

The Life Science Cluster in Central Indiana



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Central Indiana's Future: Understanding the Region and Identifying Choices

The Center for Urban Policy and the Environment has launched a new research project—Central Indiana's Future: Understanding the Region and Identifying Choices—funded by an award of general support from the Lilly Endowment. The aim of the project is to increase understanding of the region and to inform decision-makers about the array of options for improving the quality of life for Central Indiana residents. Researchers from several universities are working to understand how the broad range of investments made by households, governments, businesses, and nonprofit organizations within the Central Indiana Region contribute to quality of life. The geographic scope of the project includes 44 counties in an integrated economic region identified by the U.S. Bureau of Economic Analysis.

Susan Walcott, currently assistant professor in the Department of Anthropology and Geography at Georgia State University, studied the life science cluster in Central Indiana while serving as an affiliated faculty with the center. This technical report presents the analysis of these clusters.

The Center for Urban Policy and the Environment is part of the School of Public and Environmental Affairs at Indiana University—Purdue University Indianapolis. For more information about the Central Indiana Project or the research reported here, contact the center at 317-261-3000 or visit the center's Web site at www.urbancenter.iupui.edu.



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EXECUTIVE SUMMARY

The life science industry plays an important role in the economy of Central Indiana. Nationally, clusters in this industry occur in California, Massachusetts, and the Mid-Atlantic coastal region. Yet, because of the importance of social networks a few large firms have contributed to the success of Central Indiana's life science cluster. Start-ups, consisting of former employees of the local giants, have the potential to develop into innovative firms, enhancing the cluster.

Understanding these networks as well as the other needs of firms is crucial to supporting and assisting the growth of the life science cluster. Attracting and retaining the necessary workforce for this industry is one important factor. This study suggests that prospective employees are more likely to come to a region if there are other jobs available in the same field. Also, grouping individuals by residence with others of similar educational background and employment type minimizes commuting time. Surveyed employers in Central Indiana indicate that prior attachments to the area—having lived in the region previously or having family in the area—raise the likelihood that employees will stay in the area after hiring.

Universities play a crucial role, given the need for a highly trained and specialized labor base and increasing reliance of business on university technology transfer. In Central Indiana, the life science clusters do appear stronger in metropolitan areas with major research universities. However, survey data suggest that many of the life science firms outside of the Lafayette/Purdue University area have not experienced strong connections with universities. One proposal would establish statewide research parks jointly managed by Indiana University (in Indianapolis and Bloomington) and Purdue.

Other factors that are critical to the health of the life science industry in Central Indiana include access to capital, strong network support, and sufficient air transportation infrastructure.





INTRODUCTION

This study provides a detailed and current analysis of the life science industry cluster in Central Indiana. The competitive requirements of a particular industry and the resources (human and structural) of a particular region shape the nature and functions of each cluster in that region (Saxenian 1994; Gordon and McCann 2000). Central Indiana's life science cluster contains two Fortune 500 companies in Indianapolis: the pharmaceutical giant Eli Lilly and Company (Lilly) and its medical device division spin-off Guidant Corporation (Guidant). Though headquartered in Indianapolis, Guidant's Cardiac Rhythm business group is a major presence in Minneapolis' medical cluster along with locally headquartered medical instrument giant Medtronic. Minneapolis furnishes a similar model of a city whose major industry is composed of a small number of very large life science companies (Llobera et al. 2000). A later section compares the two midwestern counterparts. The focus of this study, however, concerns the development trajectory of Central Indiana's cluster.

The concentrated nature of the life science cluster and the size of its regional setting emphasize the critical importance of social networks to its successful functioning outside the predominant California, Massachusetts, and Mid-Atlantic coastal regions. Input-output supplier and market chains in this industry are largely global, with the critical exception of technical and managerial talent. How Central Indiana sustains its exceptional location in the life science industry, therefore, depends on the success of the region in attracting and retaining high demand, expensive talent. Particularly in biopharmaceuticals, the location of such individuals is highly correlated with the location of relevant research activities (Audretsch and Stephan 1996; Stephan et al. 1997). Network analysis in this study examines these types of extended relationships influencing the corporate and regional economy.

This study posed four basic questions. The first concerns how location in Central Indiana affects development of the life science cluster. Second, what particular factors are in place that assist the growth of that cluster? Third, what factors retard its development in this region? Fourth, how innovative and economically dynamic are firms in the life science cluster in Central Indiana? To answer the first three questions, companies were asked about the presence and importance of infrastructure features generally considered important to high technology companies, such as access to suitable real estate, transportation, finance, amenities, and a specially trained labor base. Networks were indicated through interview evidence and locating companies by size, type, and customers throughout Central Indiana. Data on patents, technology transfer, new companies and jobs were used to measure a response for the last question.



This report consists of three parts:

- First, a brief discussion of the characteristics of life science clusters provides a context for Central Indiana's situation.
- Second, the composition of Central Indiana's cluster is presented and local factors affecting its health are analyzed, such as production chain relationships, workforce, regulatory influences, and quality of life issues.
- Third, the concluding section summarizes key factors shaping the cluster and suggests considerations for future opportunities to enhance life sciences in the Central Indiana region. The appendix includes a discussion of the methodology used, including interviews, printed matter, and other data, as well as the survey instrument.



CONSIDERATIONS IN IDENTIFYING A LIFE SCIENCE CLUSTER

Determining whether Central Indiana's life science industry cluster resembles a neo-classical industry model or a sociological network model represents the first analytical task, with results shaping the direction of subsequent analysis. The industry model exhibits established production and distribution chain links, evident in clearly identifiable spatial arrangements. Pharmaceutical firms generally fall into this category (Gordon and McCann 2000). However, the exceptional location of Central Indiana's major life science companies outside the main corridor of Mid-Atlantic concentration suggests the operation of other factors, such as social networks. The underlying argument of the social network model relies on inter-firm ties based on personal trust translated to mutually beneficial business relationships. Spatial propinquity aids coordination of critical information exchange across industry boundaries.

A growing appreciation of the economic development benefits from high technology intensive activity, and the realization that such activity occurs in company clusters, spurred a new interest in the geographic nature of the regions where such clusters occur. A century of industrial studies demonstrates that industries such as the life sciences demand three basic inputs: specialized labor, appropriate facilities, and knowledge spillovers between research and development (Marshall 1890; Prevezer 1998). In particular, the growth trajectory of research and development reflects the functions of formal and informal supportive networks among linked businesses, research centers, and individuals that support transmission of knowledge and learning opportunities (Feldman 1994; Llobera et al. 1999).

