayton Development Coalition and several other groups are promoting the development of information technology, but employment in this cluster remains small. Wright State was the main academic institution sponsoring the Dayton proposal for the Wright Center of Innovation for Advanced Data Management and Analysis, a collaboration with numerous large firms around the state. If funded, this Center would boost the R&D intensity for this cluster.

Hub and Spoke

The hub-and-spoke cluster is characterized by large anchor firms whose suppliers and service providers often concentrate around them like spokes on a wheel. Smaller firms in the region can be closely linked to the dominant firm through supply chains, or may simply be located nearby to take advantage of the benefits of agglomeration. Unlike networked clusters, large firms dominate the inter-firm relationships. These interactions are based more on supply linkages, and less on collaborative innovation sharing. Financial and business services are tailored to the needs of dominant firms, and labor markets are less flexible than in the networked cluster.⁴¹ The fortunes of the region are thus tied directly to the dominant firm or industry, which can inhibit a region's ability to embrace new opportunities.⁴²

⁴¹ Markusen, 1996

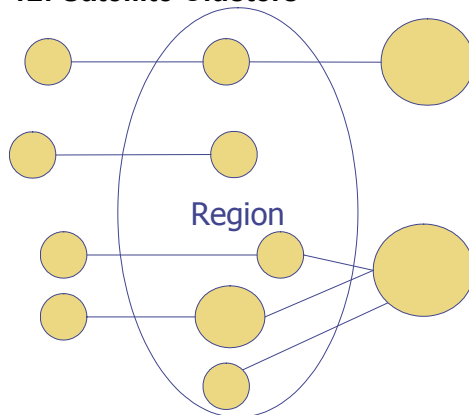
⁴² Benjamin Chinitz, "Contrasts in agglomeration: New York and Pittsburgh," in Papers and Proceedings of the Seventy-third annual meeting of the American Economic Association, *The American Economic Review* 51 no.2 (May 1961): 279-289.

Figure 11: Hub and Spoke Clusters

Source: Adapted from Markusen 1996.

Satellite (Branch Plant)

There is a flipside to the Hub and Spoke cluster. The region that is home to the headquarters may be the hub, but other regions are home only to the branch plants. The clusters that are spokes to an external hub may be called satellite clusters. Minimal trade or cooperation takes place within the region, as most linkages are to external supply chains and other facilities of the parent corporation. Labor markets are usually internal to the firm, and characterized by high degrees of labor migration to and from the district in the higher levels of the market.⁴³

Figure 12: Satellite Clusters

Source: Adapted from Markusen 1996.

⁴³ Markusen, 1996

Two of the case studies illustrate how a hub and spoke cluster may be connected to satellite clusters and how the differences in cluster organization affect these regions. Allentown, the headquarters of Mack Trucks, is a hub of the trucking industry that is connected to the New River Valley, the location of a branch plant. These cases provide an interesting example for examining the effects of hub and spoke and satellite clusters within a sector that has been increasing employment in recent years. First, there is the advantage of having the same clusters linked to two of the case study regions, and secondly, because the cluster has experienced growth nationally in recent years the effects of cluster organization and structure will not be affected by negative industry cycles.

Table 7: Employment in Transportation Equipment

	Allentown		United States	
	Employment	Annual Growth	Employment	Annual Growth
1997	2,726		1,838,711	
1998	2,793	2.5%	1,894,029	3.0%
1999	2,852	2.1%	1,892,637	-0.1%
2000	3,000	5.2%	1,850,681	-2.2%
Compound Average Annual Growth		3.3%		0.2%

Source: County Business Patterns, Transportation Equipment.

Nationally, the automotive cluster has been adding employment but it is also a mature cluster that is generally dispersing production to low-cost locations. This combination, along with the sector's high employment multiplier and desirable wages, transportation equipment is nearly 150% of the national average, has made for stiff competition for new facilities. Nationally employment in transportation equipment has been more volatile than automotive products, but it still registered a net gain of nearly 12,000 jobs between 1997 and 2000 (Table 7). Allentown has added more than 270 jobs in transportation equipment between 1997-2000, resulting in a compound average annual growth that significantly exceeds the national rate.

Allentown is a center for the trucking industry, employing approximately 3,000 people in transportation equipment and more in related industries. The sector pays high wages and has added jobs in recent years. Mack Truck anchors Allentown's trucking industry, with its world headquarters, the Engineering Development and Test Center, and an assembly operation all located in or near the metropolitan area. Outside of the Allentown area, there is a remanufacturing center in Middletown, PA; an engine and powertrain operation in Hagerstown, MD and the New River Valley Plant, which makes highway tractors. Sales offices and parts distribution centers are located throughout North America. Mack Trucks is widely considered a good corporate citizen in the Lehigh Valley.

While Mack Trucks is headquartered in the region, it has been part of Volvo since 2001 and before that was part of Renault. Before the acquisition, the cluster operated as a hub – the decision-making was regionally centered but had an impact far beyond the home region. Furthermore, as a more mature cluster, decisions about the location of new facilities are more likely to be driven by cost considerations, especially labor costs, than regional factors such as the resources and engineering expertise at Lehigh University to support the cluster. The danger for the Lehigh Valley is that this cluster will shift from being a hub, to being a satellite of the international Volvo operations, further removing regional considerations from corporate decisions.

Volvo has operated a truck manufacturing operation in the New River Valley since 1981. In 2001, when Volvo acquired Mack Truck from Renault, it merged Mack Truck's 750-employee assembly plant in Winnsboro, S.C. with Volvo Truck North America's plant in Dublin, VA.⁴⁴ The closure was part of a centralization strategy to increase efficiency, reduce production costs and increase market share.⁴⁵ The strategy has had little impact on Allentown, but it provided an immediate benefit to economic health of the New River Valley, with approximately 2,000 direct employees as well as hundreds of regional suppliers affiliated with the plant. It was not so good for Winnsboro, S.C. or the workers at the former Mack plant, where only a few of the workers were transferred to the New River Valley plant, illustrating the dangers of relying on branch plants.

Table 8: Transportation Equipment

Year	Pulaski	Virginia
1999	3,264	39,284
2000	2,908	40,086
2001	2,459	37,346

Source: County Business Patterns, Transportation Equipment.

Virginia provided approximately \$60 million in total incentives. \$6 million allocated for infrastructure improvements has been awarded, but the remainder of the package is linked to employment levels.⁴⁶ The growth of this sector has brought high-paying jobs that help to diversify the economy.⁴⁷ The trucking industry, like many others,

⁴⁴ Don Simmons Jr., "Competing Mack, Volvo Truck Brands Are Produced under One Roof in Dublin, Va." *The Roanoke Times* 20 April 2003.

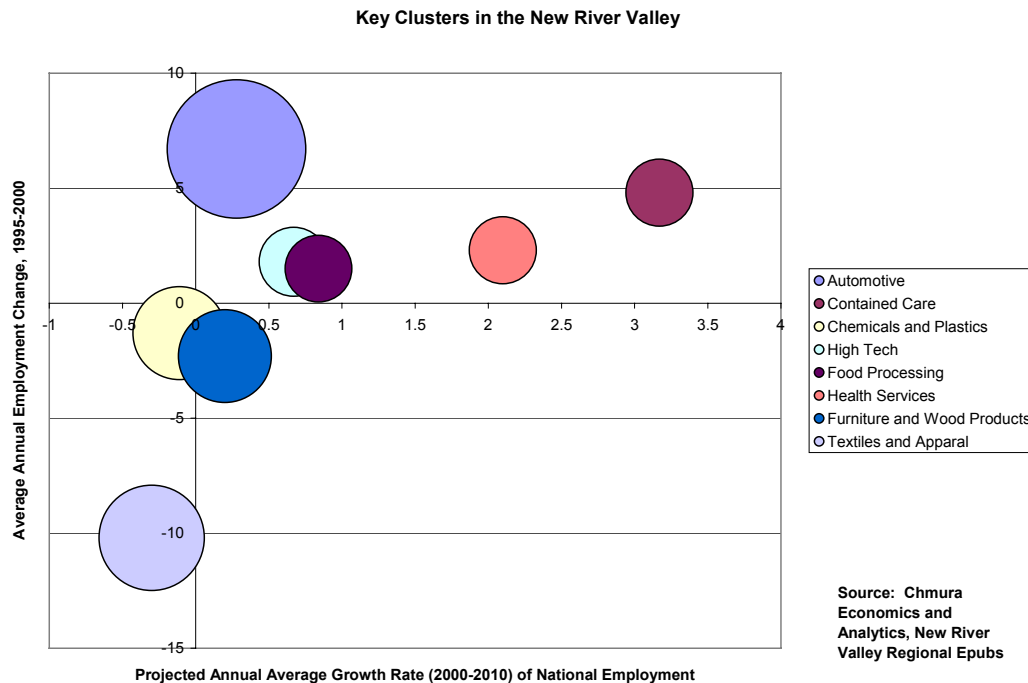
⁴⁵ Don Simmons Jr., "Competing Mack, Volvo Truck Brands Are Produced under One Roof in Dublin, Va." *The Roanoke Times* 20 April 2003.

⁴⁶ Don Simmons, Jr., "Volvo Plant Prepares For Mack Arrival," *Roanoke Times & World News* 26 November 2002.

⁴⁷ Duncan Adams, "Roanoke, Va., Area Has Growing Cluster of Automotive Suppliers," *The Roanoke Times* 4 May 2003.

enjoyed strong growth in the 1990s and then crashed. As the 1990s ended, overall employment in the transportation equipment sector has been volatile in Pulaski County and the state of Virginia (Table 8). Analysis by Chmura Economics and Analytics conducted for the New River Valley Planning District Commission demonstrates the strong growth the region has enjoyed in the automotive cluster, but projects a much lower rate of growth through 2010 (Figure 13).

Figure 13: Key Clusters in the New River Valley



The New River Valley's automotive cluster is broader than this one facility. Numerous regional manufacturers have close ties to the automotive industry. They include: Dynax America Corp.; Koyo Steering Systems of USA; Metalsa Roanoke; Virginia Forge Co.; and Altec Industries. Firms in the cluster serve a variety of customers, including Ford Motor Co., a Toyota plant in West Virginia, a Nissan plant in Tennessee, and Saturn.⁴⁸ Whereas this diversity reduces the region's reliance on any one firm, all of the regional manufacturers are suppliers or branch plants to companies headquartered outside the region. The trading patterns in the cluster are therefore not regionally-based, but are linked to the supply chains of external corporations. This reinforces the region's status as a satellite cluster.

Clusters of all kinds share a common challenge in building linkages between firms within the region. In the cases presented here, the clusters are enjoying some

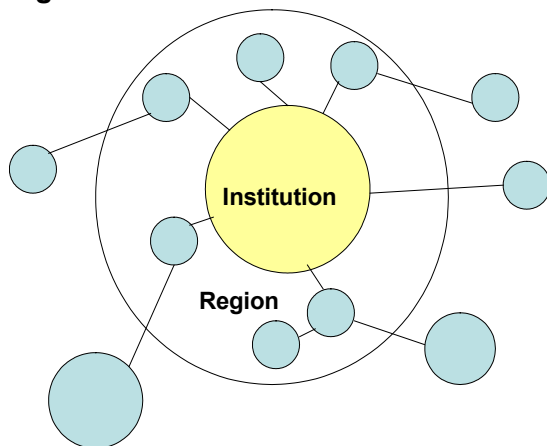
⁴⁸ Duncan Adams, "Roanoke, Va., Area Has Growing Cluster of Automotive Suppliers," *The Roanoke Times* 4 May 2003.

growth, but they are in industries that are dispersing that growth nationally and internationally. In some cases, like the New River Valley, the region may benefit from these trends, while other regions like Winnsboro, SC lose plants. The biggest challenge for a regional economy is that there is little they can do to influence these decisions. They simply lack leverage and control and are forced into higher-stakes competition with other regions if and when firms play regional hopscotch.

Institutional Clusters (State-Anchored)

Institutional clusters, also known as state-anchored districts, are dominated by public or nonprofit entities such as R&D labs, universities, defense installations, or government offices. Large facilities will attract a base of suppliers to meet the demand of the institution, although the institution maintains a dominant role over these suppliers and private firms in general compared to other cluster types. Institutional clusters are generally externally focused, responding first to their goals and needs of the institution, which may be externally focused and only secondarily providing benefits to the local economy. Institutional clusters, especially when they are dominated by a single large facility, can become economically dependent on the source of support for that institution. The characteristics of an institutional cluster have implications for a region's ability to further develop the cluster or for a university to align with the cluster.

Figure 14: Institutional Clusters



Source: Adapted from Markusen 1996.

Federal laboratories and facilities are the prototype of the institutional cluster. Albuquerque and Los Alamos are frequently cited examples. This analysis considers three regions with institutional clusters among the selected cases—Dayton, Las Cruces, and Morgantown. Each location's research facilities vary in size and function. Wright-Patterson Air Force Base near Dayton is the center for aeronautical research for the Air Force and receives several billion dollars in research funds every year. White Sands

Missile Range outside Las Cruces is used by all branches of the military, NASA, and other government agencies for research in nuclear environments, weapon systems simulation, guidance and control, propulsion, climate, microbiology and metallography. The Morgantown area's multiple federal facilities include the FBI Criminal Justice Information Services Division, NASA's National Independent Validation and Verification Center, National Energy Technology Laboratory, National Institute for Occupational Safety and Health/Center for Disease Control, and the National Research Center for Coal and Energy. Several of these facilities are local centers in a wider network of related sites. Unlike White Sands or Wright-Patterson, most of Morgantown's centers are small and relatively young.⁴⁹ Institution-dominated clusters have had different implications for the economies of each region.

Federal defense research is a critical component of New Mexico's economy, including Las Cruces. White Sands receives several hundred million dollars in research funds and about half of its 27,000 employees live in the Las Cruces area.⁵⁰ The NASA White Sands Test Facility provides flight-testing and support services to both government and private industry. The federal research programs have helped attract several aerospace firms to the region. Honeywell has a large aerospace services operation in Dona Ana County. Calculex, a manufacturer of specialized equipment for aerospace research based in Las Cruces, offers over 100 products and is one of the fastest growing suppliers in the aerospace industry. The Mesilla Valley Economic Development Alliance (MVEDA), the regional economic development agency, and New Mexico State University have recently tried to attract more aerospace support companies to the region to help establish a space port.

In Dayton, however, the institutional cluster has not had the same effect. Although WPAFB is the largest single site employer in the state of Ohio, local officials have not been able to capitalize on it for economic development. Dayton does have a high concentration of aerospace engine manufacturing firms, but employment in this area is not growing—74 jobs were lost between 1990 and 2001⁵¹. In addition, technology transfer from the base to the region is low and no prominent local start-ups have spun out of the base. Non-local companies and universities often conduct contract work; although there was once a policy requiring these companies to have a local presence in order to work with the base, this presence was often nothing more than an advertising office.⁵²

Morgantown and the state of West Virginia have focused on two emerging clusters, forensics and biometrics. Morgantown, with the help of powerful politicians, has been able to use the university to attract several high-tech research centers to the area and to secure a steady flow of federal dollars. Federal research dollars and laboratories

⁴⁹ Wright-Patterson has existed since 1918 and White Sands was built in 1945.

⁵⁰ White Sand Missile Range/White Sands Statistics/Statistics for fiscal year 1999, available from <http://www.wsmr.army.mil/paopage/Pages/stat99.htm>; Internet; accessed 13 August 2003.

⁵¹ Harvard Business School/Institute for Strategy and Competitiveness/Cluster Mapping Project; available from <http://data.isc.hbs.edu/isc/index.jsp>; Internet; accessed 4 June 2003.

⁵² Dayton interview, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, 23 July 2003.

have been a key element of building these clusters, but it has been used to seed the effort and none of the key facilities is so large that it will create an institutional cluster. Furthermore, these efforts have positioned WVU, not the federal facilities as the “anchor” of the research efforts helping to supply infrastructure and people for the research efforts. These clusters are in the very early stages of the product cycle. On the positive side, the region is competing in niches where there are few dominant players. The downside is that the size and characteristics of the market for early stage industries is unknown, which increases the risk of technology development.

Morgantown’s federal facilities are new, so their long-term implications for the regional economy are uncertain. They also have not yet reached a critical mass; all of the centers combined employ only about 3,500 people in three counties. However, local economic development officials have clearly incorporated those facilities into their cluster strategies. For example, the region is focusing on forensics and biometrics, building on the mission of its FBI facility. Morgantown’s federal facilities reflect the region’s political clout and the transition of the federal government to a new set of priorities.

In each of these cases, the university’s interaction with the federal facility is substantially different. New Mexico State University houses the Physical Science Laboratory, a non-profit aerospace testing facility for government and private industry. NMSU is also the state’s lead institution for the NASA National Space Grant program. West Virginia University is closely tied to local facilities as well, offering degree programs in fields (like forensics) designed to take advantage of nearby research labs. Although the university is often described as anchoring federal research efforts in Dayton, Wright State does not have a prominent relationship with WPAFB. Instead, the University of Dayton has historically filled this role through its Research Institute, which has programs directly related to the aerospace industry.⁵³ Thus, while there are some important connections with the base, it is not the primary research focus of the University. While the level of interaction in all three cases is different, in no case has the university/federal relationship resulted in significant technology transfer to the area. All three universities have low spin-out statistics; not one averaged more than two per year from 1998 to 2000. No prominent start-up companies were identified that originated from federal research.

Institutional clusters based on federal facilities may provide jobs and economic stability, but they don’t necessarily promote the development of new industry clusters. Although Las Cruces’ economy is growing, this has more to do with in-migration than from local gains from White Sands. Aerospace engines, for instance, is not significantly concentrated and job creation in that area between 1990 and 2001 was zero⁵⁴. Las Cruces

⁵³ This is partially due to timing: Wright State was only created in 1967 while the Research Institute was created in 1956 and UD was incorporated in 1850. Also, though it offers Master’s Degrees in several engineering subjects, Wright State’s Ph.D.s are in medical fields. Wright State does offer a degree in Aerospace Medicine.

⁵⁴ Harvard Business School/Institute for Strategy and Competitiveness/Cluster Mapping Project; available from <http://data.isc.hbs.edu/isc/index.jsp>; Internet; accessed 4 June 2003.

is so small that most changes will register as significant gains or losses—if there are only two aerospace companies, adding one more is a 50 percent increase. Morgantown's gains are also difficult to measure, in this case because the facilities are relatively new. Certainly, gaining additional high-tech jobs is a positive development, however, the real test is whether public jobs are supplemented by private sector employment. Still, in this case the federal presence has spurred growth. Finally, while in Dayton the base has helped generate a high concentration of aerospace companies, the number of jobs has decreased over time. Federal facilities may be a foundation for growth, but they are subject to the same product cycle effects as other industries where the benefits tend to wither over time.

These cases also illustrate the role of market forces. The institutional clusters in Las Cruces and Dayton are experiencing a state of decline. The Bureau of Labor Statistics shows that employment in Aerospace Products and Parts manufacturing has fallen every year since 1998. Total employment was 430,600 in July of 2003, a decline of 26 percent from a peak of 578,600 in 1998. The Cluster Mapping Project also shows a declining Aerospace cluster. Total employment in the Aerospace Vehicles and Defense cluster was 374,135 in 2001, a loss of 330,137 jobs since 1990. This cluster has lost more jobs than any other traded cluster except for Apparel. The Aerospace Engines cluster, which employed 89,885 people in 2001, lost 55,784 jobs over the same time period. Morgantown is pursuing clusters related to currently growing sectors of biotechnology and those related to homeland security.

Conclusion

Universities can play a powerful role in the development of industry clusters. There are many examples of how new industries form from university research. Similarly, new industry clusters have re-ordered the ranking of major economic regions. Unfortunately the path from university research to cluster development and finally to regional economic benefit is not simple or direct. The assets of the university must be properly aligned with clusters that are appropriate targets for the regional economy. This report concludes that the characteristics of the cluster are as important, if not more important than the characteristics of the university. The task for the university (and for regional stakeholders) is to identify and support areas of university expertise that align with clusters of opportunity for the region.