Life science firms cluster because of the needs of the key competitive component to share and exchange knowledge. Since "most technology is specific, complex, tacit, [and] cumulative" (Pavitt 1987), companies based on cutting-edge innovations cluster and thrive best in locations generating useful knowledge, with networks conducive to frequent face-to-face knowledge exchange (Scott and Storper 1987; Storper and Walker 1989). Geographic proximity between a major research center and a development site results from the propensity for knowledge spillovers to remain sticky; that is, not travel far from the source (Hall 1987; Jaffe et al. 1993; Zucker et al. 1994). This is especially true for small companies in industries such as biomedical in smaller metropolitan areas such as Indianapolis (Acs and Ndikumwami 1998).

Particular characteristics of a locality affect cluster development by attracting further investment based on fixed, unique factors such as the presence of a customized support network or a major "lighthouse" or internationally known firm, such as Lilly. For example, wise venture capitalists seek to cluster their investments in one region reflecting their network ties to service support infrastructure such as banks, lawyers, and accountants who know them and the needs of this specialty. In the life sciences,

Clusters of world-class firms in related industries are the most important economic development customers in the global economy.

—Waits 2000



demand for new product ideas and development remains great, but the odds against an idea coming to market remain high. Utilization of targeted geographic proximity maximizes the chances that product ideas can reach the marketplace. Successful pharmaceutical giants must maintain both active in-house research operations and a global presence through branches or corporate acquisitions. Rotation of global knowledge workers and managers to a Central Indiana headquarters carries with it other requirements for the local cultural milieu. Since Lilly's international employees represent the major segment of Indianapolis non-native corporate presence, for example, Central Indiana must project an inviting setting for this small but influential element of the labor force. Important factors include a range of entertainment options from the symphony to sports; high-quality schools; convenient work commute; and attractive, high amenity housing.

Universities play a crucial role in the health and development of the life science industry, given the need for a highly trained and specialized labor base and an increasing reliance of business on university technology transfer (Maki and Maki 1994; Powell and Owen-Smith 1998; Grimes and Prime 2000). The innovation capacity of small firms as well as large firms depends on geographic proximity to research and development laboratories and research universities producing both labor with industry-specific skills and intellectual products. Presence of such a technological infrastructure with both publicly and privately funded research facilities is a crucial factor for metropolitan areas seeking innovative industries (Black 2000). The funding base of research and development laboratories and research universities is largely research grants from outside sources, with innovation being leveraged to commercialization by mediating institutions such as technology transfer offices.

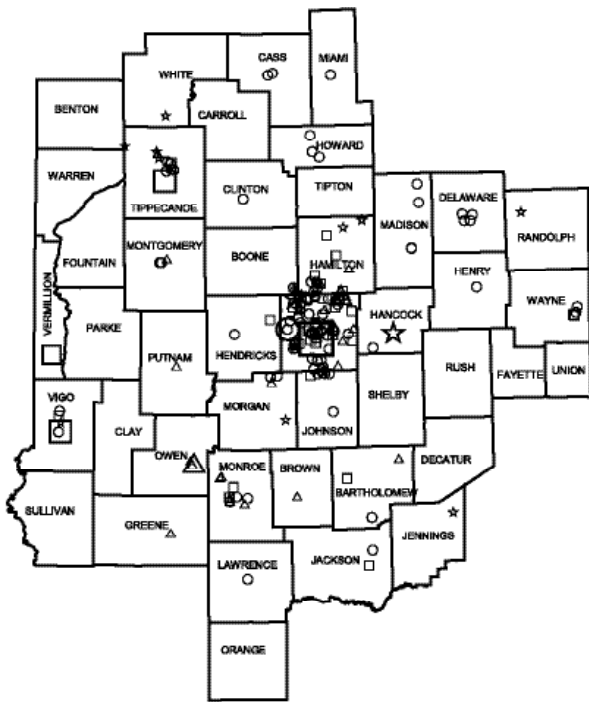
Beyond uncovering linked industries and practices, understanding the underlying dynamics of a region is crucial for attracting, retaining, and nourishing economically vibrant innovative firms. Only by identifying specific network operations can policymakers attempt to assist at specific points where such action falls within their realm of operations. Exploration of such parts requires both quantitative and qualitative methods, utilizing available industry data and information possessed by individuals based on their own experiences.

Research and development supported by Small Business Innovation Research (SBIR) program grants from the National Science Foundation (NSF) also is an important measure of a region's innovation capacity. The largest federal program dedicated to supporting small firms based on promising research-intensive products, SBIR has provided targeted assistance since its founding in 1982. The predominance of the life science cluster comes through clearly from these data sources, as analyzed in the following section organized by the previously stated industry requirements for knowledge spillovers, proximity, and networks.





Map 1: Central Indiana Life Science Establishments, 2000



Center for Urban Policy and the Environment 2000
Data Source: Dun & Bradstreet Market Place

- Type of Establishment**
- ★ Physical Research
 - Medical laboratories
 - △ Surgical/Medical Instruments
 - Pharmaceutical/Biomedical

- Total Employment***
- 0-500
 - 501-2,000
 - 2,001-11,144

* Sizes represent total employment for all establishment types.

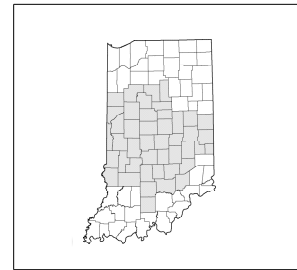


Map 2: Central Indiana Pharmaceutical/Biomedical Establishments, 2000



Center for Urban Policy and the Environment 2000
Data Source: Dun & Bradstreet Market Place

- Total Employment**
- 0-500
 - 501-2,000
 - 2,001-11,144



See page 10 for Maps 3 and 4



ANALYZING THE COMPOSITION OF THE CENTRAL INDIANA LIFE SCIENCE CLUSTER

The key components of Central Indiana's life science economy can be considered part of an interrelated cluster comprised of pharmaceutical, biotech and medical device companies, medical laboratories, and research and development institutions. Looking at the cluster in this way permits an accurate picture of the complex relationships feeding these linked companies (Waits 2000). Individual firms in related areas also should be included as they are identified, such as plastic extrusion firms for medical device manufacturers (largely located in northern Indiana), and hospitals such as those in the Clarian Health Network.

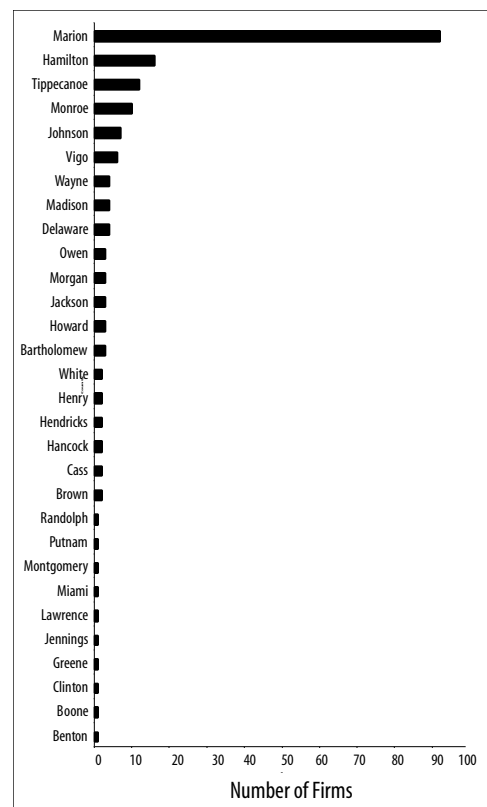
Many types of large local business service firms have relationships with the industry as well, including venture capital companies such as those affiliated with the Venture Club of Indiana, networking organizations such as the Indiana Health Industry Forum, and specialized services with a life science focus from accountancy firms such as Ernst & Young and KPMG Peat Marwick to law firms such as Baker and Daniels. Government and community networks involved directly or tangentially in creating a cluster-friendly environment also need to be assessed as critical stakeholders (Joint Venture Silicon Valley Network 1995).

Central Indiana Life Science Firms are Predominantly Concentrated in Marion County

Comparisons of an address-matched map of the Central Indiana regional life science establishments (Map 1) with other maps detailing sectoral affiliations by biopharmaceutical companies (Map 2), surgical and medical instrument companies (Map 3), and medical laboratories (Map 4) indicate that the overwhelming concentration of life science firms is within Marion County (Indianapolis). However, large companies anchor other clusters outside Marion County in each direction. As demonstrated in Figure 1, while the firm count alone indicates the dominance of Indianapolis—Marion County (92 life science companies)—made even more striking when employment numbers are taken into account—contiguous Hamilton County (16 firms) ranks second in number of firms. Tippecanoe (third with 12 firms) is anchored by Purdue University activity, as fourth-place Monroe (with 10 firms) reflects Indiana University's proximity. The location of firms in Johnson County (7) clearly reflects spillover activity from Marion, while Vigo (6) and Wayne (4) counties support their own local clusters of mixed life science companies (laboratories, pharmaceuticals, and research labs).

The spatial congruence of labor base location and corporate concentration is a considerable location convenience for workers in Indianapolis. The concentration of life science companies, which fall basically in a wedge to the north of the central city, coincides with census tract maps of labor force location by residents with advanced degrees (Map 5) and in professional specialty occupations (Map 6). Not surprisingly, a mere 5 percent of

Figure 1: Central Indiana Life Science Firms by County, 2000





Map 3: Central Indiana Surgical/Medical Instrument Establishments, 2000



Center for Urban Policy and the Environment 2000

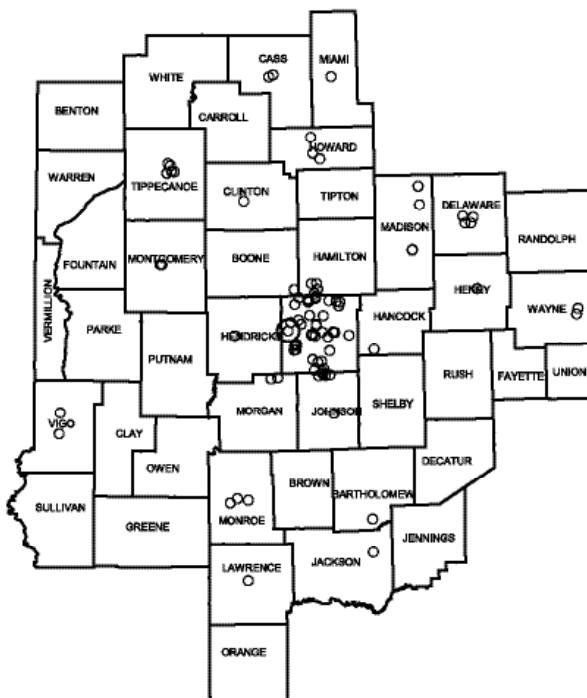
Data Source: Dun & Bradstreet Market Place

Total Employment

- △ 0-500
- △ 501-2,000
- △ 2,001-11,144



Map 4: Central Indiana Medical Laboratory Establishments, 2000

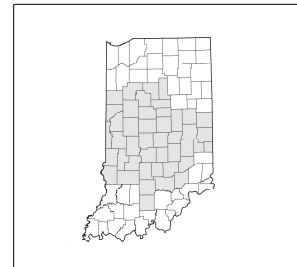


Center for Urban Policy and the Environment 2000

Data Source: Dun & Bradstreet Market Place

Total Employment

- 0-500
- 501-2,000
- 2,001-11,144



See page 12 for Maps 5 and 6



survey and interview respondents indicated any problems with their commute, particularly for managers. The high number of respondents indicating the presence of “suitable office and related facilities” (52 percent), a good “quality of life” (41 percent), and “management preference” (34 percent) for corporate location with features on these demographic maps indicate the ability of managers to choose business locations close to their residence—a large regional plus factor.

Major Life Science Firms in Central Indiana are Primarily Manufacturing

Major life science businesses attracting labor to Central Indiana include several Fortune 500 giants with global reputations. This section profiles some of the leading members of this cluster. Employment data are confidential, but the first five firms (Lilly, Elanco, Guidant, Roche, and Cook) are estimated to employ at least 15,000 people in Central Indiana. Life sciences include a range of corporations primarily from research and development (biotech) to manufacturing (pharmaceuticals, medical device) and service (laboratories). Central Indiana’s cluster emphasizes manufacturing.