For the university these clusters of opportunity are defined by an area of significant university expertise. A large base of research and development is required but not sufficient. The university must also address the business, workforce, and community issues. The university must be aligned with regional interests and industry clusters across a broad spectrum, not just in terms of technical knowledge. For the region, clusters of opportunity are defined by sectors with expanding markets and where the ability of the university to spark innovation can impact the competitive advantage of the region.

Case Profiles

University of Michigan / Ann Arbor

Regional Context



In 1999, Business Week rated Ann Arbor the best place in the United States to earn and save money.⁵⁵ The Ann Arbor MSA includes Washtenaw, Lenawee and Livingston Counties. Located in Southeast Michigan, Ann Arbor is home to several hundred information technology and life sciences firms and one of the nation's most prominent research universities, the University of Michigan. The presence of other large universities in the area, such as Eastern Michigan University in Ypsilanti and Washtenaw Community College, also help shape the labor force. More than 23 percent of the workforce in Washtenaw County possesses a bachelor's degree.⁵⁶ Total employment growth between 1990 and 2000 was higher than the national average at 21.9 percent and unemployment in 2002 was well below the national average (3.6 percent compared with 5.8 percent for the US on the whole). Median household income in 1999 was 131 percent of the national average.

⁵⁵ Washtenaw Development Council, "Community Rankings," http://wdc-econdev.com/comm_rankings.html; Internet; accessed 1 July 2003

⁵⁶ Michigan Labor Market Information, "Washtenaw County Employment Training and Community Services Group" http://www.michlmi.org/LMI/MTB_Profiles/mwa30.pdf; Internet; accessed 1 July 2003

Table 9: Ann Arbor Economic Statistics

	Ann Arbor MSA	United States
Employment Growth 1990-2000	21.9%	18.6%
Unemployment 2002	3.60%	5.80%
	Ann Arbor MSA	Percent of United States
Median Household Income 1999	\$55,016	131.01%
Per Capita Income 1999	\$26,222	121.47%

University

The University of Michigan is one of Ann Arbor's significant assets. It has been rated as the number one research institution in the country, and received \$591 million in research funding in 2001.⁵⁷ The university has more than 38,000 students. The most popular programs are engineering, social sciences and history, psychology, biological/life sciences, and English language and literature.

Table 10: University of Michigan Significant Degree Categories⁵⁸

Significant Degree Categories, 1999-2000
1. Engineering
2. Social Sciences
3. Business, Management, Marketing, and Related Support Services
4. Health Professions and Related Clinical Services
5. Psychology
6. Biological and Biomedical Sciences
7. Visual and Performing Arts
8. English Language and Literature/Letters
9. Multi/Interdisciplinary Studies
10. Architecture and Related Programs

Source: National Center for Education Statistics, 2003. Analysis by Center for Economic Development.

The university has an active technology transfer system, with one main office and two satellite offices located in the medical school and the college of engineering. The Office of Technology Transfer helps inventors secure funding, and deals with license and patent issues. It was involved in 32 university-related spinouts between 1998 and 2002.⁵⁹

⁵⁷ Michigan Economic Development Council, "Life Sciences Stats and Facts," <http://medc.michigan.org/lifescience/Stats/>; Internet; accessed 1 July 2003

⁵⁸ Significant degree categories were identified by calculating a "location quotient" for each category; this is the ratio of the subject area's percentage of total in the university to the subject area's percentage of total degrees in the country. Significant categories are categories with a ratio > 1.5, and are listed in descending order.

⁵⁹ University of Michigan, "Office of Technology Transfer Portfolio of Startups," <http://www.techtransfer.umich.edu/stories/startport.html>; Internet; accessed 8 July 2003

In addition, the University has a policy of providing funding for faculty/students who have an idea that they believe has promise. The business school also provides gap funding for businesses unable to meet their needs through venture capital or seed funding.⁶⁰

The university is engaged in local and non-local industries. Several departments at the university interact frequently with businesses. The engineering and business schools work most with the automotive and information technology industries. The business school holds symposia twice a year for businesses in the area. In addition, the Wolverine Venture Fund not only helps startups find funding with venture capitalists, but it occasionally invests in businesses itself.⁶¹ There are several research centers focused on information technology and life sciences. The medical school is the Office of Technology Transfer's largest business provider; more than 45 percent of the 298 disclosures in 2002 were related to the medical school.⁶² The university recently made a \$100 million investment in the Life Sciences Institute to bring an interdisciplinary perspective to life sciences research.⁶³

The university plays a substantial role in regional economic development planning. It has worked with the Michigan Economic Development Corporation and Washtenaw Development Council on several occasions. It sold some of its land for a \$250 million Pfizer R&D lab expansion and has been involved with MEDC in shaping the Life Sciences Corridor. The university is also involved in creating strategies at the state and local level to promote economic development. The Life Sciences Corridor and the Michigan Universities Commercialization Initiative are examples of the university working with the state's planners in creating initiatives for Michigan.

All academic units at the University of Michigan except the agriculture department conduct research, and a total of \$656 million was spent on research in 2002.⁶⁴ Life sciences is the largest funding target, receiving more than 55 percent of total funding. Medical sciences followed by biological sciences are the largest sub sectors within life sciences. The area receiving the second highest amount of funding is engineering.

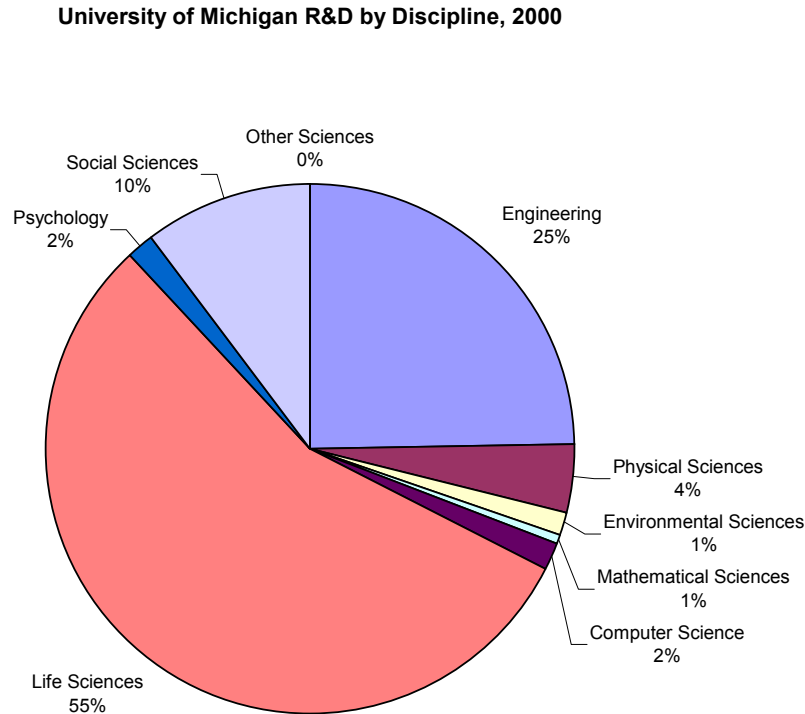
⁶⁰ Ann Arbor interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Anjani Datla, 3 July 2003

⁶¹ Ann Arbor interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Anjani Datla, between June and August 2003

⁶² University of Michigan, "2002 UM Tech Transfer Annual Report,";
<http://www.techtransfer.umich.edu/aboutus/annrpt/fy2002.pdf>; Internet; accessed 22 September 2003

⁶³ Ann Arbor interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Anjani Datla, between June and August 2003

⁶⁴ http://www.research.umich.edu/proposals/proposal_dev/UM_Resources/Overview.html 28 October 2003

Figure 15: University of Michigan R&D by Discipline, 2000

Source: National Science Foundation, available from <http://caspar.nsf.gov>; Internet; accessed 13 October 2003.

This study has chosen to focus on life sciences and information technology as areas of interest because of University of Michigan's research focus and because of the growth of these two industries in the region.

Life Sciences

There are over 80 life sciences firms in the Ann Arbor/Ypsilanti area; both the region and MEDC have given special emphasis to this growing industry. While several firms and universities in the state compete for grants awarded by the Michigan Life Sciences Corridor, 75 percent of the nearly \$45 million awarded in 2001 went to Ann Arbor area firms or to the University of Michigan.⁶⁵ The university is particularly well suited to work with the life sciences industry. There is a university-wide life sciences initiative with seven distinct areas of focus:

⁶⁵ Washtenaw Economic Development Council, "Bio Industry Information," http://wdc-econdev.com/web_bio_book.pdf; Internet; accessed 17 September 2003

- Biocomplexity
- Bioinformatics
- Biotechnology and transitional research,
- Chemical and structural biology
- Cognitive neuroscience
- Genomics and complex genetics
- Life sciences, values and society.⁶⁶

Each of these focus areas includes centers and/or labs that conduct research and analysis.

Life Sciences Institute: Built with \$100 million investment made by the University of Michigan, this institute will serve as a center for multi-disciplinary research in life sciences. The university has plans to use this institute to conduct high profile research across the life sciences spectrum.

Center for Gene Therapy: The center fosters new and collaborative research in gene therapy and has contributed to making the University of Michigan a recognized name in the field.

Information Technology

Another area of focus at the University is information technology. According to the Ann Arbor IT Zone, Washtenaw County has more than 500 IT companies and employs 9,000 people, similar to employment in industries as prominent as automotives and education.⁶⁷ Apart from having a well-structured research administration and technology transfer office, the University of Michigan has several institutes that are involved in bringing high technology research to the forefront.

- III-V Integrated Devices and Circuits Group
- The Artificial Intelligence Laboratory
- Automotive Research Center
- Biomechanics Research Laboratory
- Center for Information Technology Integration (CITI)

⁶⁶ University of Michigan Life Sciences, "Research Themes," <http://www.lifesciences.umich.edu/research/themes.html>; 14 October 2003

⁶⁷ Ann Arbor IT Zone, "Mission and History," <http://www.annarboritzone.org/history.asp>; Internet; accessed 29 October 2003

- Center for Ergonomics
- Center for Neural Communication Technology
- Center for Advanced Computing
- Center for Ultrafast Optical Science
- Collaboratory for Research on Electronic Work
- Electron Microbeam Analysis Laboratory
- Frontiers in Optical Coherent and Ultrafast Science (FOCUS)
- Institute for Environmental Sciences, Engineering, and Technology
- Japan Technology Management Program
- Michigan Memorial Phoenix Project (MMPP)
- Molecularly Designed Electronic, Photonic, and Nanostructured Materials
- Space Physics Research Laboratory
- Tauber Manufacturing Institute
- Virtual Reality Laboratory
- Women in Science and Engineering (WISE)

Center for Information Technology Integration: The Center conducts research in association with sponsors to enhance the information technology environment at the University in order to transfer the results to uses in industry, government and education.

Virtual Reality Laboratory: The laboratory conducts research on the uses of various types of virtual environments for their application in different industries. It creates resources for incorporating virtual reality into fields like accident simulations, medicine and architecture.

Critical Industries

The Ann Arbor metropolitan area has 13 important clusters. The industries range from automotive and medical devices to business services and production technology. Automotives, plastics, metal manufacturing, and motor driven products are the most

prominent clusters.⁶⁸ The economy is diversified and has strategies in place to support many up-and-coming industries.

Over the past few years Ann Arbor has become a haven for information technology and life sciences firms. There are more than 300 software and New Media firms in the Ann Arbor MSA,⁶⁹ and over 80 life sciences in Washtenaw County.⁷⁰ The automotive industry, though, is still the largest cluster in the region.

Economic Development Strategies

Ann Arbor's economy has diversified and attracted considerable investment primarily because of a concerted effort between local economic development agencies and the state's economic development wing, the Michigan Economic Development Corporation. The life sciences and information technology industries have received special emphasis in the region. Programs like Bioconnections started by MichBio (a trade organization for life sciences firms based in Ann Arbor), are geared to hire and retain life-science professionals and graduates in the region.⁷¹ In addition, dynamic economic development organizations, such as the Washtenaw Development Council (WDC), focus on bringing in new investment. In 2001, the WDC brought in \$1 billion in investment to the region.⁷² Among other accomplishments was the \$250 million Pfizer expansion won through a sizeable tax abatement measure given by the City of Ann Arbor.⁷³

The Ann Arbor IT Zone, an idea initiated at the University of Michigan, was created to provide support to the burgeoning IT industry in the Ann Arbor/Washtenaw County area. This collaboration between local IT businessmen and the University was incubated by the WDC. This was the first venture in Michigan geared towards promoting the information technology industry. The IT Zone spun out the Ann Arbor/Ypsilanti Smart Zone, a business accelerator that works to bring new industries to the region. The director of the Office of Technology Transfer at the University of Michigan is chairman of the zone.

⁶⁸ Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School.

⁶⁹ CyberState.org, "Technology Clusters and Emerging Technology in Michigan: A Report for CyberState" available from http://www.cyber-state.org/4_0/4_2_4.html#washtenaw; Internet; accessed 1 July 2003

⁷⁰ Washtenaw Economic Development Council, "Bio Industry Information," available from http://www.wdc-econdev.com/web_bio_book.pdf; Internet; accessed 26 August 2003

⁷¹ Laura Bailey, "MichBio program looks to inject outside blood into state industry; Also focuses on retaining grads," *Crain's Detroit Business* 4 November 2002 [journal online]; available from <http://web.lexis-nexis.com/universe>; accessed 1 July 2003

⁷² "Washtenaw County's Economic Development Organization Achieved \$1 billion Level in New Investment for 2001," *PR Newswire*, 6 February 2002 [journal online]; available from <http://web.lexis-nexis.com/universe>; Internet; accessed 1 July 2003

⁷³ "Pfizer Inc Opens \$250 million Technical Development Facility," *PR Newswire*, 24 June 2002 [journal online]; available from <http://web.lexis-nexis.com/universe>; Internet; accessed 1 July 2003

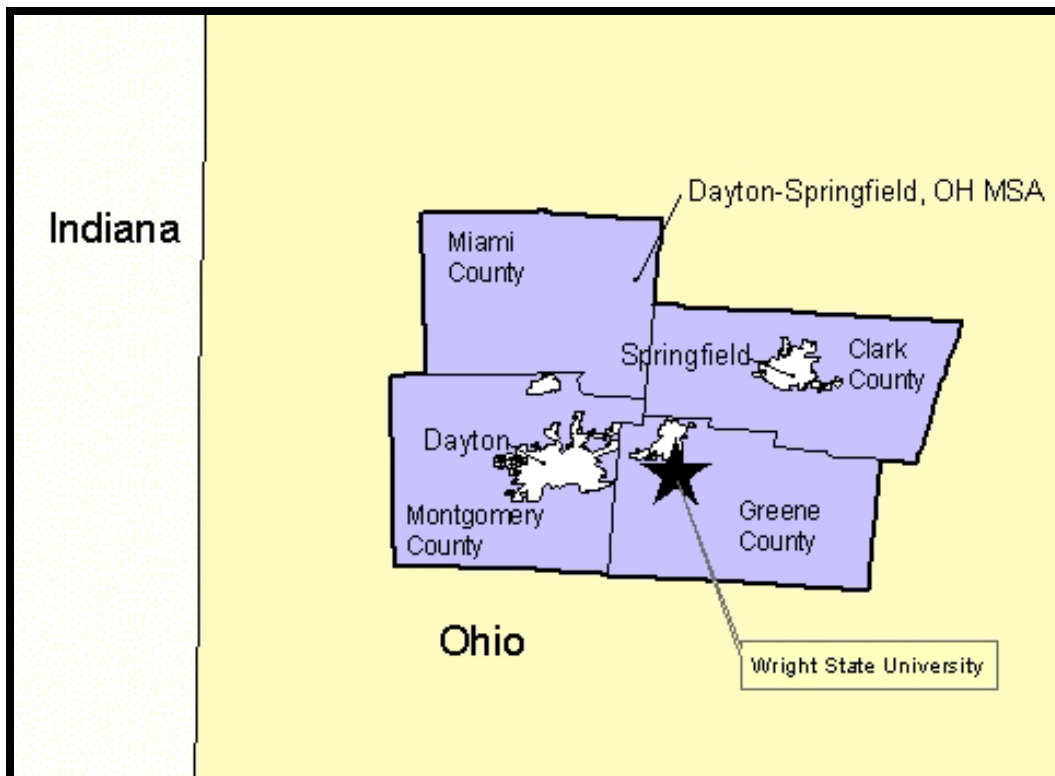
State

The State of Michigan has an extremely active economic development wing, and spent over \$244 million on economic development in 2001. The Michigan Economic Development Corporation has made significant contributions to identify and promote several industries in the state. In Ann Arbor in particular, it has worked with regional economic development organizations and universities to create economic development strategies. Michigan has invested heavily into the Life Sciences Corridor and the Next Energy Initiative.

Michigan has twelve state incentive programs in economic development. The state uses a variety of programs to encourage economic development in the state, including bonds, tax credits, and grants. Michigan prefers to give incentives in the form of tax credits and grants. While there are no statewide location targets, two programs provide incentives to state designated areas.

Wright State University / Dayton

Regional Context



Dayton, Ohio was part of the Dayton-Springfield Metropolitan Statistical Area, located 50 miles northeast of Cincinnati and 75 miles west of Columbus. It should be noted that MSA definitions for this area have changed. Previously, the MSA encompassed only four counties, but recently the MSA has been divided in two, with the Springfield MSA covering all of Clark County and the Dayton MSA covering Miami, Montgomery, Greene, and Preble Counties. This research was based on the pre-2003 definition.

Many of the organizations have a clearly delimited geographical mission, particularly those that are city- or county-based, but the identification of the regional boundaries varied. The Dayton Area Chamber of Commerce and the Entrepreneurs Center described the region as Montgomery County and adjacent counties. The Dayton Development Coalition and the i-Zone referred to a wider area comprising all or part of 12 counties: Montgomery, Miami, Clark, Green, Preble, Darke, Champaign, Shelby, Clinton, northern parts of Warren and Butler, and the southern part of Auglaize. Wright State officials also mentioned the state as a service area.

Dayton's industries are similarly dispersed. While IT companies may be mostly concentrated near the city of Dayton, the automotive cluster stretches into Shelby County, where Honda operates a plant. At a recent meeting of regional officials, the 47 participants formally agreed that there was no formal definition of the area.⁷⁴ Rather, the definition depends on the issue or industry in question.

Table 11: Dayton Economic Statistics

	Dayton-Springfield MSA	United States
Economic Growth 1990-2000	5.2%	18.6%
Unemployment 2002	5.6%	5.8%
	Dayton-Springfield MSA	Percent of United States
Median Household Income 1999	41550	98.9%
Per Capita Income 1999	21598	100.15

University

Wright State University is a public university located in Fairborn, Ohio, just east of the city of Dayton. It is a young school compared to the other main colleges in the area; while Wright State was founded in 1964, both the University of Dayton and Sinclair Community College have existed since the 19th century. Major degree areas include biological and biomedical sciences, business, communications, education, engineering, physical sciences, psychology, public administration, and social science.

Table 12: Wright State Significant Degree Categories

Significant Degree Categories, 1999-2000
1. Physical Sciences
2. Engineering
3. Education
4. Psychology
5. Biological and Biomedical Sciences
6. Public Administration and Services

Source: National Center for Education Statistics, 2003. Analysis by Center for Economic Development.