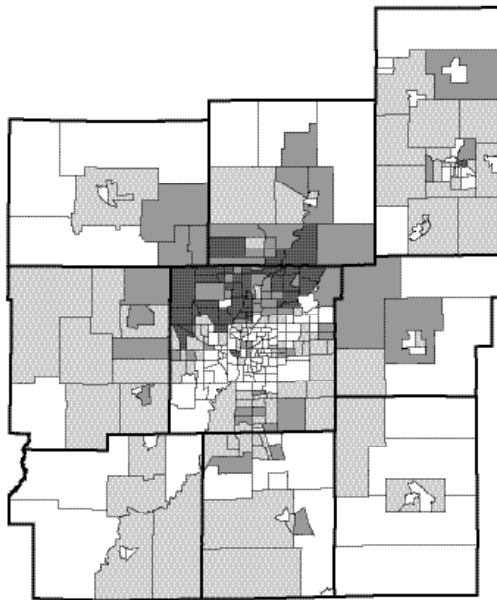
Eli Lilly and Company employs more than 31,000 people worldwide, including 6,000 people in the Lilly Research Laboratories division. Founded in 1876 by Greencastle native Colonel Eli Lilly, the pharmaceutical firm quickly found its roots in Indianapolis. The company now serves a global market comprised of 179 countries, with research and development facilities in nine countries (principally in Indianapolis and Basingstoke, England), and conducts clinical trials in approximately 70 countries. Research partnerships encompass more than 140 collaborations with public and private organizations worldwide. Examples of these collaborations range from molecular to product delivery, from Takeda Pharmaceuticals (diabetes) to Vertex, Ribozyme, and Stanford to work on hepatitis B and C treatments. Manufacturing sites locally are found in Clinton, Greenfield, and Lafayette, Indiana, as well as Puerto Rico and Mainland China.

Elanco Animal Health employs 2,000 workers worldwide and serves a 100-nation market. Its name, adopted six years after its founding in 1954, is an acronym from the parent firm, Eli Lilly and Company. The company focuses on animal products, rather than plants, as did its former partner Dow. Elanco uses Lilly facilities in Clinton and Lafayette, Indiana, to manufacture its products. Locally, research is conducted at the Greenfield Laboratories in Greenfield, Indiana.

Guidant Corporation, with over 8,000 employees worldwide and revenues of \$2.4 billion, functioned as Lilly’s medical device division until it was spun off in 1994. Headquartered in Indianapolis, it produces pacemakers in Minneapolis (home of Medtronic device giant) under the auspices of the Cardiac Rhythm Management Group. Major branches in California include the Cardiac and Vascular Surgery Group in Menlo Park and the Vascular

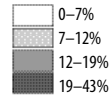


Map 5: Indianapolis MSA Graduate or Professional Degree Holders by Census Tract, 1990

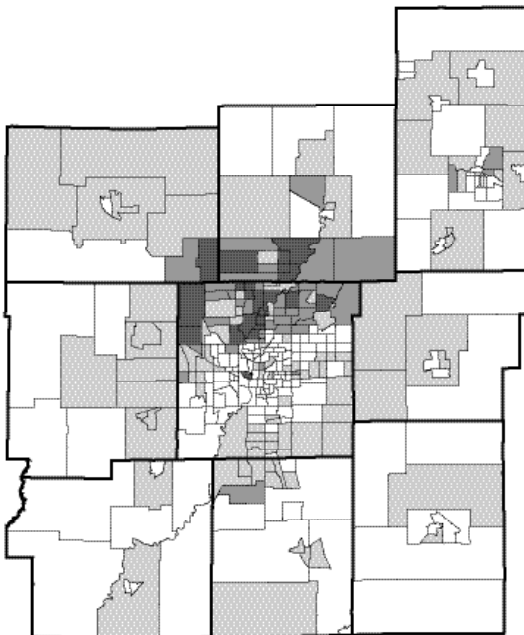


Center for Urban Policy and the Environment 2000
Data Source: U.S. Census Bureau 1990

County Proportion by Census Tract

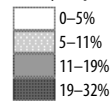


Map 6: Indianapolis MSA Professional Specialty Occupations by Census Tract, 1990



Center for Urban Policy and the Environment 2000
Data Source: U.S. Census Bureau 1990

County Proportion by Census Tract





Intervention Group in Santa Clara. Other operations are in Texas, Washington, Puerto Rico, and Ireland.

Roche Diagnostics' 1997 acquisition of the Bermuda-headquartered Corange Group, which owned German medical device manufacturer Boehringer-Mannheim and DePuy, created the largest diagnostics company in the world. Boehringer originally came to Indianapolis in 1973 when it purchased the start-up company Bio-Dynamics, founded in 1966 by a former Lilly employee. Pharmaceuticals comprise more than half of Swiss-headquartered Roche's sales and occupy 30,000 workers worldwide. Research centers are in Basel, Switzerland; Japan; New Jersey (the U.S. headquarters in the heart of the American pharmaceutical cluster); Germany; Palo Alto, California; and the United Kingdom. It also collaborates with Lilly-affiliated Genentech for research and development and marketing.

Cook Group of Bloomington, Indiana, grew from "a spare bedroom in 1963" to manufacturing over 50,000 products for a global market. A new headquarters under construction will consolidate research and development, manufacturing, warehouse, shipping, and administrative divisions in an 80,000 square-foot facility. Eleven other affiliated companies are in Europe, Australia, Ireland, Canada, and MED Instruments in West Lafayette, Indiana.

Indiana University, Purdue University, Indiana University–Purdue University Indianapolis (IUPUI), and the associated Medical Schools supply research, labor, development facilities, and receive grants to support the life science complex. The importance of university inputs to the medical device industry (Maki and Maki, 1994) and other members of the life sciences has been amply demonstrated in numerous studies. Examining patents granted in this field can measure innovative inputs of both universities and industry laboratories in Central Indiana.

Many New Patents in Central Indiana are Granted in the Life Sciences

Central Indiana's life science cluster concentrates most heavily on production elements, from market-targeted pharmaceutical products to manufactured medical devices. In an industry dependent on constant infusions of new research breakthroughs, consideration of patents that were granted to Central Indiana life science companies from 1995 to 1999 (Table 1) demonstrates the predominance of Eli Lilly in particular and life science companies in general (see page 14). Out of a total of 2,899 patents granted to all companies in Central Indiana, almost one-half (1,199) were filed by companies in this sector. Table 1 also demonstrates the predominance of Indianapolis–Marion County as an innovation center in the life sciences. The life science cluster of Lilly, Roche, and DowElanco is particularly strong with 80 percent of all the Central Indiana life science patents granted.



Table 1: Central Indiana Patents by Company, 1995–99

MSA	Organization	1995	1996	1997	1988	1999	Total
Bloomington	Cook Inc.	3	2	3	3	0	11
Subtotal							11
Indianapolis	Eli Lilly and Company	133	218	198	159	162	870
	DowElanco	10	9	10	2	0	31
	Dow Agrosciences	0	0	0	5	6	11
	Roche Diagnostics Corp.	0	0	0	0	5	5
	Lucent Technologies Inc.	0	4	19	20	28	71
	Boehringer-Mannheim Corporation	13	9	5	14	2	43
	Indiana University Foundation	4	4	8	5	3	24
	Methodist Hospital of Indiana Inc.	0	0	4	3	0	7
	Ecomed, Inc.	1	2	3	0	0	6
	Agouron Pharmaceuticals, Inc.	0	1	0	3	1	5
Subtotal							<u>1,073</u>
Lafayette	Purdue Research Foundation	9	8	22	15	16	70
	Eli Lilly and Company	5	9	12	8	11	45
Subtotal							<u>115</u>
Total Central Indiana Life Science Patents							1,199



Dividing patents into specific classes (Table 2) reveals that more than one-third (1,271 out of 3,432) can be considered life sciences related (see page 16). Patents classified by class of organization continue this trend; 11 of the top 20 classifications concern life science–related discoveries, including four of the top five categories. The strength of this cluster clearly eclipses that of any other as measured by its innovative products. In turn, this should translate into economic vitality for the region.

Given the tremendous variety of patent classes included, both figures confirm the dominant position of life sciences as the key innovative sector within the region. Biotechnology insights are acquired, as well as created, in local laboratories. For example, Lilly has been credited with initiating the modern biotechnology industry in 1976 with the race to produce insulin from human molecules. This followed directly from an insulin symposium held that year in Indianapolis (Hall 1987). Lilly maintains a position in all three areas key to the biotech sector—therapeutics, diagnostics, and agriculture.

Technology Transfers Between Central Indiana Universities and Businesses Contribute to the Strength of the Life Science Cluster

Purdue University's origin as a Land Grant institution predisposed it to applied research, more easily transferable to production than a predominantly research institution such as Indiana University. Areas of Purdue University's research strengths useful for a life science cluster focus include analytical chemistry, pharmacy, veterinary medicine, molecular structural biology, and the agriculture school. In addition, Purdue's 600-acre Research Park and incubator Gateways Program aids start-up high technology businesses with shared office space and services they could ill afford at the early stage of development. Gateways further cites studies showing that incubated businesses demonstrate an enviable 87 percent success rate, with an average of 84 percent remaining locally (Purdue University 2000).

Several life science companies established through connection to Purdue and the Gateways program (BioAnalytical Systems (BAS), Endocyte, SSCI, MEDInstrument, and Cook Biotech) anchor West Lafayette's life science industry cluster and meet together on a monthly basis. Their success illustrates how small companies can be formed from university research in one place, draw on advice from specialists in another close-by place (the Kelley School of Business in Bloomington, Krannert School of Management in West Lafayette, accountants and lawyers in Indianapolis), and be sustained by face-to-face information sharing locally. The firm SSCI was the first start-up to move from the Purdue Research Park incubator to a facility for stand-alone companies nearby. It also pioneered the concept for Purdue of permitting a professor's idea to grow into a company, formed the basis for the incubator, and proved technology transfer can be an advantageous partnership that the university should support.



Table 2: Central Indiana Patents by MSA and Class, 1995–99

MSA	Grant	1995	1996	1997	1998	1999	Total
Bloomington	Class 435,Molecular Biology and Microbiology	0	1	1	1	1	4
	Class 606,Surgery	2	2	2	5	5	16
Indianapolis	Class 128,Surgery	2	0	2	7	3	14
	Class 385,Optical Waveguides	0	2	4	2	2	10
	Class 424,Drug, Bio-Affecting, Body Treating Compositions	5	3	15	5	8	36
	Class 435,Molecular Biology and Microbiology	22	29	30	35	27	143
	Class 514,Drug, Bio-Affecting, Body Treating Compositions	80	140	140	123	101	584
	Class 530,Natural Resins or Derivatives; Peptides	1	21	13	4	2	41
	Class 536,Organic Compounds	5	3	6	6	3	23
	Class 540,Organic Compounds	7	4	8	3	3	25
	Class 544,Organic Compounds	5	4	4	1	5	19
	Class 546,Organic Compounds	11	17	6	9	8	51
	Class 548,Organic Compounds	8	11	3	6	10	38
	Class 549,Organic Compounds	2	6	4	1	12	25
	Class 564,Organic Compounds	4	1	0	0	2	7
	Class 600,Surgery	5	2	1	7	1	16
	Class 602,Surgery:Splint, Brace, or Bandage	0	1	0	1	2	4
	Class 604,Surgery	3	2	4	3	4	16
	Class 606,Surgery	8	3	1	5	2	19
	Class 623, Prosthesis (i.e.,Artificial Body Members)	0	3	3	0	4	10
Class 800,Multicellular Organisms, Unmodified Parts	2	0	2	1	4	9	
Kokomo	Class 800,Multicellular Organisms, Unmodified Parts	2	4	1	7	5	19
Lafayette	Class 127,Sugar, Starch,and Carbohydrates	1	1	1	1	0	4
	Class 424,Drug, Bio-Affecting and Body Treating	3	3	3	3	4	16
	Class 435,Molecular Biology and Microbiology	2	1	5	6	2	16
	Class 514,Drug, Bio-Affecting, Body Treating Compositions	7	3	4	5	6	25
	Class 536,Organic Compounds	2	3	4	2	2	13
	Class 540,Organic Compounds	1	1	3	1	0	6
	Class 546,Organic Compounds	0	0	2	1	1	4
	Class 549,Organic Compounds	1	3	2	2	2	10
	Class 556,Organic Compounds	0	2	0	0	1	3
	Class 568,Organic Compounds	1	3	0	1	2	7
	Class 600,Surgery	1	1	0	1	1	4
	Class 604,Surgery	1	1	0	0	1	3
	Class 623, Prosthesis (i.e.,Artificial Body Members)	0	0	1	2	3	6
	Class 800,Multicellular Organisms, Unmodified Parts	0	1	7	1	4	13
Muncie	Class 435,Molecular Biology and Microbiology	1	1	0	0	1	3
	Class 514,Drug, Bio-Affecting	0	1	1	1	0	3
Terre Haute	Class 514,Drug, Bio-Affecting	0	1	1	1	0	3
	Class 606,Surgery	0	0	0	0	3	3