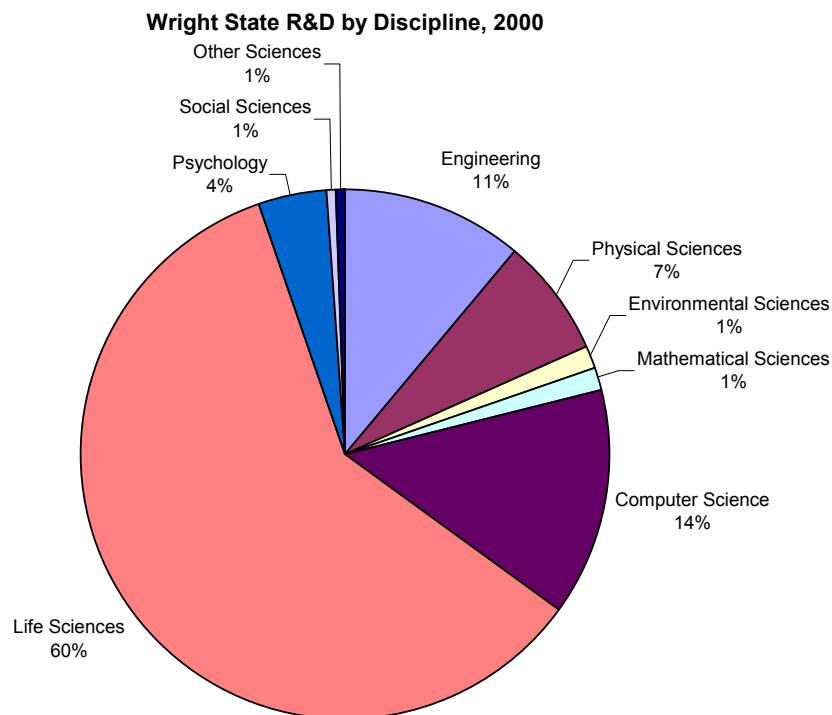
Wright State University is not the largest or oldest university in Dayton, nor is it the most active in economic development.⁷⁵ Perhaps due to its age or industry contact, the University of Dayton is more connected with both the automotive industry and the

⁷⁴ Dayton interview, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, 23 July 2003.

⁷⁵ Dayton interview, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, between June and August 2003.

Air Force base, and the University of Dayton Research Institute conducts more industry-specific research. Wright State has chosen different targets and is more focused on biomedicine and information technology. This is not to suggest that Wright State plays no role in economic development—the University was the main academic institution sponsoring the Dayton proposal for an IT Wright Center for Innovation, which has been resubmitted for approval. The Information Technology Research Institute has also been an important link to industry, but the university’s relative newness to formalized technology transfer and commercialization has not yet achieved a scale that can generate significant regional impact or large numbers of spin-off firms. However, the university does have representatives in regional groups and often performs industry research for these organizations.

Figure 16: Wright State R&D by Discipline, 2000



Health, Biotechnology, and Life Sciences

Wright State’s research expenditures totaled \$29,092,000 in 2000. Much of Wright State’s research is collaborative, involving multiple disciplines as well as research partners from other organizations. For this study, two areas of research were particularly relevant: biotechnology and information technology. Currently, over 50% of Wright

State's expenditures are in life sciences, with medical sciences comprising 84% of that total. Research covers a variety of topics, including human genomes, human growth, geriatrics, and toxicology. Existing research centers include:

- Genome Research Infrastructure Project
- The Lifespan Health Research Center
- Center for Interventions, Treatment, and Addictions Research
- Center for Brain Research
- Environmental and Hyperbaric Cell Biology Facility
- Gene Expression Laboratory

Genome Research Infrastructure Project (GRIP) - GRIP represents the collaborative nature of Wright State's research. Spearheaded by the Genome Research Institute at the University of Cincinnati, this effort includes Wright State, Wright-Patterson Air Force Base, Proctor and Gamble, Children's Hospital Research Foundation in Cincinnati, and Acero, Inc. The group was recently awarded \$9 million dollars to build a biomedical research and biotechnology center in Southwest Ohio. Research will be conducted in cancer biology, neuroscience, endocrinology and cardiovascular/pulmonary biology.

The Lifespan Health Research Center - This center tracks changes in human health over an average lifespan. Since 1997, the Center has been home to the Fels Longitudinal Study, which has been gathering data on human growth and body composition since 1929. Unlike other such studies, the Fels Study incorporates a psychological evaluation, an element of its multidisciplinary nature.

Environmental and Hyperbaric Cell Biology Facility - A new facility funded by the Office of Naval Research, this center conducts research on the effect of different levels of oxygen on the human brain. The goal of this research is to gather more information about oxygen toxicity and methods of treatment for it.

Information Technology

Information technology has been targeted by economic development officials as a critical cluster for the region. Wright State has several centers that complement this effort. Computer science currently accounts for 14% of Wright State research expenditures.

Information Technology Research Institute (ITRI) - ITRI represents another collaborative research effort, sponsored by the Ohio Board of Regents, the Ohio Department of Development, the Miami Valley Economics Development Coalition, the Greater Dayton IT Alliance, federal and local government, and private industry, as well as Wright State University. The Institute serves as an access point to university research

in IT and a facilitator of technology transfer. Research projects cover multiple disciplines, including bioinformatics, databases, networking, and intelligent systems.

Dayton Area Graduate Studies Institute (DAGSI) - Wright State University, the University of Dayton, and the Air Force Institute of Technology combined to form DAGSI, an institute designed to increase educational opportunities for graduate students in engineering. DAGSI serves as a consortium that allows students to take courses at any of the member schools. It also helps stimulate research projects between area institutions and with the Air Force Base.

Critical Industries

Data from the Harvard Cluster Mapping Project indicate that the economy is diversified across thirteen different clusters but many of them are directly related to three industries: aerospace, automotive, and metal manufacturing. Of all clusters with location quotients larger than 1.5, only production technology saw a major decline in employment during the 1990s. More recently, however, the industrial-machinery, automotive, and defense industries have also lost a significant number of jobs.⁷⁶

Wright-Patterson Air Force Base is considered an important economic engine leading to spin-off employment in aerospace, technology, and manufacturing.⁷⁷ The potential benefits have to date surpassed the actual benefits—although the number of patents in the region is high, this has not resulted in the creation of many prominent start-ups.⁷⁸ Economic development groups based in Dayton are particularly focused on the information technology sector, drawing on the area's high number of IT companies, including major firms like LexisNexis and Reynolds & Reynolds. However, IT jobs do not yet offset the decline of other industries. Automotive, manufacturing and related industries remain important, employing 19 percent of the region's population.⁷⁹ The tool-and-die industry, which was once quite prominent, is currently in a state of decline.

The Dayton Development Coalition and Wright State University are promoting information technology for the area, but actual employment in this area remains small and concentrated near the city of Dayton. According to the Cluster Mapping Project, 1,315 people were employed in information technology in 2001, which ranked Dayton 93rd out of 318 metropolitan areas.⁸⁰ The region will also need to develop the skills of

⁷⁶ Thomas Traynor, "The State of the Dayton Regional Economy: Limping Along," *Regional Economic Report/Wright State University* (Spring, 2003).

⁷⁷ Dayton interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, between June and August 2003.

⁷⁸ Dayton interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, between June and August 2003.

⁷⁹ U.S. Census Bureau/EPCD/County Business Patterns 2001; available from <http://www.census.gov/epcd/cbp/view/cbpview.html>; Internet; accessed 30 September 2003.

⁸⁰ Harvard Business School/Institute for Strategy and Competitiveness/Cluster Mapping Project; available from <http://data.isc.hbs.edu/isc/index.jsp>; Internet; accessed 30 September 2003.

the workforce in order to sustain a successful transition to more technology-intensive industries.⁸¹

Economic Development Strategies

The governor of Ohio is currently pushing a tech-based “Third Frontier” of innovation to reinvigorate the state’s core industries. The most prominent component of this is funding for Wright Centers for Innovation, which will provide state money for joint private companies and university plans. Locally, however, leadership is less clear. Public officials in each county and city retain a great deal of control over economic development efforts. Food distribution, for example, was mentioned as a growing industry by leaders in Springfield but not by leaders in Dayton. The Dayton Development Coalition has recently emerged as the most prominent leader in economic development. This may be partially due to the incorporation of the Dayton Regional Development Alliance into the Coalition’s auspices, giving it a public persona it previously lacked. The Coalition had previously been a privately funded group, perhaps reflecting the presence of many large, established companies. Other important players include the Greater Dayton IT Alliance, the I-70/75 Association, and Wright-Patterson Air Force Base.

Regional development strategies are technology and entrepreneurial driven and are relatively young. Several people mentioned that the Coalition is adding leadership and focus that was previously lacking. The incubator only opened in 2000. As mentioned above, technology is a major focus area, particularly since there are approximately 1,000 small IT firms in the Dayton area. In this case, “small” means five or fewer employed, so it is unclear how this sector will develop. Also, plans to develop the IT industry have not been accompanied by plans to deal with the already present manufacturing industry. Workforce transition is perhaps the greatest problem facing regional officials, which may be eased by the well-developed community college system. Focus on entrepreneurship is new, and there remains a great deal of focus on keeping old firms (like General Motors, NCR, and Reynolds & Reynolds) fit and happy.

There are several obstacles to regional cooperation in the Dayton Area. The first is a state-level problem derived from the principle of home rule. While cities and villages have a great deal of autonomy, counties and townships must abide by state statute.⁸² As a result, individual communities can thwart regional efforts not to their liking, especially those that are county initiatives. The second is a regional problem resulting from Dayton’s close proximity to Cincinnati. Although there has been talk of developing closer relations between these areas, competition remains. Finally, there are problems relating to demographics. Development in the region has been largely uncoordinated,

⁸¹ Dayton regional interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, between June and August 2003.

⁸² Lawrence Budd Warren, “Changes proposed for rural land use affect developers,” *Dayton Daily News*, 18 April 2003 [online journal] available from <http://web.lexis-nexis.com/universe>; Internet; accessed 5 June 2003.

resulting in growth of suburban areas that takes funding and jobs from cities.⁸³ For example, between 1992 and 1997, “Dayton lost 1,474 jobs and 163 businesses while its suburbs gained 40,232 jobs and 753 companies.”⁸⁴ At the same time, Dayton is the only area in this study that actually saw negative population growth during the 1990s. As a result, there is growing concern that there may not be enough demand to sustain the area’s businesses.

State

Ohio offers thirty incentives programs, more than any other state in the study except Pennsylvania. These programs are almost exclusively provided by the Department of Development and are comprised mostly of loans, tax credits, and grants. As mentioned above, the state has recently initiated several new initiatives for economic development under its Third Frontier Program. Along with the Wright Centers for Innovation, other new elements include an internship program to retain college graduates, the Wright Capital Project Fund to promote commercialization, and the Third Frontier Action Fund to promote tech-based development. Ohio’s budget for Economic Development totaled \$648,320,000 in 2001.

⁸³ Lynn Hulsey, “Road to Cooperation Bumpy,” *Dayton Daily News*, 29 October 2001[online journal] available from <http://web.lexis-nexis.com/universe>; Internet; accessed 5 June 2003.

⁸⁴ Lawrence Budd Warren, “West Chester Twp. at epicenter of growth,” *Dayton Daily News*, 28 October 2001[online journal] available from <http://web.lexis-nexis.com/universe>; Internet; accessed 5 June 2003.

New Mexico State University / Las Cruces

Regional Context



Las Cruces is the second largest city in New Mexico, located 223 miles south of Albuquerque and 45 miles north of El Paso, Texas. New Mexico has the third fastest growing economy in the nation,⁸⁵ and Las Cruces itself is experiencing significant growth; during the 1990s employment grew at 3.6 percent (compared to a growth rate of 2.01 percent nationwide).

The Las Cruces MSA includes Dona Ana County, where federal aerospace research has a large presence. Las Cruces is less than one hour from the White Sands US Army Missile Testing Facility. It is also home to a branch of Honeywell Technology Services, which operates the White Sands Testing Facility and is the primary contractor to NASA's LBJ Test Facility. The New Mexico State University Physical Science

⁸⁵ Economic Development Department of New Mexico. "New Mexico Economic Development Department Annual Report FY 2002," <http://www.edd.state.nm.us/PUBLICATIONS/02anrep.pdf>; Internet; accessed 24 June 2003

Laboratory and Center for Aerospace Science Technology & Education also conducts aerospace research for the government.

Per capita income in 2001 was \$17,984, only 59 percent of the US average, while 2002 unemployment was 6.9 percent, compared to the US rate of 5.8 percent. Development in the border region has been hampered in the last 18 months by the loss of 65,000 jobs from the maquiladoras⁸⁶ in Ciudad Juarez, Mexico.⁸⁷

Table 13: Las Cruces Economic Statistics

	Las Cruces MSA	United States
Employment Growth 1990-2000	3.56%	2.10%
Unemployment 2002	6.70%	5.80%
	Las Cruces MSA	Percentage of United States
Median Household Income 1999	\$29,808	70.98%
Per Capita Income 1999	\$13,999	64.85%

Critical Industries

Although agriculture and mining remain important sources of employment, the manufacturing sector has been growing and currently accounts for about one-sixth of all non-agricultural jobs in the region.⁸⁸

An official at the Las Cruces area economic development agency, MVEDA (Mesilla Valley Economic Development Alliance) listed maquila suppliers, aerospace, call centers, and food processing as the important clusters in the region. The fastest growing clusters in the region are plastics, processed food, agricultural products, transportation and logistics, and heavy construction services.⁸⁹ With only a few large clusters, the economy is not very diversified.

Although the government employs a sizeable number of people in Las Cruces, New Mexico State University is the largest employer in the area. Additionally, because Las Cruces serves as the regional center for southern New Mexico, there are other offices like the FBI and Border Patrol that employ a fair number of people.

⁸⁶ Maquiladoras are Mexican facilities that assemble finished goods, especially appliances and automobiles, for export to the United States. They are located near the U.S.-Mexico border where they can take advantage of inexpensive labor and low tariffs.

⁸⁷ Romo, Rene. "Developer Says Border Area in an Economic Slump" *Albuquerque Journal*, 16, August 2002 [journal online]; available from <http://web.nexis-lexis.com/universe>; Internet; accessed 24 June 2003

⁸⁸ Mesilla Valley Economic Development Alliance, "Reasons to Locate Here," available from http://www.mveda.com/html/reasons_to_locate.html; Internet; accessed 24 June 2003

⁸⁹ Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School.

Economic Development Strategies

Forbes magazine ranked Las Cruces as the number one small American city in which to start a business, but this has not yet translated into interest from corporate investors. MVEDA recently restructured itself and shifted its focus to attract new businesses to the region. It created a marketing plan for the Las Cruces area and hopes to focus its energies on specific industries that it feels have some competitive advantage. The industries that have been identified are aerospace, high technology, advanced business and financial services, maquiladora suppliers and logistics, and food processing.

MVEDA's new marketing plan and business incentives provided by New Mexico's Economic Development Department are the primary elements of the economic development strategy for the area. There is some recognition that the region must address how to commercialize the research conducted at the government research bases and university.

University

New Mexico State University is a land-grant institution and has more than 24,000 students. Major degree fields include engineering, business and administrative services, engineering, social sciences, and protective services.

Table 14: New Mexico State University Significant Degree Categories

Significant Degree Categories, 1999-2000
1. Education
2. Business, Management, Marketing, and Related Support Services
3. Engineering
4. Social Sciences
5. Protective Services
6. Health Professions and Related Clinical Services
7. Computer and Information Sciences and Support Services
8. Biological and Biomedical Sciences
9. Public Administration and Services

Source: National Center for Education Statistics, 2003. Analysis by Center for Economic Development.

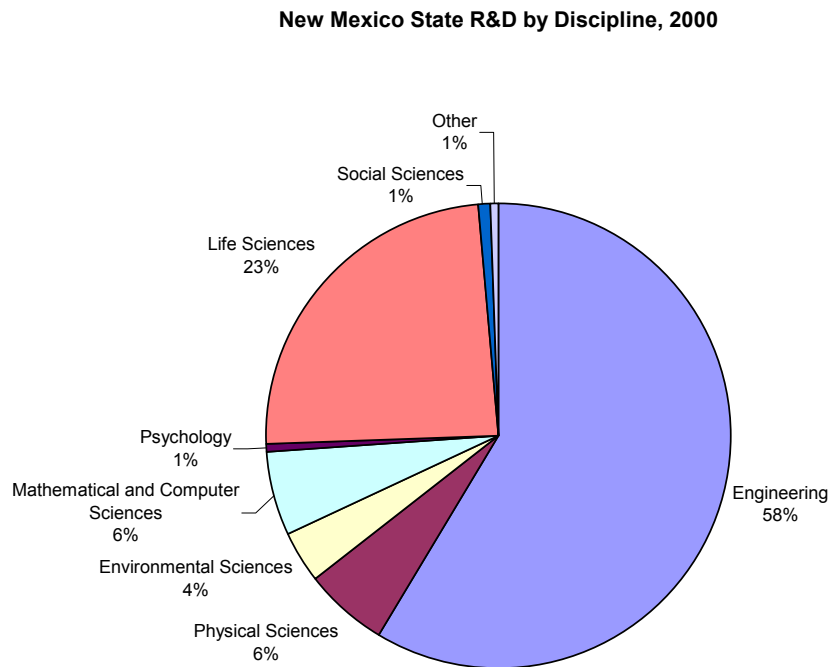
The university recently created the Technology Transfer Corporation. The TTC is a not-for-profit corporation that will assist in the development and marketing of university technology and intellectual properties.⁹⁰ The establishment of this corporation provided a more concerted effort to drive commercialization of research. While there are few formal ties between the university and regional economic development agencies, the business school on occasion collaborates with the state's economic development department. A university official noted that NMSU recently worked with the state on a

⁹⁰ New Mexico State University "Technology Transfer Corporation," available from <http://www.nmsu.edu/manual/chapter02/2.68.html>; Internet; accessed 26 August 2003.

proposal for Boeing to consider New Mexico for construction of a new assembly plant. In June, a Technology Research Corridor was established to unify the technology-research efforts of universities in the region.

The university is home to NASA's only space grant program in New Mexico and it also houses the Physical Science Laboratory which works as a non-profit aerospace testing facility for government and private industry and the Department of Energy's Waste-management Education & Research Consortium. Several observers expressed the need to involve the university in regional economic development activity and to transfer research conducted there to private enterprise.⁹¹

Figure 17: New Mexico State R&D by Discipline, 2000



Total research and development expenditure at New Mexico State University was \$79,695,000 in 2000. Fifty-eight percent of that expenditure was in engineering, and approximately half of that total was in aerospace.

⁹¹ Las Cruces interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Anjani Datla, between June and August 2003

Aerospace

Driven by federal aerospace research in the region, aerospace is a major industry in the Las Cruces region. Aerospace is the largest R&D target at NMSU, and there are several research assets at the university supporting the aerospace industry. Major research initiatives focused on aerospace are listed below.

Center for Aerospace Science, Technology, and Education – CASTE is a consortium of 12 research and education centers at New Mexico State University. CASTE supports space-related education programs, focusing on involving New Mexico residents in space programs. More than sixty researchers and educators from different NMSU departments are involved in CASTE.⁹²

New Mexico Space Grant Consortium - The mission of NMSGC is to encourage every citizen of New Mexico to participate in the economic, education, and scientific benefits of space. New Mexico State University is the lead institution in NMSGC.⁹³

Physical Sciences Laboratory – The Physical Sciences Laboratory is comprised of a number of divisions, many of which have aerospace applications. The Telemetry and Missile Systems provides engineering services for NASA, and the Suborbital Center for Excellence promotes research and outreach in suborbital space engineering. Other divisions include Unmanned Aerial Vehicles, the National Scientific Balloon Facility, and Modeling and Simulation.⁹⁴

Agriculture

Another cluster of interest in Las Cruces, which is surrounded by rural areas, is agriculture. Within the College of Agriculture and Home Economics at NMSU, there are a number of initiatives with an agricultural focus.

The Agriculture Experiment Station works to enhance agricultural profitability, to stimulate economic development using natural resources, and to manage and protect natural resources.⁹⁵

The New Mexico Agricultural Mediation Program – This program works with the U.S. Secretary of Agriculture, and provides mediation on agricultural issues including: wetlands determinations; compliance with farm programs; conservation programs;

⁹² “Center for Aerospace Science, Technology and Education,” available from <http://spacegrant.nmsu.edu/caste/>; Internet; accessed 1 December 2003.

⁹³ “New Mexico Space Grant Consortium,” available from <http://spacegrant.nmsu.edu>; Internet; accessed 1 December 2003.

⁹⁴ “Physical Science Laboratory,” available from <http://www.psl.nmsu.edu/>; Internet; accessed 1 December 2003.

⁹⁵ “Research: Agricultural Experiment Station,” available from <http://cahe.nmsu.edu/aes/>; Internet; accessed 1 December 2003.

agricultural credit; rural water loan programs; grazing on Forest Service lands; pesticides, and other issues.⁹⁶

The New Mexico Certified Crop Adviser Program – This is a certification program in agriculture housed at the NMSU College of Agriculture and Home Economics.⁹⁷

State

The total state budget for economic development is \$12,368,800. New Mexico has twenty five state-incentive programs in economic development. The state uses a variety of programs to encourage economic development in the state, including bonds, tax credits, and grants. New Mexico provides a significant portion of its incentives through loans. The state is particularly focused on direct financing, and provides more than incentives in this area than all the states studied. New Mexico also has one of the most aggressive training-incentive packages in the country. The Industrial Development Training Program provides classroom and on-the-job training, paying from 50 percent to 65 percent (depending on geographic location in the state) of employee training costs and wages for an expanding or relocating business for up to six months.⁹⁸

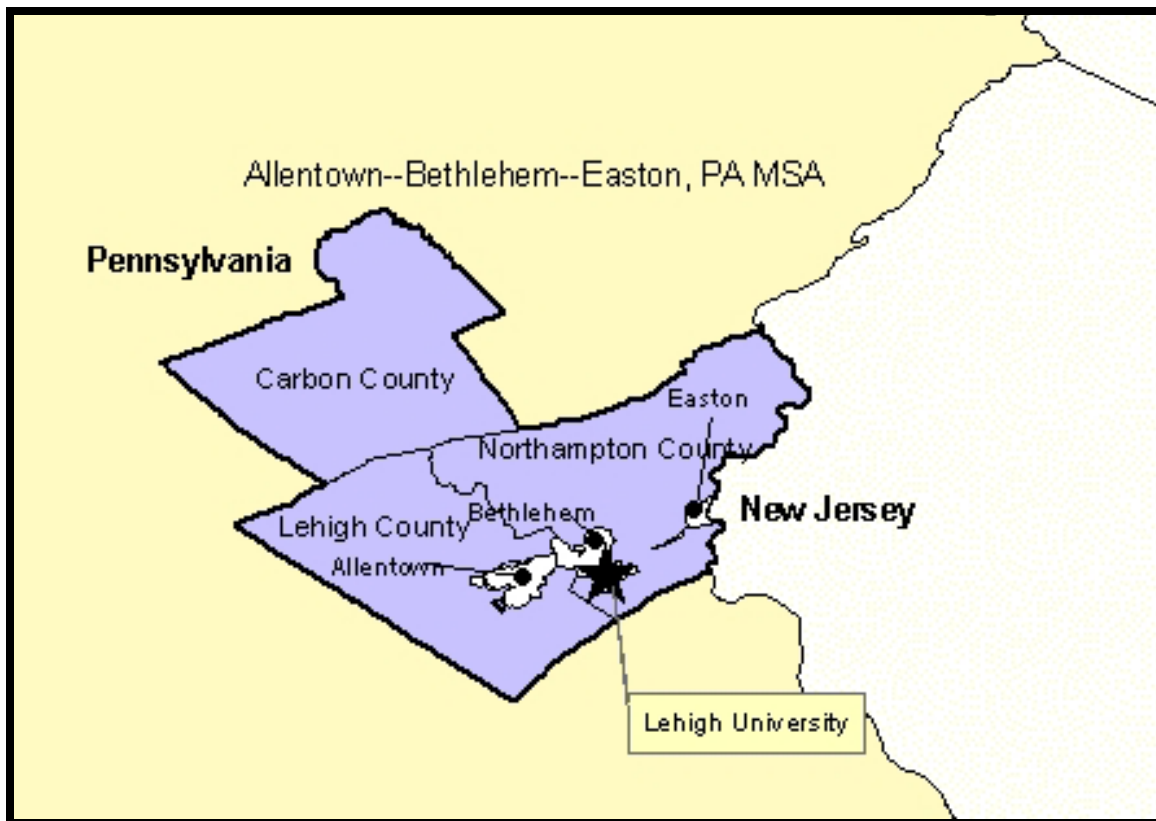
⁹⁶ “Solutions for New Mexico Issues,” available from http://cahe.nmsu.edu/task_force.html#mediation; Internet; accessed 1 December 2003.

⁹⁷ “Crop Consultant Advisers,” available from <http://cahe.nmsu.edu/employee/cca/>; Internet; accessed 1 December 2003.

⁹⁸ New Mexico Business Incentives, “August 2003 Update,” available from <http://www.edd.state.nm.us/FACTBOOK/PDF/incentives.pdf>; Internet; accessed 24 June 2003.

Lehigh University / Lehigh Valley (Allentown)

Regional Context



The Lehigh Valley region corresponds with the borders of the Allentown-Bethlehem-Easton metropolitan statistical area, which (as of April, 2003) included Northampton, Carbon and Lehigh counties, as well as the three urban areas Allentown, Bethlehem, and Easton.⁹⁹ The MSA is located 65 miles north of Philadelphia, PA, and 95 miles west of New York City.

The economic focus of the region has broadened from the Allentown-Bethlehem-Easton axis to the Valley as a whole. In 1994, the Postal Service's plan to bring the country's bar-coding service to the Lehigh region generated significant inter-community

⁹⁹ As of June, 2003, the Allentown-Bethlehem-Easton MSA also includes Warren County, NJ. Because our period of analysis predates this change, we did not include Warren County in our definition of the MSA.

competition, though the facility was eventually situated to service the entire area.¹⁰⁰ Today, the Lehigh Valley Economic Development Corporation (LVEDC, est. 1995) is seeking to avoid such conflicts by promoting regional unity and acting as a marketing arm for the region.¹⁰¹ A great deal of activity in Economic development, workforce initiatives (through Lehigh Valley CareerLink and the Workforce Investment Board), and planning (through the Lehigh Valley Planning Commission), now takes place at a regional level. Regional business associations, such as the Lehigh Valley Chamber of Commerce (GLVCC), are increasing membership and taking precedence over local groups; the GLVCC is currently the second largest Chamber of Commerce in Pennsylvania.¹⁰²

Table 15: Lehigh Valley Economic Statistics

	Allentown-Bethlehem-Easton MSA	United States
Employment Growth 1990-2000	13.2%	18.6%
Unemployment 2002	5.7%	5.80%
	Allentown-Bethlehem-Easton MSA	Percent of United States
Median Household Income 1999	\$43,098	102.63%
Per Capita Income 1999	\$21,243	98.4%

University

Lehigh University is a private university located in Bethlehem, Pennsylvania, and is the only private university in this study. Lehigh has 6,579 total students, 4,650 of which are undergraduates. Lehigh is comprised of four colleges: the College of Business and Economics, the College of Arts and Sciences, the P.C. Rossin College of Engineering and Applied Science, and the College of Education. One thousand and seventy nine bachelor's degrees were conferred in 2002; the most popular programs are business management and administrative services, engineering, social sciences and history, computer and information sciences, and psychology.¹⁰³ Subject areas where Lehigh issues a disproportionately high number of degrees include engineering, architecture, the physical sciences, and science technologies/technicians.

¹⁰⁰ Matt Assad, "Forget the Old ABE and Celebrate the Valley, Marketing Folks Say," *The Morning Call*, 9 March 2003 [journal online]; available from <http://web.lexis-nexis.com/universe>; Internet; accessed 29 May 2003.

¹⁰¹ Lehigh Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

¹⁰² Lehigh Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

¹⁰³ National Center for Education Statistics, "Lehigh University," available from <http://nces.ed.gov/ipeds/cool/Programs.asp?UNITID=213543>; Internet; accessed 15 September 2003.

Table 16: Lehigh University Significant Degree Categories

Significant Degree Categories, 1999-2000
1. Engineering
2. Physical Sciences
3. Science Technologies/Technicians
4. Architecture and Related Programs
5. Philosophy and Religion
6. English Language and Literature/Letters
7. Mathematics and Statistics
8. Biological and Biomedical Sciences

Source: National Center for Education Statistics, 2003. Analysis by Center for Economic Development.

Economic development of the Lehigh Valley has been a high-level priority for the university, particularly in the area of industrial partnerships. President Farrington has a dedicated page on economic development on his website, defining the university's stake in the success of its region in pragmatic terms, describing the success of both entities as "interwoven".¹⁰⁴ Accordingly, the President's Office maintains paid positions in federal, state, and community relations. In addition, the Office of Corporate and Foundation Relations, the Vice Provost for Research, and the Office of Government Relations have frequent interactions with regional industry and community groups. The combined effect of Lehigh's various economic development programs has been an enhancement of the regional economy, particularly in South Bethlehem.¹⁰⁵ In 1998 a study by Human Capital Research Corp of Chicago estimated the economic impact Lehigh University to be \$370.8 million.¹⁰⁶

Other entities within the university support a variety of centers that assist local companies. Major resources include the Manufacturers Resource Center, which works with manufacturing companies, both nationally and in the region; the Small Business Development Center (located in the College of Business and Economics), which is one of the oldest SBDCs in the country and consults with local entrepreneurs on a variety of small-business related topics; and the Ben Franklin Technology Center, which is located on the Lehigh campus, and helps to support technology-based economic development. The Ben Franklin incubator, also on the Lehigh campus, has spun-out a fair number of local companies, and won the 2001 "Incubator of the Year" award in the technology division from the National Business Incubation Association.¹⁰⁷ Lehigh faculty and staff

¹⁰⁴ Lehigh University Website. "Lehigh University – About: Economic Development Engine."

<http://www3.lehigh.edu/about/economicdevelopment.asp>; Internet; accessed 15 September 2003.

¹⁰⁵ Lehigh Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

¹⁰⁶ Christina Gostonski, "Eleven area colleges are a major force in Valley's economy," *The Morning Call*, 9 March 2003 [journal online]; available from <http://web.lexis-nexis.com/universe>; Internet; accessed 29 May 2003.

¹⁰⁷ "2001 Incubator Award Winners," available from http://www.nbia.org/awards_showcase/2001/2001_incubator.php; Internet; accessed September 15, 2003.

play leadership roles on boards and committees of all four of these organizations, as well as on the board of the LVEDC.¹⁰⁸

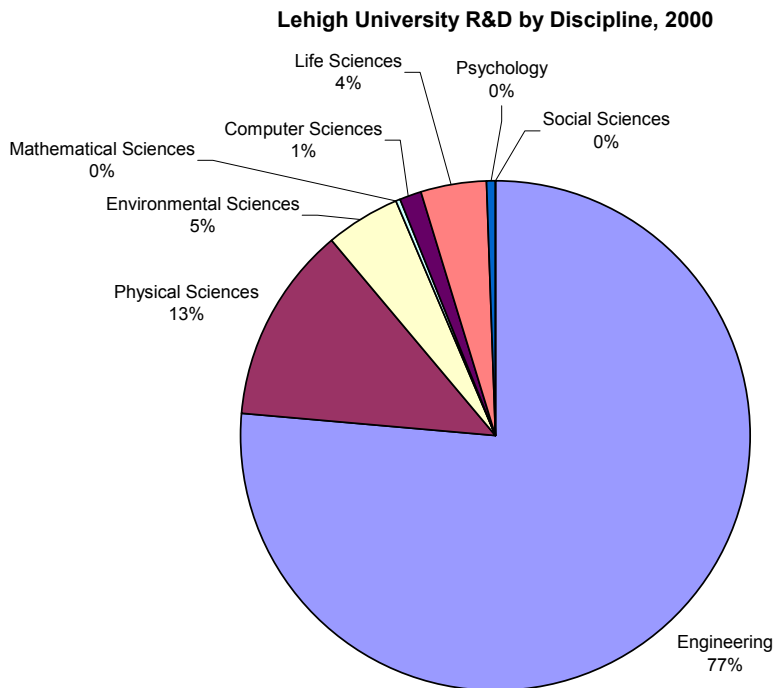
The College of Business and Economics provides a great deal of business expertise to companies in the Lehigh Valley. Besides the SBDC, the Musser Center for Entrepreneurship consults with small firms and start-ups, and allows students to consult directly with local small businesses. The Lehigh CORPS engages students in projects in the area focusing on regional and urban economic development. Technology transfer activity at Lehigh is handled by the Office of Research and Sponsored Programs, and the University recently received a state grant to improve its technology transfer program.

Lehigh has 25 research centers and institutes pursuing research in science, engineering and the humanities.¹⁰⁹ Engineering is a major funding target at Lehigh; seventy-six percent of R&D expenditures at Lehigh are spent in engineering. Within engineering, the largest subsectors are civil engineering and chemical engineering.¹¹⁰ These figures are for 2000 and some sectors may have gained emphasis since the publication of these statistics. For example, these figures do not include a bioengineering program begun in 2002 that recently received \$1.38 million in funding from the National Science Foundation.

¹⁰⁸ Lehigh Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

¹⁰⁹ "Lehigh University – Research: Centers and Institutes", available from <http://www3.lehigh.edu/research/recenters.asp>; Internet; accessed 13 October 2003.

¹¹⁰ National Science Foundation, Survey of Research and Development Expenditures at Universities and Colleges.

Figure 18: Lehigh University R&D by Discipline, 2000

Source: National Science Foundation, available from <http://caspar.nsf.gov>; Internet; accessed 13 October 2003.

All Lehigh research centers have unique connections to local companies, some formal and some informal. Lehigh's Integrated Product Development Program assists regional companies in developing new products and business plans; the university recently invested \$5 million to renovate a local facility in the region which will serve as office space for technology ventures resulting from this program. A formal mechanism for transferring knowledge at Lehigh to local industry, the Industrial Liaison Programs span across the university, and connect Lehigh research with local industry.¹¹¹ Chemicals and the life sciences (particularly medical devices) are two areas of interest, based on research expertise at Lehigh and economic activity in the Lehigh Valley.

¹¹¹ Lehigh Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

Chemicals and Allied Products

Chemicals and allied products is a cluster in the Lehigh Valley that has been targeted as “emerging” by the Lehigh Valley Economic Development Corporation. Employment in this cluster grew by 9 percent between 1995 and 2000, and as of 2000, the average wage in the sector was \$76,837. The third largest employer in the Lehigh Valley, Air Products and Chemicals, is in the chemicals field. Lehigh has many research centers that are well-equipped to work with this sector, including:

- Center for Advanced Materials and Nanotechnology
- Center for Polymer Science and Engineering
- Chemical Process Modeling and Control Research Center
- Materials Research Center
- Polymer Interfaces Center
- Emulsion Polymers Institute
- Center for Manufacturing Systems Engineering

The Center for Polymer Science and Engineering is an interdisciplinary center combining students and faculty from chemistry, chemical engineering, materials science and engineering, mechanical engineering and mechanics, and physics, to perform research in polymers.¹¹²

The Emulsion Polymers Institute conducts research in the area of polymer colloids, focusing on the preparation, characterization, and application of polymer latexes.¹¹³

Life Sciences

Another area of interest for this study is the life sciences, particularly medical devices. Because life sciences is a younger industry in the Lehigh Valley and a more recent focus at Lehigh, there has not been as much established growth. However, medical devices is a rapidly growing subsector. According to the Cluster Mapping Project at the Harvard Business School’s Institute for Strategy and Competitiveness, between 1990 and 2001 medical devices has been the fifth largest jobs producer among

¹¹² “Center for Polymer Science and Engineering,” available from <http://www.lehigh.edu/~esd0/cpse/home.html>; Internet; accessed 13 October 2003.

¹¹³ “Emulsion Polymers Institute,” available from <http://www.lehigh.edu/~esd0/epihome.html>; Internet; accessed 13 October 2003.

all traded clusters in the region.¹¹⁴ OraSure, a company that manufactures oral HIV test and which spun-out of the Ben Franklin incubator, has grown a great deal and is mentioned by many economic development professionals as one of the region's most successful spin-outs; it is now the 147th largest employer. B. Braun, a manufacturer of disposable surgical and medical supplies, is the 19th largest employer in the Lehigh Valley.¹¹⁵ Lehigh University has biology and engineering majors, and recently received \$1.38 million from the National Science Foundation to enhance its bioengineering program.

- Institute for Biomedical Engineering and Mathematical Biology
- Center for Advanced Materials and Nanotechnology
- Biopharmaceutical Technology Institute
- Materials Research Center
- Center for Optical Technologies
- Bioengineering Program
- Biology Program

The Center for Optical Technologies has received a great deal of attention for being a leader in optics research in the country, and has attracted some commercial activity to the region. Much of this optics research has applications in the life sciences field.

The Biopharmaceutical Technology Institute focuses on the improvement of processes in biotechnology and in pharmaceuticals.¹¹⁶

Critical Industries

The Lehigh Valley region suffered a decline following the loss of its primary industry, steel manufacturing; employment in the Lehigh Valley declined by 0.7% between 1985 and 1990, a period of major Bethlehem Steel lay-offs.¹¹⁷ Diversification efforts have brought some new jobs to the region and maintained median incomes similar

¹¹⁴ Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School. Traded clusters sell products across different economic areas.

¹¹⁵ Lehigh Valley Economic Development Corporation, "Estimated Local Employment at Lehigh Valley Employers (9/23/2003)", available from http://www.lehighvalley.org/assets/pdfs/econ/Employ_largest.pdf; Internet; accessed 13 October 2003.

¹¹⁶ "Biopharmaceutical Technology Institute," available from <http://www.lehigh.edu/~jth0/bti.html>; Internet; accessed 13 October 2003.

¹¹⁷ Bureau of Economic Analysis.

to national levels, but employment growth, overall, has lagged behind national rates. Today, the largest employers in the Lehigh Valley are in the medical field.¹¹⁸ In addition, the fastest growing industries are mostly service-oriented rather than goods-producing. They include: financial services, business services, hospitality and tourism, and education and knowledge.¹¹⁹ The LVEDC has recently identified “critical industry” clusters in the Valley including chemical and allied products, health-related companies, technology intensive manufacturing/service companies, engineering management and business consulting firms, and financial and insurance services companies. The LVEDC, along with other economic development groups in the Lehigh Valley, plans to collaborate in creating economic development strategies around these targeted clusters.¹²⁰

Economic Development Strategies

Since the early 1990s, the Lehigh Valley has been organizing a regional economic strategy. Because this expanded regional identity is fairly recent, the first step is transitioning economic development strategy from a local to a regional geography. The LVEDC, originally created to market the valley as a single entity, has also been charged with coordinating economic development strategy, and has been working to identify target clusters for development efforts.

During the 1990s, economic development strategies aimed to position the Lehigh Valley as a high-tech center, with some success: 65 high-technology companies moved into the region in the latter part of the decade.¹²¹ However, cost of production and international labor competition has caused this sector to take a major hit. Agere Systems, formally part of Lucent Technologies, decided in 2003 to move its manufacturing operations outside of the country, closing manufacturing operations in the region. After the plants shut down, Agere will employ 2,000-3,000 people in the region, down from a high of over 6,000 in the 1980s.¹²² Presently, economic development strategies focus on diversification of the economy, and strengthening such industries as food production, plastics, technology, and health care.¹²³ Because of regional hospital and long term care facility assets, health care has been a major focus. The area also has a significant presence in chemicals; the region’s second largest employer is Air Products and Chemicals. Regional groups are currently looking to position the Lehigh Valley as a major location for biotech firms. Statistically, restructuring efforts have been relatively

¹¹⁸ Gary Karp, “Health Care Dominates Local Employers,” *The Morning Call* 5 January 2003; [journal online]; available from <http://web.lexis-nexis.com/universe>; Internet; accessed May 22, 2003.