Within Indianapolis, clinical testing research centers at IUPUI and the IU School of Medicine provide services and collaboration opportunities for local companies in several different ways. For instance, Lilly Laboratory for Clinical Research (Lilly Clinic) occupies the fifth and sixth floors of the Indiana University Hospital of Clarian Health Adult Outpatient Center on the campus of the IU Medical Center. Lilly Clinic conducts Phase I studies (small trials) of potential new drugs at this facility. Researchers at companies such as Lilly serve as adjunct faculty at the School of Medicine, which receives grants from local life science firms as well as national sources. The faculty at the Lilly Clinic provides important training programs for the IU Pharmacology and Clinical Pharmacology fellows and students.

Grant and contract research funds captured by universities also play a part in cluster development. Tables 3 and 4 (see page 18) compare several measures of research and grant yields among Indiana universities and industry leaders in California, North Carolina (Research Triangle Park), and Georgia. For purposes of comparison, top grant states are California and Massachusetts (AUTM 1998; Black 2000; Ernst & Young 2000). North Carolina established the nation's first spatially designated research park 40 years ago to attract high technology companies and funding, while Georgia's Research Alliance pursues policies designed to attract scientists as well as companies for the last decade. The latter two are located in regions that, like Indiana, generally lag the national average for economic development based on high technology.

With the exception of 1995, a low year for grants in every area, the amount of sponsored research in the four institutions tracked annually follows an upward trend, though not the volume indicated for the other institutions and locations (see Table 4). Purdue predominates as a technology transfer center within Indiana by producing a combination of engineering and biochemistry applications. The main purpose of Indiana University's Advanced Research and Technology Institute (ARTI) is to advise and assist Indiana University employees on the process of taking their inventions through patent to production stages. Results for ARTI largely represent the IUPUI campus in general (reportedly 75 percent) and the medical school in particular. The Indiana University School of Medicine includes the adult University Hospital Riley Hospital for Children, School of Allied Health Sciences, School of Dentistry, and the largest School of Nursing in the country. Research areas run the gamut from AIDS and Alzheimer's to X-ray crystallography and yeast antifungal compounds (Bepko 1995).

A proposal to establish statewide research parks jointly managed by IU (in Indianapolis and Bloomington) and Purdue (in West Lafayette) awaits further negotiation and agreement on an already located facility in downtown Indianapolis. As part of a Manufacturing Technology Center at Indianapolis, ARTI advocates a MedAmerica Research Park for locating health industry companies in a section of land adjacent to IUPUI.



Table 3:1997 Technology Transfer Measurements

College	Sponsored Research Expenditure FY97	License Income Received	Active Licenses and Options	1997 Patent Applications	1997 Start-Up
UC System	1,586,533,000	67,279,000	832	500	13
Stanford	391,141,224	51,762,090	1,044	183	15
CA Tech	153,000,000	4,056,829	121	240	9
CA TOTAL	2,130,674,224	123,097,919	1,997	923	37
Duke	360,977,000	1,520,000	180	69	
NC State	334,393,941	3,164,795	455	48	1
UNC	263,517,405	1,684,093	257	66	2
NC TOTAL	958,888,346	6,368,888	892	243	3
Emory	156,990,000	2,800,000	45 (34 LS)	37	3
UGA	225,457,000	3,072,601	122 (108 LS)	28	5
GA Tech	175,573,089	2,291,709	104	37	0
GA TOTAL	558,020,089	8,164,310	271	102	8
Purdue	206,600,000	1,788,000	202	61	2
IU (ARTI)	186,933,015	455,652	87 (57 LS)	30	1
Ball State	8,375,315	139,880	32	0	0
IN TOTAL	401,908,330	2,383,532	321	91	3

Table 4:Annual Technology Transfer Measurements, 1991–97 *

Sponsored Research In \$ thousands	1997	1996	1995	1994	1993	1992	1991
Stanford	391,141	395,464	373,000	370,500	293,000	303,300	280,100
UNC	263,517	262,900	240,300	355,900	150,600	211,100	174,000
GA Tech	175,523	193,000	167,000	194,000	176,000	115,000	133,000
IU (ARTI)	186,933	180,414	172,191	180,000	157,000	166,671	145,609
Patent Applications Filed							
CA Tech	145	90	60	45	69	30	60
Stanford	128	88	40	70	72	53	40
UNC	66	47	113	46	40	30	32
GA Tech	30	61	35	50	32	24	20
IU (ARTI)	11	22	17	5	20	29	5
Licenses Yielding \$							
Stanford	272	259	220	200	214	165	160
UNC	61	50	49	33	35	36	24
GA Tech	86	85	26	27	25	21	15
IU (ARTI)	32	33	21	29	40	23	13

Total IU (ARTI) Research Expenditures, 1991–97

Industrial Sources	\$87,000,000
Governmental Sources	\$766,500,000

Data Source (Tables 3 and 4):Association of University Technology Managers, Inc., AUTM Licensing Survey: FY 97. Norwalk, CT.

* Annual measurements are provided only for those institutions that consistently report for each of the years recorded.



However, efforts to work with purported partners Lilly, Clarion, Dow, Roche, the city of Indianapolis, the Indianapolis Economic Development Commission, and IUPUI have led at this time only to the attraction of an experimental rat breeding company. IUPUI's organizational arm ARTI currently handles the task of attempting to locate and open facilities for a research park and incubator, pending substantive actions by potential partners.