¹¹⁹ Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School.

¹²⁰ Lehigh Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

¹²¹ Claudia H. Deutsch, “Eastern Pennsylvania Region Recovers by Turning to Technology Companies.” *The New York Times* 7 October 1999 [journal online]; available from <http://web.lexis-nexis.com/universe>; Internet; accessed 3 June 2003.

¹²² Jeanne Bonner, “The Factory Made Memories” *The Morning Call* 18 May 2003 [journal online]; available from <http://web.lexis-nexis.com/universe>; Internet; accessed 29 May 2003.

¹²³ Lehigh Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

successful—regional per capita income was \$30,317 in 2001, 100 percent of the nation-wide average, and unemployment was 5.7 percent in 2002, 0.1 percent lower than the US rate.¹²⁴

There has also been a focus in the Lehigh Valley on developing industrial parks, and Lehigh Valley Industrial Park, Inc., founded by the Bethlehem Area Chamber of Commerce, is a non-profit organization devoted exclusively with this singular focus. Regional industrial parks have been largely successful in attracting new companies and jobs, but there is concern that this has had a negative effect on the urban areas of Bethlehem, Easton, and Allentown.¹²⁵ Revitalization of these urban cores is another focus of economic development strategies.

State

Pennsylvania state government is very active in economic development and has a substantial history in the area; the state spent \$656.9 million on economic development in fiscal year 2001. A significant portion of state-funded programs are organized and operated regionally, and counties and municipalities play substantial roles. The Pennsylvania Department of Community and Economic Development funds programs encouraging entrepreneurship, venture financing, technology transfer, small businesses development, and technology development.

Pennsylvania has more state incentive programs than any other state in this study (37), most of which are direct financing programs. Pennsylvania spends a great deal of resources developing these incentives, and is particularly focused on technology-based economic development through its Ben Franklin program. The state has also invested a great deal in regional biotechnology strategies, and Lehigh University is a partner in the Life Sciences Greenhouse of Central Pennsylvania, part of a statewide DCED initiative. Pennsylvania has also stressed the role of universities as a key resource in regional economies, and funds programs to encourage the transfer of technology from university campuses to regional industry. A recent initiative of the Rendell Administration, the Keystone Innovation Zone program, focuses on the link between universities and their regional economies by offering tax breaks and incentives to businesses that locate near colleges and universities.

¹²⁴ Bureau of Labor Statistics/Local Area Unemployment Statistics.

¹²⁵ Lehigh Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

West Virginia University / Morgantown

Regional Context



Historically, West Virginia's wealth has come from natural resource production and heavy manufacturing, much like its neighbors Pennsylvania and Ohio. However, when these industries became unprofitable in the 1980s, West Virginia's economy did not restructure, as did the neighboring states'.¹²⁶ As a result, economic development in the state has lagged behind national growth; per capita income in West Virginia's is \$22,862, 75 percent of the national average, ranking it 48th in the nation in 2001 (ahead of Arkansas and Mississippi).¹²⁷

Monongalia County, however, is one of the strongest economic regions in the state. Located 75 miles south of Pittsburgh, Pennsylvania, per capita income in the county was 85 percent of the national average in 2001, making it the sixth richest county in West Virginia. Its main city, Morgantown, is the fastest growing city in the state.¹²⁸

¹²⁶ Randy Coleman, "West Virginians ready for economic change, study says" *The Associated Press*, (15 December 2000; available from <http://www.wvaftercoal.org/stories/market.html>; Internet; accessed 5 June 2003.

¹²⁷ "Bureau of Economic Analysis/State Bearfacts for 2000-2001,"; available from <http://www.bea.gov/bea/regional/bearfacts/stbf/>; Internet; accessed 5 June 2003.

¹²⁸ Morgantown Area Economic Partnership, "A Brief Community and Economic Profile Morgantown and Monongalia County, West Virginia"; available from <http://www.morgantown.org/community.shtml>; Internet; accessed 5 June 2003.

Growth has been significant enough that the county was designated as the Morgantown Metropolitan Statistical Area in 2003.¹²⁹

Because of its economic strength and the presence of West Virginia's only major research university, the county is often a feature of state economic plans. Regionalism is an evolving concept in the area. Locally, the region is described as the Morgantown area, mostly referring to Monongalia County. With the recent metropolitan designation, the region includes Preston County as well. The Morgantown Area Economic Partnership serves both of these counties. There is also a regional planning organization that comprises Doddridge, Harrison, Marion, Monongalia, Preston and Taylor counties, but this aggregation is not widely recognized as an economic region. More commonly, Morgantown is considered part of a technology corridor along I-79 from Lewis County to the Pennsylvania border, or even extending into southwestern Pennsylvania to Pittsburgh.¹³⁰

Table 17: Monongalia County Economic Statistics

	Monongalia County	US
Economic Growth 1990-2000	17.7%	18.6%
Unemployment 2002	2.8%	5.8%
	Monongalia County	Percent of US
Median Household Income 1999	28,625	68.2%
Per Capita Income 1999	17,106	79.2%

University

West Virginia University is the largest single-site employer in Monongalia County, employing almost twice as many people as the next largest employer, WVU hospitals.¹³¹ It is one of the nation's top research universities and the only nationally recognized research university in West Virginia. In 2000, WVU ranked 118th in federal science and engineering obligations and 74th in full-time graduate students.¹³² WVU's role in local economic development efforts has become more important with the introduction of several federal facilities. Programs in forensics and energy research are being targeted to benefit from and bolster these other institutions.

¹²⁹ Morgantown Area Economic Partnership, "2003 Economic Outlook for the Greater Morgantown Area"; available from <http://www.morgantown.org/forecast.shtml>; Internet; accessed 5 June 2003.

¹³⁰ Morgantown interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, between June and August, 2003.

¹³¹ Morgantown Area Economic Partnership, "Major Employers," available from <http://www.morgantown.org/employers.shtml>; Internet; accessed 5 June 2003.

¹³² National Science Foundation, Academic Institutional Profiles.

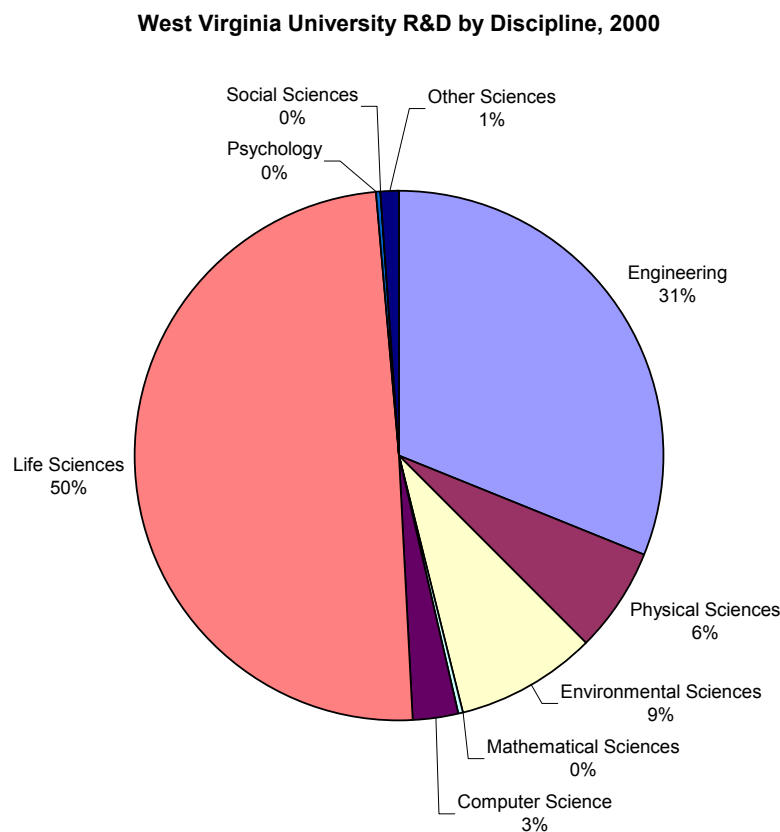
Table 18: West Virginia University Significant Degree Categories

Significant Degree Categories, 1999-2000
1. Agriculture
2. Natural Resources and Research
3. Family and Consumer Sciences/Human Sciences
4. Engineering
5. Parks, Recreation, Leisure and Fitness Studies
6. Communications
7. Public Administration
8. Foreign Languages
9. Multi/Interdisciplinary Studies
10. Law and Legal Services
11. Physical Sciences

Source: National Center for Education Statistics, 2003. Analysis by Center for Economic Development.

According to some officials, technology transfer is in a “maturation” phase at WVU. The university has only had a tech-transfer office since 1999, and different departments have traditionally been fairly autonomous in their efforts. A significant amount of technology was developed on a contract basis for individual companies. These companies, however, were often not locally based and few spin-offs emerged. WVU’s main role in local economic development efforts has therefore been to help attract federal jobs in conjunction with regional efforts, rather than to generate employment independently.¹³³ This role seems to be changing with the new emphasis on technology transfer and the active pursuit of new clusters established with federal support.

¹³³ Morgantown interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Jerry Paytas and Alexis Haakensen, between June and August 2003.

Figure 19: West Virginia University R&D by Discipline, 2000

Health, Biotechnology, and Life Sciences

Research expenditures at West Virginia University totaled more than \$66 million in 2000. Life sciences comprised almost fifty percent of that sum, with about half going to medical sciences and the rest distributed between biological and agricultural sciences. Much of WVU's research complements work done at federal facilities in the region. For example, the Forensics Identification Program, which provides multidisciplinary education for students with strong math and sciences backgrounds, complements the FBI facility in Clarksburg. Students and faculty at the Health Science Center also collaborate with researchers at the National Institute for Occupational Health and Safety, which is adjacent to WVU's facility. Other centers related to the universities growing life sciences activities include:

- Center for Identification Technology Research
- Blanchette Rockefeller Neurosciences Institute
- Center for Advanced Imaging
- Sensory Neuroscience Research Center

- Center of Biomedical Research Excellence

The Center for Identification Technology Research (CITeR) is a National Science Foundation (NSF) Industry/University Cooperative Research Center (IUCRC) focusing on biometrics. It is a membership-based organization whose members meet twice a year to approve new projects and receive updates on running projects. In addition, members may oversee projects of particular interest. Research topics at CITeR include biometric imaging/signal processing, biometric sensing/analysis, biometric system statistical design/evaluation, and biometric information assurance.

Center of Biomedical Research Excellence - This research center is located at the Mary Babb Randolph Cancer Center and was established with funding from the National Institute of Health. The Center's mission is to study how signaling proteins cause and affect cancer. Research focuses on developing new treatments based on proteomic proteins.

Engineering

The second important category of research at WVU is engineering, with about half of the funding going towards mechanical engineering. As above, several of the research centers have connections to government facilities. A sampling of these are:

- NASA Independent Verification and Validation Facility
- NASA West Virginia Space Grant Consortium
- National Research Center for Coal and Energy
- Coal and Energy Research Bureau

NASA Independent Verification and Validation Facility – The NASA IV&V Center was founded in 1993 to maintain the safety and cost-effectiveness for mission critical software, a mission resulting from the Challenger incident in 1986.

National Research Center for Coal and Energy - This Center addresses current issues related to energy and the environment through research, training, and technology transfer. It incorporates a number of smaller research centers and programs that encompass a variety of topics, including alternative fuels, mine land reclamation, and water research. Based at WVU, the Center also collaborates with other academic institutions and private research facilities.

Critical Industries

The economy in the Morgantown area is becoming more diversified. According to County Business Patterns, traditional industries such as mining and manufacturing only account for more than 8 percent of the workforce, while health care has become the major employer.¹³⁴ A report by the Bureau of Business and Economic Research at West Virginia University details that “strong gains in services and government combined with modest gains in trade” compensated for job losses in mining, construction, manufacturing, and other industries in the 1990s.¹³⁵ The clout of United States Senator Robert Byrd and Congressman Alan Mollohan has helped secure national research facilities that are introducing new types of jobs to the area. Morgantown is currently trying to develop an identity in areas like forensics and biometrics.

The region has a significantly higher percentage of residents with bachelor’s degrees than the state on the whole (21.1 percent compared to 14.8 percent), but this figure is below the national average (24.8 percent). There is also a basic population problem—there are only 82,000 people in the area. The recent trend of population growth may alleviate this. Finally, the close proximity of Pittsburgh could be complementary or competitive to Morgantown’s efforts. At the very least, the presence of Pittsburgh to the north provides opportunities lacking in more remote parts of the state.

Economic Development Strategies

At the local level, Senator Byrd and Congressman Mollohan are key figures in economic development. They have been able to bring research institutions and federal development dollars to the state. These actions have helped shape local development strategies, particularly in the Morgantown area. The local economic development community is interconnected through a number of individuals, who serve on the boards of all major development groups. Collaboration amongst these groups is therefore relatively strong.

Economic development strategies are focused on bringing a high-tech identity to the area, developing the health sciences cluster, and strengthening entrepreneurship. The federal research centers are concentrated in the I-79 High-Tech Corridor, with West Virginia University in Morgantown serving as the “anchor.” The Small Business Development Center in Morgantown is also working to strengthen West Virginia’s entrepreneurship sector.

¹³⁴ US Census Bureau, “North American Industry Classification System/County Business Patterns,” available from <http://censtats.census.gov/cbpnaic/cbpnaic.shtml>; Internet; accessed 4 June 2003.

¹³⁵ George Hammond “Executive Summary,” *I-79 High Tech Corridor Region Outlook* (Morgantown: Bureau of Business and Economic Research, West Virginia University): 1.

State

West Virginia has developed its Vision Shared program as a “blueprint for economic development and growth.”¹³⁶ It targets four main areas to transition West Virginia away from its old mining and manufacturing base: creating an intellectual infrastructure, diversifying the economy, creating a results-based state government with an eye to reform, and building regional partnerships. This effort has resulted in several legislative changes, such as reworking the tax system and creating state funding for venture capital. West Virginia currently has 19 incentives programs, most of which are provided by the West Virginia Development Office. Approximately half of these are tax credits and exemptions, while the other half provides direct and indirect financing through bonds, equity, grants, guarantees, and loans. The total West Virginia budget for Economic Development was \$99 million in 2001.

Legal and political issues have hampered the West Virginia Development Office’s effort to distribute money throughout the state. Nonetheless, the Office is moving forward and the state has several initiatives to spur growth throughout the state. For example, Senate Bill 646 promotes the creation of non-profit centers for economic development and technology advancement in association with each of the state’s doctoral institutions. These centers will work to increase technology commercialization and industry-university partnerships. The legislature has also called for the creation of the West Virginia Academy of Science and Technology. The Academy’s mission is to promote research and technology commercialization and will be responsible for benchmarking science and technology progress in the state, coordinating efforts to attract private and federal funding, and strengthening collaboration and leadership across the state.

¹³⁶ West Virginia Development Office, “West Virginia: A Vision Shared,” available from <http://www.wvdo.org/vision.htm>; Internet; accessed 4 September 2003.

Virginia Polytechnic University (Virginia Tech)/ New River Valley

Regional Context



Virginia Tech is located in the New River Valley Planning District, 42 miles west of Roanoke and 122 miles northwest of Winston-Salem, NC. The District, comprised of Montgomery, Pulaski, Giles, and Floyd Counties, as well as Radford City,¹³⁷ is the widely recognized regional definition. The major towns are Blacksburg and Christiansburg, the former being home to the region's largest employer, Virginia Tech. In 2003, the Office of Management and Budget designated the entire region, except for Floyd County, as an MSA.

The region experienced modest economic growth during the 1990s. Although per capita personal income is only 80 percent of the US average, this is up from 75 percent in 1989. Employment growth (12.8 percent from 1990-2000) was below the national rate, while unemployment (4.2 percent) is better than the national average.

The New River Valley and Roanoke are distinct regions, but they have a history of collaboration that is growing stronger. The regions' main development groups—the New River Valley Economic Development Alliance and the Roanoke Valley Economic Development Partnership—work together, as do the respective regional commissions.

¹³⁷ Virginia has independent cities that are counted separate from the county.

One project to connect the two areas was proposed in 1989 and has resulted in the construction of the “Smart Road,” a unique transportation research facility at Virginia Tech. Amongst other initiatives—such as attracting a discount airline to the region and establishing a regional name—the New River Valley and Roanoke Valley District Planning Commissions produced a joint strategy in 2002.¹³⁸

Table 19: New River Valley Economic Statistics

	New River Valley	United States
Employment Growth 1990-2000	12.8%	18.6%
Unemployment 2002	4.2%	5.8%
	New River Valley	Percent of United States
Median Household Income 1999	32203	76.7%
Per Capita Income 1999	17284	80.1%

University

Table 20: Virginia Tech Significant Degree Categories

Significant Degree Categories, 1999-2000
1. Family and Consumer Sciences/Human Sciences
2. Agriculture, General
3. Natural Resources and Research
4. Engineering
5. Architecture and Related Programs
6. Mathematics and Statistics
7. Agriculture and Related Sciences
8. Biological and Biomedical Sciences
9. Physical Sciences

Source: National Center for Education Statistics, 2003. Analysis by Center for Economic Development.

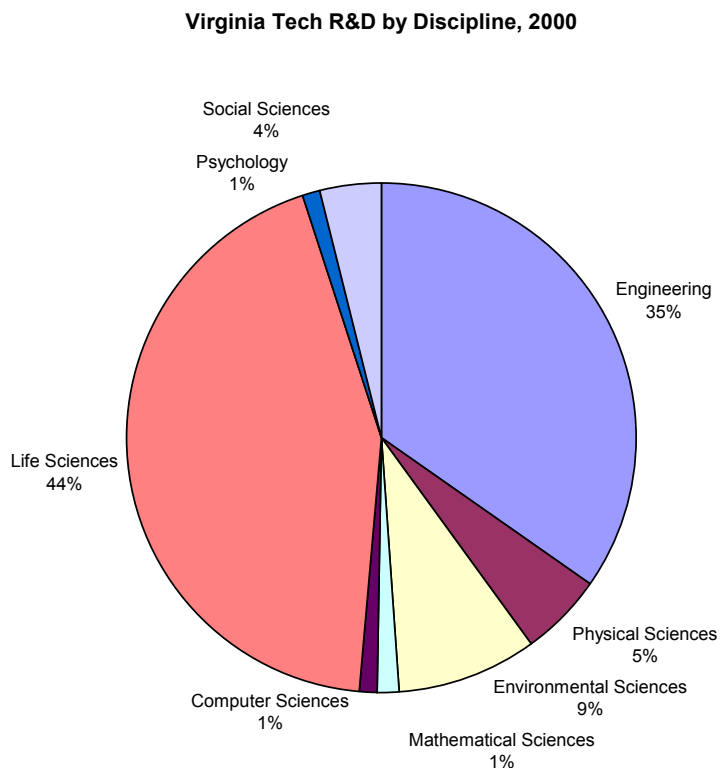
Virginia Tech is the largest university in the Commonwealth of Virginia and one of the nation’s top 50 research universities.¹³⁹ Virginia Tech has more than 100 centers and institutes pursuing research in a wide variety of fields. Major degree fields include agriculture, architecture, biology and biomedicine, engineering, mathematics and statistics, natural resources and research, and physical sciences. The Corporate Research Center has more than 100 businesses conducting research in agriculture, biotechnology, design automation, diagnostics, electronics, engineering, environmental engineering,

¹³⁸ Paul Dellinger, “Economic leaders agree to unite valleys,” *The Roanoke Times*, 31 January 2002 [journal online]; available from: <http://proquest.umi.com/pqdweb?RQT=306&TS=1054919009>; Internet; accessed 6 June 2003.

¹³⁹ Virginia Tech, “About Virginia Tech, University at a Glance”; available from <http://www.vt.edu/aboutvt/universityataglance.html>; Internet; accessed 9 June 2003.

information technology, library science, materials and chemistry, and transportation. Virginia Tech Intellectual Properties, Inc. (VTIP) facilitates technology transfer at Virginia Tech. VTIP is a non-profit corporation that handles, licenses, and protects technology developed at the university.¹⁴⁰ Because it is independent, businesses do not have to participate in the state bidding system when licensing technology.¹⁴¹ Technology transfer is driven partially by the state's desire to turn public institutions into engines for economic growth and partially by the school's desire to become a top 30 research university; having a plethora of technology related-research programs helps the university attract grants to fund projects.

Figure 20: Virginia Tech R&D by Discipline, 2000



¹⁴⁰ Virginia Tech Intellectual Properties, Inc.; available from <http://www.vtip.org/>; Internet; accessed 22 September 2003. Also see Policy on Intellectual Properties, No. 13000, August 31, 1999, Section 2.4(D) "Virginia Tech Intellectual Properties, Inc. (VTIP), a non-profit corporation affiliated with the university has been established and charged with the mission of protecting and utilizing IPs for the benefit of the university. All IPs assigned to the university shall flow to VTIP by assignment for operational management." Accessed from <http://www.vt.edu/administration/policies/13000.html>.

¹⁴¹ New River Valley Interviews, conducted by Alexis Haakensen, 25 June 2003, Carnegie Mellon University, Pittsburgh, PA.

Health, Biotechnology and Life Sciences

Research expenditures at Virginia Tech totaled \$192,672,000 in 2000. The research expertise at the university is vast and interdisciplinary, making it difficult to summarize. Rather than characterize all of the resources at Virginia Tech, two areas of particular interest for our study were life sciences and transportation. Life sciences accounted for more than 40% of the R&D expenditure in 2000, with agricultural sciences comprising 76% of that total. Research in life sciences spans plant genetics, bioinformatics, biomedical engineering, biochemistry, laser surgery optics, health behaviors and public health and safety. The diversity of activity is displayed by the range of research centers involved:

- Agricultural Research and Extension Centers
- Center for Applied Behavior Systems
- Center for Biomedical Engineering
- Center for Comparative Oncology
- Center for Molecular Medicine and Infectious Diseases
- Center for Reproductive Excellence using Assisted Technology and Endocrinology
- Center for Research in Health Behavior
- Center for Self-Assembled Nanostructures and Devices
- Fralin Biotechnology Center
- Harvey W. Peters Research Center for the Study of Parkinson's Disease and Disorders of the Central Nervous System
- Human Factors Engineering and Ergonomics Center
- Optical Sciences and Engineering Research Center
- Virginia Bioinformatics Institute
- Virginia Tech Applied Biosciences Center
- Virginia Tech Center for Genomics
- Virginia Tech Horseshoe Crab Research Center

Center for Self-Assembled Nanostructures and Devices (CSAND) is a good example of the interdisciplinary nature of Virginia Tech. CSAND conducts research in a wide range of industry applications, including computing and telecommunications, but its work in nanocomposites is impacting new drugs and drug delivery systems, as well as biosensors. CSAND includes researchers from Chemistry, Physics, Chemical Engineering, and Electrical and Computer Engineering. CSAND is supported by the National Science Foundation, the U.S. Department of Energy, the Air Force, and private corporations.

The Fralin Biotechnology Center combines faculty experts in Biochemistry, Biology, Forestry, and Plant Pathology, Physiology and Weed Science. The Fralin Center is a focal point of biotechnology research, education and outreach at Virginia Tech and the state of Virginia. Research at the Fralin Center includes biochemistry, molecular biology and genetics, molecular biology and ecology, and bioinformatics. Faculty entrepreneurs from Fralin have created six local biotechnology companies.

Optical Sciences and Engineering Research Center (OSER) explores the application of optical technologies for laser surgery, advanced implant materials, non-invasive diagnostics, and drug delivery tools. The Center employs optics to provide new biological research tools for visualization, measurement, analysis and manipulation.

The Virginia Bioinformatics Institute (VBI), combines biological and computer science research to advance cutting-edge bioinformatic technologies. One of VBI's goals is to "nurture economic development in Virginia and beyond."¹⁴² Research at VBI is increasing understanding of molecular, cellular, and environmental interactions. The National Science Foundation, US Department of Agriculture, and US Department of Defense, are a few of the agencies supporting VBI's activities. VBI is also a hub of collaboration with universities such as the Johns Hopkins University and companies like IBM and Sun Microsystems, to name a few.

Transportation Technology

Virginia Tech leverages substantial engineering research into a variety of fields, with significant funding allocated to electrical, mechanical, and civil engineering projects. One field of particular importance is transportation, where Virginia Tech research spans the range from infrastructure and civil structures, such as bridges to advanced vehicles, to next generation technologies such as vehicle fuel cells. Some of the centers in this area include:

- Advanced Vehicle Dynamics Laboratory
- Center for Automotive Fuel Cell Systems

¹⁴² Virginia Bioinformatics Institute, Our Mission. Accessed on 13 October 2003 from <https://www.vbi.vt.edu/article/articlestatic/99/>.

- Center for Rapid Transit Systems
- Multidisciplinary Analysis and Design Center for Advanced Vehicles
- Virginia Cooperative Center for Bridge Engineering
- Virginia Tech Transportation Institute

The Virginia Tech Transportation Institute (VTTI) is an interdisciplinary research center that is part of the U.S. Department of Transportation's University Transportation Centers Program. VTTI pursues research, education and technology to advance transportation safety and efficiency. VTTI unites a variety of science and engineering departments with social science. VTTI is funded by a diverse array of federal agencies, the Virginia Department of Transportation and numerous corporations such as General Motors, Volvo Heavy Truck, SAIC and Michelin.

The Virginia Smart Road in southwest Virginia is a state-of-the-art facility for research and evaluation of new technologies, products and systems for roadways and transportation. The facility is testing Intelligent Transportation Systems (ITS) concepts on more than two miles of roads and bridges. Eventually, the Smart Road will be a nearly six-mile, four-lane, limited access highway linking Blacksburg and Interstate 81.

The Economic Development Assistance Center at Virginia Tech is a critical element of the university's outreach and economic development activities, organized as a component of the Outreach Division of the university's Public Service Programs. Funded by the Economic Development Administration, the EDAC serves a number of economically distressed communities throughout southwest Virginia. Community planning assistance is just one facet of the Center. The EDAC also provides an interface between university researchers, industry and the community. The EDAC is involved in diverse projects, such as the university's effort to attract an automobile design center and the creation of the Blacksburg Electronic Village. The Blacksburg Electronic Village, a partnership between the university and the town, has greatly increased internet access in the area and was a key reason for its recognition as the Most Wired Community.

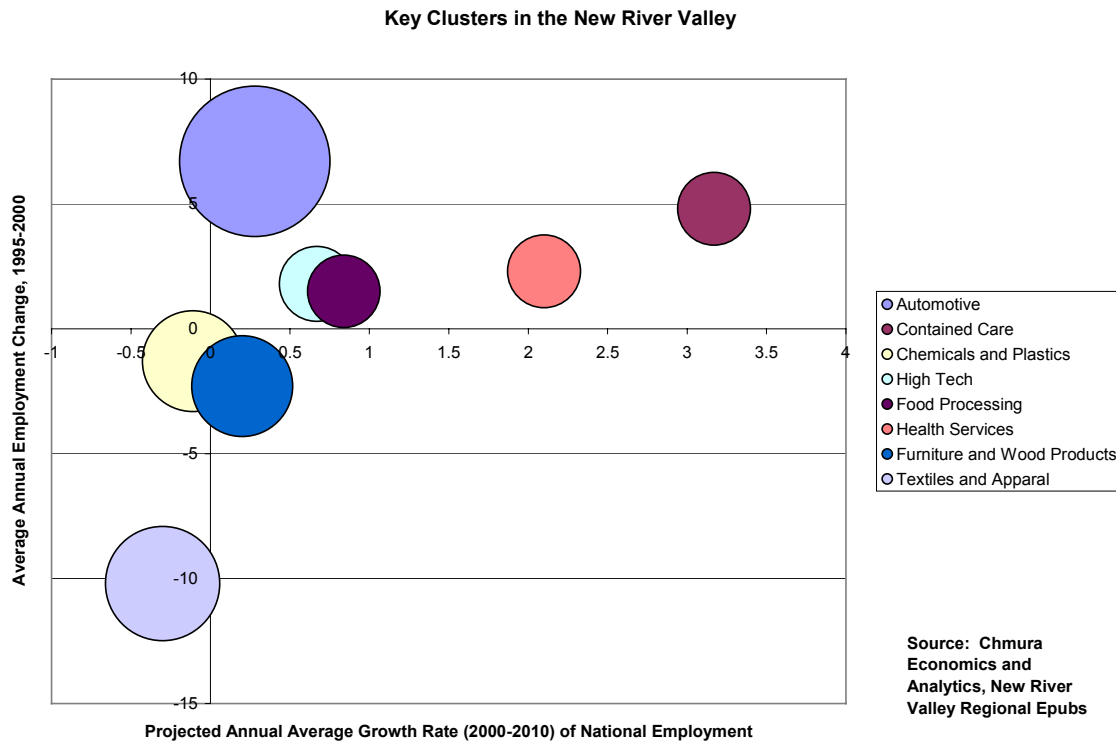
Critical Industries

The New River/ Mount Rogers Workforce Investment Board singled out the following industries as most significant in the region: wood products, industrial products, motor vehicles, textile and apparel, electronics and computers, high-tech services, and personal services.¹⁴³ While this indicates that the economy is somewhat diversified, there is still a significant base of manufacturing jobs, particularly in areas such as wood products and textiles, where the future growth outlook is uncertain. Due to the presence

¹⁴³ Because the NRV was not incorporated as an MSA prior to this year, the Porter project does not have the relevant data on clusters.

of the Volvo/Mack Plant in Pulaski County, auto manufacturing will likely remain an important industry. However, recent lulls in demand have decreased employment through the first two quarters of 2003.¹⁴⁴ An analysis commissioned by the New River Valley Planning District Commission projects that the automotive sector will continue to be a critical industry, but its projected growth is low. Higher growth is expected from health services and contained care.¹⁴⁵

Figure 21: Key Clusters in the New River Valley



Finally, the presence of Virginia Tech has led to the creation of small software, engineering, and other technology companies located in Blacksburg. The university is working to upgrade technology in a wider area of southwest Virginia, but these efforts are still in the development stages.¹⁴⁶ Meaningful transition from the Old Economy will

¹⁴⁴ According to a 1999 deal between Volvo Trucks and the Virginia Economic Development Partnership, Volvo was supposed to increase employment from 2,430 workers to 3,707 by December 2002. Instead, 700 people were laid off in 2000 and after callbacks employment remains around 2,200. Don Simmons, Jr., "Shifting Gears," *The Roanoke Times*, 20 April 2003 [journal online]; available from: <http://web.lexis-nexis.com/universe>; Internet; accessed 22 September 2003.

¹⁴⁵ Chmura Economics and Analytics. CEA Regional Economic Publication - New River Valley. Accessed from <http://regionepub.chmuraecon.com/login.asp?pdc=4>.

¹⁴⁶ New River Valley interview, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, 25 June, 2003.

require a combination of retraining the old workforce, retaining graduates from Virginia Tech, and attracting new corporations to the area.

Economic Development Strategies

The governor of Virginia has been an important advocate for tech-based development. At the local level, there are strong organizations, such as the New River Valley Economic Development Alliance and the Roanoke Valley Economic Development Partnership. Technology development strategies rely a great deal on building off research at Virginia Tech, and entrepreneurship strategies are focused on commercializing these technologies. Areas of interest include biotechnology, optics, and computer engineering. For example, one biotechnology strategy would assist the agricultural sector of southwest Virginia.¹⁴⁷ Finally, the New Century Technology Council was created in 1998 to help promote technology development in the Blacksburg/Roanoke area. Lack of venture capital has made commercialization of new technologies more difficult. Finally, the lack of jobs in relevant fields forces many Virginia Tech graduates to look outside the area for employment.¹⁴⁸

Bolstering the cultural reputation of the area has also become more important. Officials hope the closer relationship with Roanoke will enhance the urban identity of the New River Valley. Part of this strategy includes encouraging new amenities and restaurants to bolster tourism. In addition, a branding project has been initiated to improve the region's national profile. One development official referred to Roanoke as the "Lost Colony", a problem exacerbated by the area's isolation.¹⁴⁹ Although located along major road and rail lines, the Roanoke Regional Airport is small, and people often drive more than 100 miles for less expensive flights at other airports. There are numerous organizational efforts to repair old infrastructure, and the region continues to focus on its telecommunications infrastructure with an effort to deploy broadband to maintain the region's status as a Wired City. The region is collaborating with Virginia Tech on several initiatives, including one plan to turn Blacksburg into a transportation technology laboratory, and the Fralin Biotechnology Center's effort to increase awareness of bioengineering issues in public schools.

State

Virginia has 23 state incentive programs, most of which are provided by the Virginia Economic Development Partnership (VEDP) and the Virginia Small Business Financing Authority. The state uses a variety of types of incentives, including tax credits,

¹⁴⁷ New River Valley interview, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, 15 July 2003.

¹⁴⁸ New River Valley Interviews, conducted by Alexis Haakensen, 19 September 2003 Carnegie Mellon University, Pittsburgh, PA.

¹⁴⁹ New River Valley interview, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, 23 June, 2003.

grants, and loans, and does not favor any specific type. Approximately half of these programs provide direct financing, while an additional six are tax credits or exemptions. Programs focus on a range of issues, particularly business development, job creation, and environmental responsibility. Total economic development expenditures totaled \$168,000,000.

As mentioned above, the Commonwealth of Virginia has increasingly put pressure on the universities to serve as engines of economic growth. As such, public institutions such as Virginia Tech are pursuing research with a greater focus on commercialization, particularly in the bioinformatics area. Because Virginia is divided into planning districts, regions have significant amounts of decision-making authority. VEDP provides substantial assistance to local organizations, but development efforts are locally run.¹⁵⁰ This presents two challenges for the NRV. First, rural areas such as southwest Virginia may be losing power in the state legislature as suburban interests assume dominance.¹⁵¹ Second, because the state brings business prospects to every region rather than to underdeveloped areas, the NRV must compete with regions with greater resources to match the state's incentives package.¹⁵²

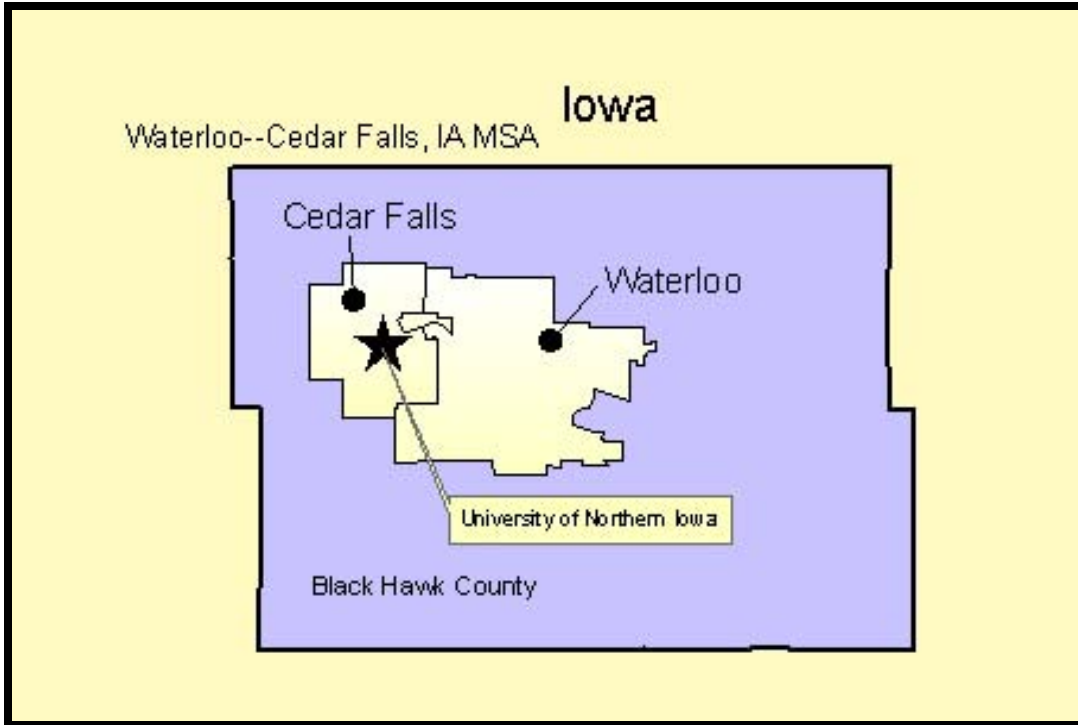
¹⁵⁰ New River Valley interview, conducted by Alexis Haakensen, 29 July 2003, Carnegie Mellon University, Pittsburgh, PA.

¹⁵¹ New River Valley interview, conducted by Alexis Haakensen, 15 July 2003, Carnegie Mellon University, Pittsburgh, PA.

¹⁵² New River Valley interview, Carnegie Mellon University, Pittsburgh, PA; conducted by Alexis Haakensen, 24 July 2003.

University of Northern Iowa / Waterloo-Cedar Falls

Regional Context



Waterloo-Cedar Falls, Iowa, is a Metropolitan Statistical Area located 53 miles northwest of Cedar Rapids and 111 miles northeast of Des Moines. The MSA is one of Iowa's few major population centers. The area is commonly referred to as the Cedar Valley, and is comprised of Black Hawk County. Black Hawk County is partially rural and is surrounded by rural counties; the closest metropolitan area is Cedar Rapids located more than fifty miles away.

Table 21: Cedar Valley Economic Statistics

	Waterloo-Cedar Falls MSA	United States
Employment Growth 1990-2000	18.6%	18.6%
Unemployment 2002	4.3%	5.8%
	Waterloo-Cedar Falls MSA	Percentage Of United States
Median Household Income 1999	\$37,266	88.74%
Per Capita Income 1999	\$18,885	87.48%

University

The University of Northern Iowa (UNI), a public university located in Cedar Falls, Iowa, has an enrollment of 14,410 students, 12,680 of whom are undergraduates. UNI awarded 2,420 bachelors degrees in 2002; the most popular fields are education, business management, social science and history, communications, and liberal arts and sciences.¹⁵³ Fields with a disproportionately high number of degrees include education and foreign languages, literature, and linguistics. UNI was once a teaching college, but has expanded its focus to include business and some research.

Table 22: University of Northern Iowa Significant Degree Categories

Significant Degree Categories, 1999-2000
1. Foreign Languages, Literatures and Linguistic
2. Education
3. Library Science
4. Parks, Recreation, Leisure and Fitness Studies
5. Communications, Journalism, and Related Fields
6. Public Administration and Services
7. Family and Consumer Sciences/Human Sciences
8. English Language and Literature/Letters
9. Mathematics and Statistics

Source: National Center for Education Statistics, 2003. Analysis by Center for Economic Development.

UNI's College of Business Administration's Business and Community Services (BCS) division is very active within the regional economy. Within BCS, the Institute for Decision Making advises economic development corporations, chambers of commerce, convention and visitors' bureaus, community planning groups, and other similar groups and organizations. The Institute does a great deal of economic research, including infrastructure analyses, workforce profiling, and economic impact analyses across Iowa.¹⁵⁴ Also within BCS, the UNI Regional Business Center offers technical, financial, and support services for entrepreneurs. It includes a Small Business Development Center, which serves business clients in northeast Iowa, and the John Pappajohn Entrepreneurial Center, which provides educational and consulting services to promote entrepreneurship in Iowa. The Pappajohn Center is often mentioned as one of the only entrepreneurial resources in the region.¹⁵⁵ BCS also coordinates the Heartland Economic Development Course, which offers intensive economic development training for professionals from various midwestern states.