Central Indiana Life Science Firms are Recognized through National Grants

The National Science Foundation's Small Business Innovation Research Program (SBIR) assists small companies (500 or fewer employees) with research ideas to develop them into marketable products. SBIR's goal is to encourage commercialization of innovative ideas, and encourage scientists in this direction. The number of awards earned by Indiana companies since SBIR's founding in 1982 is noted in Table 5, revealing that 77 Indiana firms have received a total of 203 awards. Phase I awards support companies at the beginning stage of development. Only firms receiving awards in the Phase I round are eligible for Phase II awards, for products most likely to reach the market stage. The U.S. Department of Health and Human Services, associated with the life sciences, represents the largest donor of funds to Indiana recipients (Table 6).

By metropolitan area in Central Indiana, Lafayette/West Lafayette received 49 awards, followed by Indianapolis (30), Bloomington (20), Elkhart (14), and Columbus (8). Other Indiana areas that have received awards include Floyds Knobs (6) and Fort Wayne (5). The total value of \$29,105,900 dispensed to the 77 firms—of which 28 represented life science companies—went to a total of 203 projects. While the amount as a whole is modest by national standards, it indicates that the state does produce this type of company which is capable of attracting competitive national level funding support. Key problems in Indiana noted by these companies, however, include the lack of information concerning such programs, insufficient support to sustain small companies at their most vulnerable growth stage, and few larger companies serving as mentors to smaller ones (Audretsch, et al.2000).

Indiana Health Industry Forum and Others Support the Life Science Networks

Local and life science industry giants such as Lilly, its affiliated service companies, and major state universities formed the Indiana Health Industry Forum (IHIF) in 1994 as an advocate organization for the health industry. IHIF is widely credited with effective lobbying resulting in the Indiana 21st Century Research and Technology Fund. Perhaps even more important, IHIF functions to connect businesses with each other and support networks, sustaining new entrepreneurial endeavors.

Table 5: Number of SBIR Awards Earned by Indiana Firms, 1983–96

Year	Phase I	Phase II	Total
1983	6	na	6
1984	8	2	10
1985	8	7	15
1986	6	4	10
1987	13	1	14
1988	14	3	17
1989	9	3	12
1990	15	3	18
1991	5	4	9
1992	13	2	15
1993	13	3	16
1994	15	3	18
1995	13	7	20
1996	17	6	23
1983–96	155	48	203

Source: Small Business Administration, unpublished data

Table 6: Funding Agencies of Indiana SBIR Projects, 1983–96

Funding Agency	Projects Funded	Percent of Total
Health and Human Services	61	39.4
Department of Defense	45	29.0
National Aeronautics and Space Administration	23	14.8
National Science Foundation	13	8.4
Department of Agriculture	5	3.2
Department of Energy	4	2.6
Environmental Protection Administration	3	1.9
Department of Commerce	1	0.6

The health industry is growing, and it has so much room for entrepreneurs in it. It is really a niche industry. At one time, it was the auto industry that presented Indiana businesses with opportunities for entrepreneurs to provide products or services to the big companies. . . . Now it is the health field where the entrepreneur has a chance of building a business.

—Thomas W. Binford 1999



A large company like Lilly forms an all-encompassing familial embrace, dominating the landscape by the size and extent of its functions. Less well known, yet critical both to the health of the regional economy and Lilly's own ability to attract desirable and highly location-competitive employees, is the ability of non-Lilly life science industry personnel to find local jobs in other related companies. More than generally realized, small regional companies in this industry do exist, often thanks to networks such as that provided through the IHIF as meeting ground or to the personal networks formed by business and government associations in past positions.

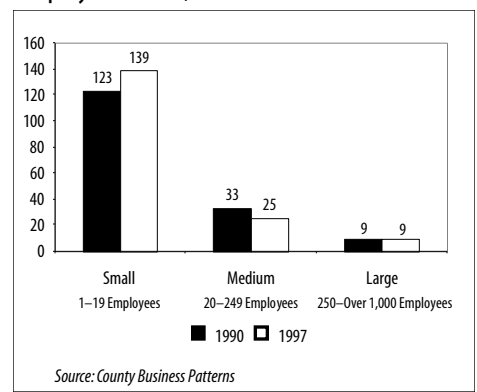
The number and size (measured by employees) of Central Indiana life science establishments exhibits a generally healthy trend through the 1990s (Figure 2). While large companies remain few and stable in number, the small decline in mid-size companies is more than made up by the increase in vital small companies. Although difficulties in establishing small companies remain daunting throughout the industry, Central Indiana's record demonstrates overall growth.

Individuals remaining in the area following a job change include former Lilly employees, such as the current head of the Indiana Health Industry Forum (left Lilly in 1985), several individuals who took early retirement in 1987 and founded their own consulting firm, and others affiliated more recently with small life science firms in metro Indianapolis such as Integrity Pharmaceuticals. Integrity found funding from an out-of-state venture capitalist who purchased a small drug manufacturing company on the northeast side of Indianapolis for a British firm, then went on his own but stayed in Indianapolis by starting Integrity. Former Indianapolis Deputy Mayor David Frick (under former Mayor William Hudnut) and Larry Gigerich, assistant to the mayor, (under former Mayor Steven Goldsmith), currently work in life science companies. In an example of the importance of networks, Gigerich is employed by RealMed, a healthcare claims resolution and payment network firm funded by the former head of Lilly.

These small companies often find supplier relationships with other small firms in the region who understand the needs of and are anxious for the business offered by their small, flexible, niche market-oriented counterparts. While large firms in Central Indiana seldom split or spin-off other companies, individuals, with their ideas and innovations, do occasionally leave to start their own firms. More of this sort of activity, building on niche products less profitable for the large companies' investment but excellent venture ideas, could multiply into a true innovative cluster.

Indianapolis' situation differs somewhat from that of Minneapolis, which has an economy that also features a few large life science firms. Small firms in the latter benefited from investments by former local computer company millionaires (as have so many life science start-ups in other states) constituting a local venture capital pool. A small group of creative entrepreneurs started numerous local firms, working in concert with Medtronic to develop products the larger firm didn't find cost effective to develop. In turn, Medtronic helps them with expertise to bring the product to market when it passes through the development stage (Llobera et al. 1999).