¹⁵³ Cedar Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

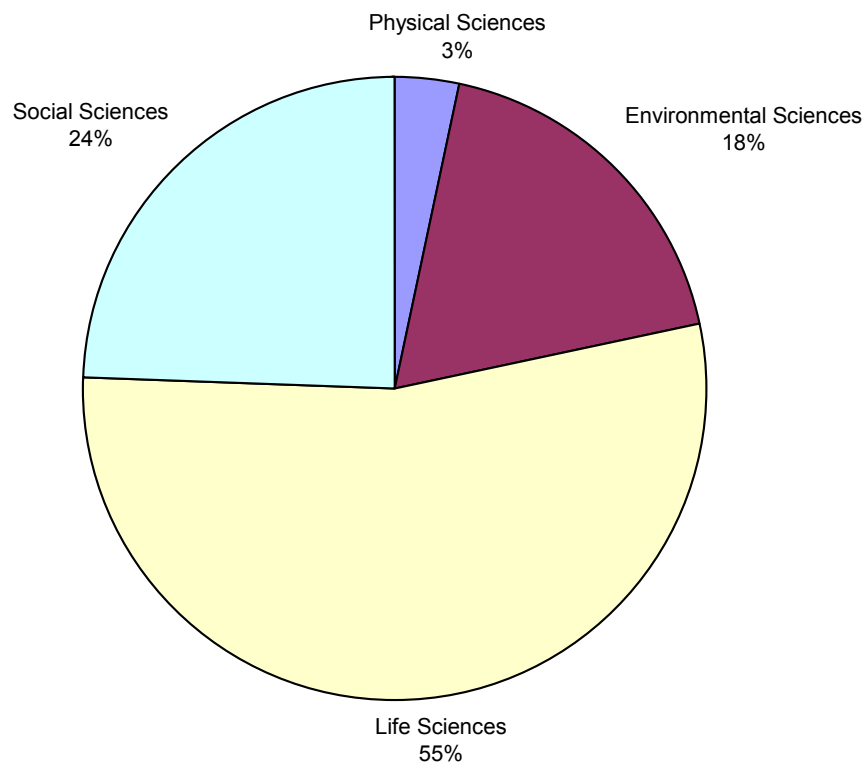
¹⁵⁴ Cedar Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

¹⁵⁵ Cedar Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

Technology transfer activity at UNI is just beginning to emerge. Because UNI was primarily a teacher's institute until the 1970's, and is more focused on teaching and educating students than research, there is not a great deal of infrastructure in place. Technology transfer currently takes place in the Office of Intellectual Property. University research is currently focused on soy-based lubricants, particularly through the Ag-based Industrial Lubricants Research Program (ABIL), but there has been additional success with a trademark issued for seed cultivars of short and long prairie grasses.¹⁵⁶

Figure 22: University of Northern Iowa R&D by Discipline, 2000

University of Northern Iowa R&D by Discipline, 2000



University of Northern Iowa's research and the Cedar Valley regional economy are agriculture-driven, both through advanced manufacturing and through the life sciences. The Institute for Strategy and Competitiveness at Harvard Business School identifies the largest traded clusters in the Waterloo-Cedar Falls MSA as being heavy machinery (mainly farm machinery) and processed food.¹⁵⁷ UNI research has been

¹⁵⁶ Cedar Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

¹⁵⁷ Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School. Traded clusters sell products across different economic areas.

focused on the life sciences; over half of all UNI research expenditures in 2000 were in this field. Nearly all life sciences research and development spending was identified as agricultural. Another 18 percent of research and development spending went to environmental sciences, a discipline with clear links to agriculture.

Agriculture

The Ag-based Industrial Lubricants Research Program (ABIL) program was initiated in 1991, and is working on the development of industrial lubricants from soy-beans and other vegetable oils.¹⁵⁸ ABIL has commercialized a variety of lubricants that are available through Environmental Lubricants Manufacturing, Inc., located in Waverly, Iowa.¹⁵⁹

National Performance Center for Biobased Lubricants - UNI has recently received funding from the Department of Energy to form a national center for the study of soy-based lubricants.

Production Technology and Manufacturing

The Metal Casting Center works with the foundry industry to improve productivity and competitiveness. The center has recently been working on a bio-based binder.¹⁶⁰

Recycling and Reuse Technology Transfer Center (RRTTC) works to find economic solutions to solid waste problems around the country.¹⁶¹

Critical Industries

Currently, the largest employer in the area is John Deere Waterloo Works, which produces farm tractors and components. It employs twice as many people (5,072) as each of the next largest employers, Covenant Medical Center (2,479) and IBP, Inc. (2,230).¹⁶² The largest clusters in the region are Heavy Machinery, Building Fixtures/Equipment/Services, Processed Food, and Metal Manufacturing.¹⁶³ The region's employment growth is exactly the same as the national average, but the average per capita income is \$25,826, only 85 percent of the national average.

¹⁵⁸ "ABIL – About ABIL," available from http://www.bcs.uni.edu/abil/HTMLpages/About_abil/About_abil.cfm; Internet; accessed 14 October 2003.

¹⁶⁰ "Metal Casting Center," available from <http://www.mcc.uni.edu/>; Internet; accessed 14 October 2003.

¹⁶¹ "About RRTTC," available from <http://fp.uni.edu/rrtc/about/rrtc.asp>; Internet; accessed 14 October 2003.

¹⁶² Cedar Valley Economic Development Corporation, "Major Employers," http://www.cvedc.com/major_private_employers.htm; Internet; accessed 16 May 2003.

¹⁶³ Cluster Mapping Project, Harvard Business School, Institute for Strategy and Competitiveness.

Economic Development Strategies

As one of Iowa's major population centers, Waterloo-Cedar Falls is a primary target for the state of Iowa's programs to increase competitiveness in the New Economy. This program targets three industry clusters for expansion: life sciences (including production agriculture, pharmaceuticals, and food processing), advanced manufacturing, and information solutions (insurance, finance, and information technology).¹⁶⁴ Food processing and farm machinery are both listed as major clusters by the Institute for Strategy and Competitiveness' Cluster Mapping Project; food processing grew a great deal between 1990 and 2001 while farm machinery lost employment.¹⁶⁵

Development in the area has not progressed evenly. For example, despite the fact that property values are higher in Cedar Falls than in neighboring Waterloo, construction has tripled since 1996, while it has fallen in Waterloo to its lowest level since 1994.¹⁶⁶ This disparity has been attributed to many factors, one of which is slower Internet access in Waterloo, which does not have the same broadband capability as Cedar Falls.¹⁶⁷ In 2002, Cedar Falls' unemployment rate was 3.6 percent while Waterloo's was 5.2 percent.¹⁶⁸

Recent efforts to bolster development in the region include the newly proposed Cedar Valley TechWorks facility, which would serve as the Waterloo component of the statewide Iowa Values Fund, an economic development initiative pending in the Iowa Legislature. This initiative would complement John Deere's \$127 million redevelopment project, and would spawn the creation of a "bioproducts merchandise mart" -- an incubator for new businesses -- a TechWorks education center, and an exhibition center.¹⁶⁹ The project was developed by the Iowa Department of Economic Development, MidAmerican Energy, the Cedar Valley Economic Development Corporation (CVEDC), John Deere, and the University of Northern Iowa (UNI). Other major events include the resumption of flights from the Cedar Valley by Northwest Airlines after a six-year absence.¹⁷⁰ The Cedar Valley Economic Development Corporation has issued an RFP for a regionally-focused cluster study to supplement state cluster strategies, but the study has not yet begun.

¹⁶⁴ Iowa Department of Economic Development, "Iowa in the New Economy", available from <http://iowasmartidea.com/economy.html>; Internet; accessed 4 June 2003.

¹⁶⁵ Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School.

¹⁶⁶ "City Owned Broadband Network Fueling Economic Growth," *Public Power Weekly* 42 (October 21): 8.; available from http://www.appanet.org/pdfreq.cfm?PATH_INFO=/LegislativeRegulatory/broadband/news/news20021021.pdf&VARACTION=GO; accessed 22 May 2003.

¹⁶⁷ Cedar Valley interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Lena Andrews, between June and August 2003.

¹⁶⁸ Bureau of Labor Statistics, Local Area Unemployment Statistics; available from <http://data.bls.gov/cgi-bin/dsrv?la>; Internet; accessed 29 May 2003.

¹⁶⁹ "High Tech Agricultural Center Key to Waterloo, Iowa, Economic Development." *Waterloo Courier*. 23 April 2003 [journal online]; available from <http://web.lexis-nexis.com/universe>; Internet; accessed 22 May 2003.

¹⁷⁰ Jennifer Kramer Williams, "Jet Service Returns to Waterloo, Iowa, Airport," *Waterloo Courier*, 2 May 2003 [journal online]; available from <http://web.lexis-nexis.com/universe>; accessed 22 May 2003.

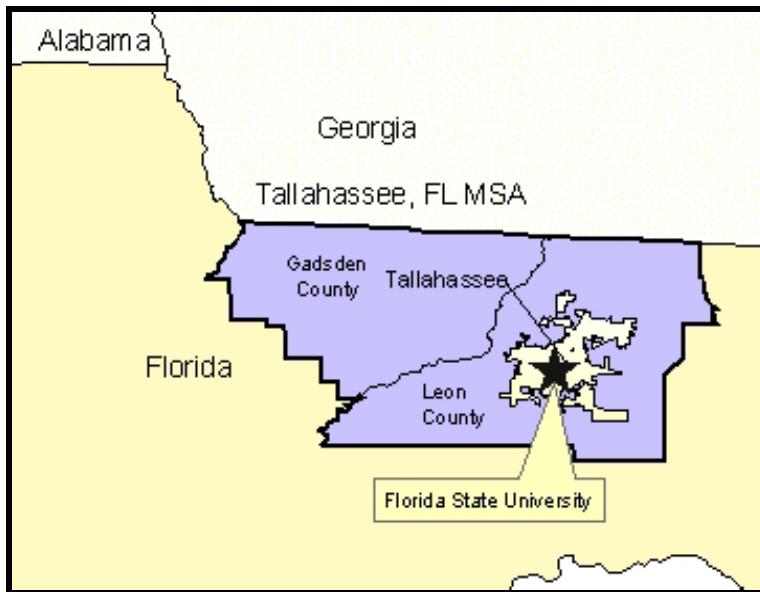
State

Iowa spent \$122 million on economic development in fiscal year 2001. Iowa has twenty state-incentive programs in economic development, less than all states studied except Florida (19) and Michigan (12). Iowa uses a variety of programs to encourage economic development in the state, including bonds, loans, grants, and mixed financing. A particular focus in Iowa is workforce development, with four workforce-related incentive programs. Iowa has more direct- financing programs than any other type, and is the only state in the study that has no indirect financing programs.

As mentioned above, statewide cluster strategies issued by the Iowa Department of Economic Development have been influential in Iowa's few population centers, many of which do not have specific industry-targeted strategies. Much economic development planning in Iowa takes place at the statewide level.

Florida State University /Tallahassee

Regional Context



Florida's state capital, Tallahassee, is located in northwest Florida in Leon County, twenty miles north of the Gulf of Mexico and fourteen miles south of the Georgia border.¹⁷¹ Recently, the Tallahassee metropolitan area was redefined to include Wakulla and Jefferson Counties, in addition to Leon and Gadsden Counties. This extension, according to some local economic-development officials, has been long overdue; unofficially, Wakulla and Jefferson Counties were often included in the region's economic development plans.¹⁷²

The Tallahassee metropolitan area is shaped by the presence of local and state government and two state universities. State and local government employ more than 38 percent of the workforce in Leon County, making government the largest employer in the area. Florida State University is the second largest employer with more than 11,000 employees.¹⁷³ Leon County has a highly educated population. With nearly 42 percent of

¹⁷¹ Tallahassee Leon County Planning Department, "2002 Statistical Digest," <http://talgov.com/citytlh/planning/support/statdigest/statdigestbanner/statdgest2002a.pdf>; Internet, accessed 19 June 2003

¹⁷² The MSA was defined as Leon and Gadsden Counties when this study began in March 2003. The statistics in this report are for this definition of the MSA.

¹⁷³ Economic Development Council of Tallahassee/Leon County, "Regional Economic Profile," <http://www.edctallahasseeleon.com/index.php3>; Internet, accessed 19 June 2003

its residents having completed at least four years of college, it is the most educated county in Florida.¹⁷⁴

Tallahassee's economy grew at a higher rate than the national average in the 1990s. The unemployment rate has typically been low. In 2002 it was 3.7 percent, lower than the national average of 5.8 percent. Per-capita income in 1999, however, was lower than the national average.

Table 23: Tallahassee Economic Statistics

	Tallahassee MSA	United States
Employment Growth 1990-2000	28.8%	18.6%
Unemployment 2002	3.70%	5.80%
	Tallahassee MSA	Percentage of United States
Median Household Income 1999	\$36,441	86.77%
Per Capita Income 1999	\$19,990	92.60%

University

Florida State University is a public university with nearly 35,000 students, of which approximately 28,230 are undergraduates. It issued 5,912 bachelors degrees during the 2001-02 academic year. The largest programs are business and administrative services, education, social sciences, and visual and performing arts.

Table 24: Florida State University Significant Degree Categories

Significant Degree Categories, 1999-2000
1. Business, Management, Marketing, and Related Support Services
2. Education
3. Social Sciences
4. Visual and Performing Arts
5. Communications, Journalism, and Related Fields
6. Family and Consumer Sciences/Human Sciences
7. Protective Services
8. English Language and Literature/Letters
9. Health Professions and Related Clinical Services
10. Psychology

Source: National Center for Education Statistics, 2003. Analysis by Center for Economic Development, 2003

¹⁷⁴ Tallahassee Leon County Planning Department, "2002 Statistical Digest," <http://tal.gov.com/citytlh/planning/support/statdigest/statdigestbanner/statdgst2002a.pdf>; Internet, accessed 19 June 2003

The Office of Technology Transfer is active and its major revenue source is Taxol, the cancer treatment drug. Recently the Office of Technology Research expanded its personnel to include the university's Corporate Relations and Development Office to actively seek corporate partners within and outside the region. In addition, FSU's Research Foundation (a not-for-profit corporation) tries to promote research activity through several programs, and has policies in place to improve ties between research at the university and industry.¹⁷⁵

A number of both faculty and senior administrative staff at FSU are involved with Tallahassee's Chamber of Commerce and Economic Development Council.¹⁷⁶ The university is also associated with the Tallahassee Technology Alliance (Tal Tech), a regional alliance geared towards expanding the business of technology firms based in the area. The university has an entrepreneurship program that provides consultancy and training services to up-and-coming and established businesses.¹⁷⁷ Perhaps FSU's largest foray into regional economic development was a proposed research park. Several Tallahassee economic development organizations are now seeking to leverage the university's technological expertise to assist in the area's growth.

FSU's research funding more than doubled between 1994 and 2003. It received nearly \$148 million for research in the year 2002.¹⁷⁸ Physical sciences received a significant portion of this funding followed by environmental sciences and engineering. The university has several research centers and institutes to study fields ranging from hurricanes to aging and from materials research to molecular biophysics.

¹⁷⁵ Florida State University, "Office of Research Technology Transfer.,"

<http://www.techtransfer.fsu.edu/rf.html>; Internet, accessed 4 September 2003

¹⁷⁶ Center for Economic Development interviews, Carnegie Mellon University, Pittsburgh, PA; conducted by Anjani Datla, between June and August 2003

¹⁷⁷ Florida State University, "Jim Moran Institute for Global Entrepreneurship.,"

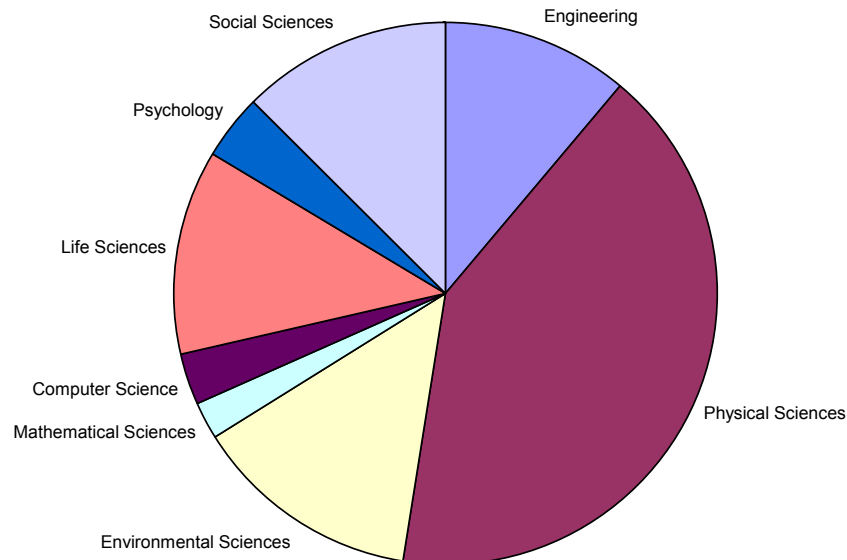
<http://www.cob.fsu.edu/jmi/index2/index.asp>; Internet, accessed 4 September 2003

¹⁷⁸ Florida State University Office of Research, "Fiscal Year 2002, Overview.,"

<http://www.research.fsu.edu/activity/2002/overview.html>; Internet, accessed 29 October 2003

Florida State University R&D by Discipline, 2000

Florida State University R&D by Discipline, 2000



Source: National Science Foundation, available from <http://caspar.nsf.gov>; Internet; accessed 13 October 2003.

Information technology and healthcare are two key areas of interest in terms of Florida State University's research focus and the growth of these two industries in the region.

Information Technology

Tallahassee's economic development organizations have identified information technology as one of their target industries. According to the Cluster Mapping Project, the number of software firms went down between 1995 and 2000 but the number of communications services firms rose during the same time.¹⁷⁹ Firms like Mainline Information Systems, based in Tallahassee, are now recognized names in the field of information technology. Florida State University's College of Engineering has several industry research and outreach programs that are oriented towards issues and trends in the

¹⁷⁹ Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School

information technology industry. Below are research assets at FSU relevant to the information technology cluster:

High Performance Computing and Simulation Research Lab (HCS)

The lab is a joint research facility associated with the University of Florida, Florida A&M University, and Florida State University, and serves as the National Security Agency's Center of Excellence in High-Performance Networking and Computing. HCS conducts research on high performance computing and communications.¹⁸⁰

Information Processing and Transmission Engineering Laboratory (IPTTEL)

The lab provides support to FSU's Traffic Engineering Research Laboratory, which works closely with the Florida Department of Transportation. IPTTEL's areas of focus are neural networks, fuzzy logic and wireless communication.

Healthcare

Healthcare is a growing industry in Tallahassee. There are more than 14,000 people employed in healthcare and social services in the region.¹⁸¹ Tallahassee Memorial Healthcare is the fifth largest employer and several other healthcare providers in the area employ hundreds of people.¹⁸² Florida State University has long provided training and research emphasis to areas like neurological and biological sciences. In June 2000 it also began a new medical school that has made significant progress since.

FSU research assets pertaining to health care include:

FSU College of Medicine

The FSU College of Medicine uses new technologies and an interdisciplinary mode of teaching to train its future physicians. The school offers training in several disciplines such as biomedical sciences, clinical sciences and geriatrics. The first class is expected to graduate in May 2005.

Program in Neuroscience

This program under FSU's Human Sciences department conducts research in areas such as energy balance and metabolism and cellular and molecular neuroscience. It offers training and resources for research conducted by faculty and graduate students.

¹⁸⁰ High Performance Computing and Simulation Lab, "Laboratory Overview.," <http://www.hcs.ufl.edu/lab/overview.php>; Internet, accessed 30 October 2003

¹⁸¹ Tallahassee Economic Development Council, "Employment by sector in Tallahassee.," <http://www.taledc.com/es202.php3>; Internet, accessed 30 October 2003

¹⁸² Greater Tallahassee Chamber of Commerce, "Major Employers.," <http://www.talchamber.com/majemp.php3>; Internet, accessed 30 October 2003

Critical Industries

Tallahassee has four important clusters – communications equipment, business services, printing and publishing, and furniture.¹⁸³ It is important to note, however, that a fair portion of employment and activity is geared towards supporting the state and local governments in the area. There has recently been some growth in the healthcare industry. There are three large healthcare rehabilitation centers within Tallahassee’s city limits.¹⁸⁴ Northwest Florida is home to several aerospace/aeronautical industries, but the Tallahassee metropolitan area has not seen much related activity. The advanced technology industry, however, has made considerable investments in the region.¹⁸⁵ Most businesses in Tallahassee are small, with less than 100 employees.¹⁸⁶ Tallahassee promotes itself as a city that is open for business with “shovel ready” sites, but the area is still dominated by its role as the state capital and has not yet attracted significant corporate investment.¹⁸⁷

Economic Development Strategies

Emphasis has been placed on projecting Tallahassee as a hub for research and development activity. FSU, Florida A&M University and Leon County set up Innovation Park more than 20 years ago to attract large scale, private sector businesses to Tallahassee.¹⁸⁸ It currently houses the National Science Foundation’s National High Magnetic Field Laboratory and some research centers associated with both FSU and Florida A&M.¹⁸⁹

Another research park, spearheaded by Florida State University, was initially envisioned to be similar to University of North Carolina’s Centennial Park.¹⁹⁰ Heavy opposition against FSU receiving control of the park’s board may result in the new

¹⁸³ Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School

¹⁸⁴ Greater Tallahassee Chamber of Commerce, “Major Employers.”

<http://www.talchamber.com/majemp.php3>; Internet, accessed 19 June 2003

¹⁸⁵ Florida’s Great Northwest “Advantages for Advanced Technology Companies.”

<http://www.floridagreatnorthwest.com/map/hitechmap.jpg>; Internet; accessed 19 June 2003

¹⁸⁶ Economic Development Council of Tallahassee/Leon County, “Major Employers.”

<http://www.talchamber.com/majemp.php3>; Internet, accessed 19 June 2003

¹⁸⁷ “St. Joe Breaks Ground on New Commerce Center Near Tallahassee Airport,” *Business Wire*, 23

October 2002 [journal online]; available from <http://web.lexis-nexis.com/universe>; Internet; accessed 19 June 2003

¹⁸⁸ Jordan, Juana. “Research Park May Help Solve Problems in Tallahassee,” *The Tallahassee Democrat*, 4 September 2002 [journal online]; available from <http://web.lexis.nexis.com/universe>; Internet; accessed 19 June 2003

¹⁸⁹ Innovation Park, “Tallahassee Research and Development Center,”

<http://www.co.leon.fl.us/innovate/page1.htm>; Internet, accessed 19 June 2003

¹⁹⁰ Yeager, Melanie. “FSU Eyes Proposed Research Park,” *The Tallahassee Democrat*, 12 June 2002

[journal online] <http://www.tallahassee.com/mld/democrat/3449621.htm>; Internet, accessed 4 September 2003

research park becoming an expansion of the existing Innovation Park.¹⁹¹ Regardless of the size and ultimate location of the park, the initial idea was to spur economic development, representing a shift in focus towards attracting and retaining research-oriented industries in the area. Tallahassee Community College recently began a program to teach students how to manufacture semiconductor chips, which is another part of the city's larger effort to promote itself to the semiconductor industry.¹⁹²

State

Florida has Enterprise Florida, a public-private partnership in charge of economic development activities in the state that is similar to the Michigan Economic Development Corporation. Enterprise Florida provides services to business that want to expand or relocate in the region and gives businesses access to university technology transfer offices and export advice to firms within the state.¹⁹³

Florida spent more than \$16 million on economic development and \$471 million on workforce development in 2001. The state currently has 28 statewide incentive programs in economic development; from the states studied, only Pennsylvania has more programs. The state uses a variety of programs to encourage economic development in the state, including business assistance, tax credits, tax refunds, and mixed financing. Florida is particularly focused on tax credits, with seven incentive programs in the area. It has more market development programs than any other type, and is the only state in the study that has given this much emphasis to the area.

¹⁹¹ Yeager, Melanie. "Research-park Plans Take Shape", *The Tallahassee Democrat*, 16 July 2003. [journal online] <http://www.tallahassee.com/mld/democrat/2003/07/16/news/local/6311999.htm>; Internet, accessed 4 September 2003

¹⁹² Sams, Rachel. "Tallahassee, Fla., College Starts Semiconductor Chip Manufacture Program", *The Tallahassee Democrat*, 12 June 2002 [journal online]; available from <http://web.lexis-nexis.com/universe>; Internet; accessed 24 June 2003

¹⁹³ Enterprise Florida, "About Us," <http://www.eflorida.com/aboutus/efi.asp?tn=3&bn=1>; Internet, accessed 23 September 2003

Appendix 1 – Case Selection Methodology

Initial Case Selection

Universities are becoming more involved in their regional economies, but there is a great deal of debate on how to measure that involvement. Because our study is focused on cluster development, we chose to use university orientation towards industry as a proxy for involvement. As part of our project, we determined selection criteria for case studies using the matrix below. In order to do this, we created a quantitative index that would allow us to rank university involvement in regional economies, as well as a quantitative measure of a “growing economy”.

Table 25: Selection Criteria

High Growth Economy Industry Oriented University	Low Growth Economy Industry Oriented University
High Growth Economy Non-Industry Oriented University	Low Growth Economy Non-Industry Oriented University

For the university criteria, we focused on research and intellectual contributions to regional economies, rather than expenditure based criteria. Daniel Felsenstein classifies these two categories of university-economy linkages as backward (expenditure) and forward (knowledge-related), and notes the importance of differentiating between the two.¹⁹⁴ We included measures of technology transfer, as well as industry contributions to research. There are many other vehicles for knowledge transfer from universities to regional economies, such as joint research symposium between university and industry, hiring of university graduates by industry, and publications, but none for which there exist quantitative data on a large enough scale to use in a wide range comparison of universities. We focus more on other knowledge-based links between universities and their regional economies in the case study analysis.

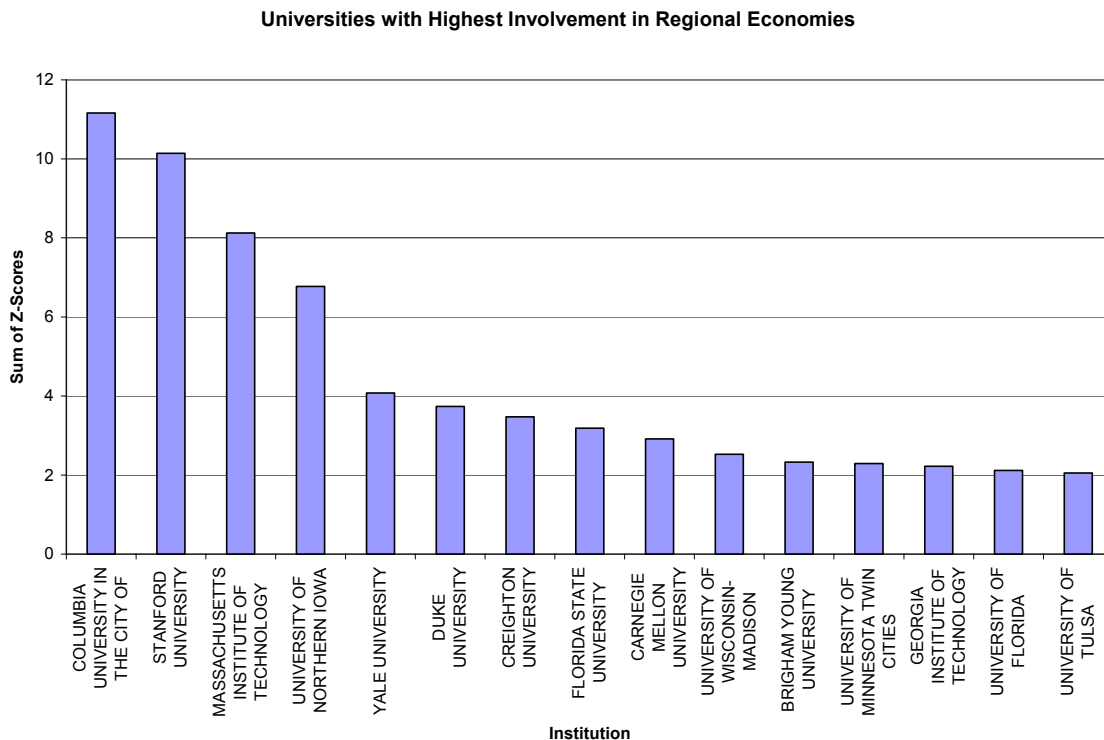
The four university measures that were selected include licensing income, percentage of research and development funded by industry, start-ups per million dollars of research and development funding, and full-time employees in the technology transfer office. We used data from the annual Association of University Technology Managers survey for all indicators except for percentage of research and development funded by

¹⁹⁴ Daniel Felsenstein, “The University in the Metropolitan Arena: Impacts and Public Policy Implications,” *Urban Studies* (1996) 3 No. 9: 1561-1580.

industry, which we obtained from the National Science Foundation's Survey of Academic Research and Development Expenditures.

For each of these indicators, we averaged three years of data (1998-2000), and then created z-scores for each indicator in order to normalize the distributions. We added the four z-scores together to create one score, and then used this cumulative index to rank the universities. The top fifteen universities, along with the sums of their four z-scores, are displayed in the graph below.

Figure 23: Universities with Highest Involvement in Regional Economies



Source: AUTM, Data for 1998-2001, compiled and analyzed by the Center for Economic Development.

After the universities had been ranked numerically using the indicator described above, we examined other factors, such as the total number of major research universities located in the region, and whether the university was located in a metropolitan or rural area. Rural location is an important factor because we wanted case studies from both rural and metropolitan areas, and no rural universities were in our top “involved” universities. We also considered whether or not the universities had funded research centers focused on regional economic development.

Regional economic conditions were also incorporated into the case selection criteria. Z-Scores for employment change between 1975 and 2000 were developed using covered employment and wages data (commonly referred to as ES-202) collected as part

of the unemployment insurance system by the Bureau of Labor Statistics. The 25 year time frame was selected in order to provide a long-range perspective on regional growth, limiting the influence of short-term change.

The number of regional industry clusters with a location quotient greater than one was also examined as a measure of industrial diversity, although it was not incorporated in to the statistical aspect of the selection process. Location quotients are a commonly used measure of industry concentration. A value greater than one indicates that the region's share of employment in an industry exceeds the national share. The year 2000 cluster data was obtained from the Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School.

After examining the university list using the above-mentioned criteria, and examining the MSAs in which the universities were located, we selected the universities/MSAs in the matrix below for our case studies.

Table 26: Initial Case Selection

<p>High Growth Economy</p> <p>Industry Oriented University:</p> <p>Ann Arbor (University of Michigan)</p> <p>Tallahassee (Florida State)</p>	<p>Low Growth Economy</p> <p>Industry Oriented University:</p> <p>Allentown /Lehigh Valley (Lehigh University)</p> <p>Waterloo-Cedar Falls (University of Northern Iowa)</p>
<p>High Growth Economy</p> <p>Non-Industry Oriented University:</p> <p>Morgantown (West Virginia University)</p> <p>Las Cruces (New Mexico State)</p>	<p>Low Growth Economy</p> <p>Non-Industry Oriented University:</p> <p>New River Valley (Virginia Tech)</p> <p>Dayton (Wright State University)</p>

Assessing University Involvement

The initial selection of cases was influenced by the university's technology-transfer activity, which we termed "industry-oriented." This decision was based in part on the literature review and on the availability of relevant data on universities. The wide availability of technology-transfer data makes it a useful resource for screening the population of universities, but it is not the best representation of a university's involvement with industry. Secondly, a university's involvement with industry may not translate directly into benefits for a region. Our case analysis led to a broader set of criteria for assessing a university's engagement with the regional economy. These factors are described in Table 27 and differentiate engaged universities from non-engaged.

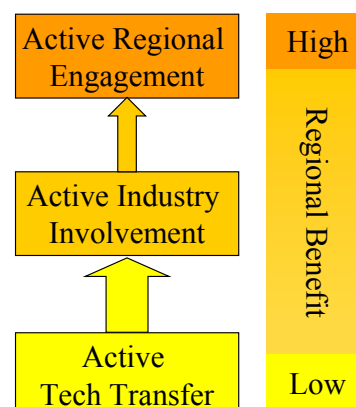


Table 27: Factors for Engaged Universities

Factor	Importance to regional benefit	Aspect of Engagement
Initial Factors		
Licensing Income	Low	Reflects the ability to generate technology of commercial interest, although the benefits accrue mainly to the university.
Tech Transfer Office Employment	Low	Staffing of the technology transfer activity is a measure of university's commitment to technology transfer.
Industrial R&D	Medium	Signifies the strength of university partnerships with industry that can often provide leverage to attract research operations.
R&D Expenditures per Startup	Medium	Measures the efficiency of the university in creating startups, but the measure is highly variable and can boom and bust as deals are processed through the system.
Number of Startups	High	Represents the ability of the university to generate commercial ventures that are often likely to stay in the region due to the personal and professional ties of the founders.
Revised Factors		
Total R&D Expenditures	High	Higher levels of sustained R&D provide more opportunities for innovation that can take seed in the region.
Breadth of Outreach	High	Reflects the infusion of an outreach mission and values throughout the university rather than concentrating it as a function within a specific office.
Alignment with regional industry	High	Reflects the orientation of the university with the regional economy and therefore the ability of regional firms to absorb university technology and transform it for commercial growth.
Number of Startups	High	Represents the ability of the university to generate commercial ventures that are often likely to stay in the region due to the personal and professional ties of the founders.

As a result of the case analysis and revised criteria, several universities were identified as engaged with the regional economy. These universities ranked highly on the

objective criteria and were consistently identified as partners in a variety of aspects of regional development related to research and education activities, as well as providing other resources and support for regional development. These universities are not merely targets or assets that the region seeks to use, but are a partner in the regional development enterprise. These engaged universities were analyzed to determine what factors differentiated the ability of the engaged universities to impact their regional economy. Table 28 categorizes the engaged universities according to the performance of the regional economy.

Table 28: Engaged Universities

	<i>Above US average</i>	<i>Close to US average</i>	<i>Below US average</i>
<i>Economy is growing</i>	Ann Arbor (University of Michigan)	Morgantown (West Virginia University)	Allentown / Lehigh University New River Valley (Virginia Tech)
<i>Per Capita Income is</i>	Ann Arbor (University of Michigan)	Allentown (Lehigh University)	Morgantown (West Virginia University) New River Valley (Virginia Tech)

Appendix 2 – Incentive Programs in the Case States

Figure 24: State Incentive Programs by Finance Type

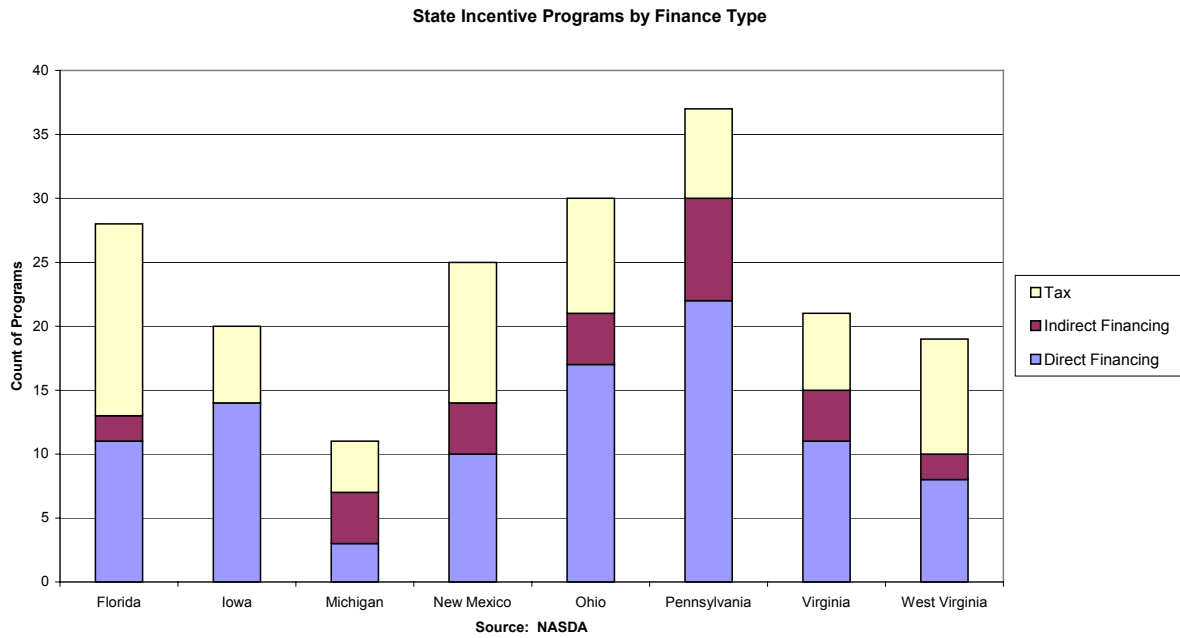


Table 29: Methods of Financing

	FL	IA	MI	NM	OH	PA	VA	WV
Bond	1	1	1	2	2	1	2	2
Equity	1			1		1		1
Grant	3	3	3	1	8	15	5	3
Guarantee					1	1	2	2
Loan	5	7	2	10	10	10	4	2
Mixed financing	1	5		1	1		2	
Tax Abatement/Reduction/Refund	4			2	1	1		
Tax Credit	7	2	3	4	3	6	5	6
Tax Exemption	4	2		4	4	1	1	2
Unclassified			2				1	1
Grand Total	26	20	11	25	30	36	22	19

Source: NASDA

Table 30: Geographic Targeting

	FL	IA	MI	NM	OH	PA	VA	WV
Certified cultural properties				1				
Statewide	6	1		6				4
Local Designated areas		1						
State Designated areas	6		2	4	2	2	1	
Distressed areas				1	1		1	
Special consideration for distress	1							
Rural counties	1			2				
Grand Total	14	2	2	14	3	2	2	4

Source: NASDA

Appendix 3 – Data Sources for Statistics

<p>Employment Growth 1990-2000</p> <p>Bureau of Labor Statistics/Local Area Unemployment Statistics. available from; http://data.bls.gov/cgi-bin/dsrv?la; Internet; accessed 24 June 2003</p>
<p>Unemployment 2002</p> <p>Bureau of Labor Statistics/Local Area Unemployment Statistics</p>
<p>Median Household Income 1999</p> <p>United States Census 2000, "American Factfinder"; available from http://factfinder.census.gov; Internet; accessed 24 June 2003</p>
<p>Per Capita Income 1999</p> <p>United States Census 2000, "American Factfinder"; available from http://factfinder.census.gov; Internet; accessed 24 June 2003</p>
<p>Significant Degree Categories</p> <p>National Center for Education Statistics, 2003. Significant degree categories were identified by calculating a "location quotient" for each category; this is the ratio of the subject area's percentage of total in the university to the subject area's percentage of total degrees in the country. Significant categories are categories with a ratio > 1.5, and are listed in descending order.</p>
<p>R&D Expenditures at Universities and Colleges</p> <p>National Science Foundation, Survey of Research and Development Expenditures at Universities and Colleges. R&D Expenditures at Universities and Colleges, by Science and Engineering Field: FY 2001 (Table B-39). Association of University Technology Managers, <i>AUTM Licensing Survey: 2001, 2000, 1999 & 1998</i>.</p>
<p>Cluster Data</p> <p>Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School.</p>
<p>State Economic Development Expenditures and Incentives</p> <p>National Association of State Development Agencies. NASDA State ED Expenditure Survey, 2001(CD-ROM) 2002 Director of State Incentives for Business (CD-ROM).</p>