Figure 2: Central Indiana Life Science Firms by Employment Size, 1990 and 1997





SURVEY RESULTS INDICATE AGREEMENT ON CENTRAL INDIANA'S STRENGTHS AND WEAKNESSES AS A LIFE SCIENCE CLUSTER

Responses to the mail survey and individual interviews, as summarized in Table 7, reveal general agreement on the outlines of regional attraction features and needs as they concern the health of Central Indiana's life science industry (see page 22). Fifty percent of respondents were from the Indianapolis area, almost 60 percent of whom came from small companies. Their experience in the Central Indiana region appears evenly divided between new and long-time residents (48 percent were here for 15 years or less). Much of the future of the life science cluster in Central Indiana depends upon building on regional strengths to offset weaknesses.

Most Survey Respondents Have Labor Needs

While local supplies of production chain factors often are cited in the literature as a key cluster advantage, another complementary consideration is the ability of companies to attract and retain needed labor—a complaint of 62 percent of survey respondents. Among the respondents, technical and highly skilled employees are cited as the most difficult skill levels to find, but the need for workers with basic labor skills also was mentioned frequently. Indianapolis seems to experience problems similar to other life science firms across the country, reaffirming the perception of a shortage of technical and highly skilled labor. Interviews in technology hot spots from San Diego to Research Triangle, as well as national studies across the United States, revealed the dearth of locally produced technical labor that this year led to more lenient guidelines permitting entry to the United States of immigrants with sorely needed technical skills (Acs and Ndikumwami 1998; Audretsch and Stephan 1996; DeVol 1999). Central Indiana's situation is exacerbated by the clear clustering of employment on both coasts, attracting a disproportionate number of both jobs and grants supporting research and development to California, Massachusetts, and the Mid-Atlantic states (Prevezer 1998). In 1999 the number of public biomedical companies in California represented one-third of the nation's total and 42.5 percent of the total sector's employment, while second-place New England's share (largely metropolitan Boston) was 17.6 percent of the public companies and 16 percent of the total jobs, a combined total for these two continental bookend regions of 51 percent of total public biomedical companies, and 58 percent of the jobs (Ernst & Young 2000).

Whether employees will stay in a region cannot be answered definitively. However, interview testimony supports the assertion that employees tend to stay in this area for future employment, even though initial attraction to Central Indiana may pose a challenge because of a less attractive image than other areas such as California and Massachusetts. Almost every company interviewed noted that a key hiring consideration was whether the applicant previously or at present resided in this region of the country or had family in the area, raising the likelihood they would remain if hired.



Table 7: Selected Survey and Interview Responses—Central Indiana Location Dynamics

	Response Category	Percent Frequency
1. Why at Current Location	Suitable office and related facilities	52
	Quality of life	41
	Proximity to major market	38
	Management preference	34
	Access to highway	28
	Proximity to other companies	21
	Labor market	21
2. Labor Base Issues	Difficulty finding labor in general	62
	Technical	34
	Highly skilled	34
	Basic	31
	Managerial	14
	Commute problems	5
3. Number of Employees	1–20	59
	21–50	10
	51–100	5
	101–500	17
	500+	9
4. Do Business with Type of Company	Hospital	66
	Pharmaceutical	48
	Medical device	48
	Computer services	48
	Accounting	48
	Legal	45
	University	45
	Legal	38
	Chemical	38
	Distribution	28
	Research	14
5. Location of Establishment	Indianapolis	52
	Lafayette	12
	Columbus	5
	Terre Haute	5
6. How Long in Central Indiana (years)	1–5	17
	6–15	31
	16–25	14
	25+	38



Capital Needs of Life Science Firms Can Exceed Local Supply

Another limiting consideration continues to be insufficient funds for new businesses, undeveloped networks, and insufficient publicity for the many attractive factors present (Indiana Chamber of Commerce 2000). Venture capitalists prefer to invest in their home regions or their own companies, using geographic proximity to keep an eye on their high-risk investments. Areas with the largest amounts of venture capital also contain the highest concentration of risky high technology companies.

As reflected in a recent publication by the Indiana Chamber of Commerce (2000), capital needs increasingly outpace locally available supplies—a dangerous development for the short- and long-term growth of a local cluster in this capital-needy sector. Although successful companies find ways to cope with the dearth of venture capital through university sponsorships, non-local founder-funders, acquisition by larger regional companies, or a combination of factors, companies can be drawn unwillingly out of the region by a non-local venture capitalist. While some successful small life science company entrepreneurs noted the presence of friendly banks willing to make loans (such as Union Planters), others stressed financial pressures to sustain a long and expensive drug development process push the industry toward mergers and acquisitions that affect companies of all sizes (Ernst & Young 2000).

Drug development moves through seven basic steps, from discovery in the laboratory to animal testing, Phase I trials with 20 to 30 healthy volunteers, Phase II with 100 to 300 patient volunteers, and Phase III tests with 1,000 to 5,000 patient volunteers, where hospitals are needed as a venue. Review by the Federal Drug Administration (FDA) and post-market testing complete the often lengthy and expensive development procedure, resulting in an average of one drug marketed for every 5,000 to 10,000 compounds screened (Ernst & Young 2000).

Informal Social Networks Strengthen Central Indiana's Life Science Cluster

The founding of the Indiana Health Industry Forum in 1994 by regional major players represents an important move to advocate the growth of this sector in the region.

The IHIF remains the main network organization for the life sciences, but one in its infancy. A Web page has been developed, but legislative advocacy may be needed as well to improve the prospects for the life science cluster in areas such as adjusting the inventory tax.

Other pertinent organizations and initiatives include: Access to Technology Across Indiana (ATTAIN); Advanced Research and Technology Institute (ARTI); Indiana 21st Century Research and Technology Fund (\$50 million); Indiana Business Modernization and Technology Corporation; Indiana Medical Device Manufacturers Council; and Venture Club of Indiana, Inc.



Social networks involving ties to former employers such as Lilly and places of activities other than employment remain very important (Saxenian 1994; Keeble and Lawson 1997). Several interview participants either personified or pointed out the existence of companies started or staffed by former employees of large local life science firms “flying below the radar screen” of general observers. Many of these entrepreneurs indicate they have benefited from programs such as those sponsored by Fort Wayne’s Northeast Indiana Innovation Center, Ball State’s Entrepreneurship program, the new program at Purdue for a joint M.S. and Management degree, and IU Bloomington’s Johnson Center for Entrepreneurship and Innovation at the Business School.

Central Indiana Life Science Firms Lack Strong University-Incubator Connections

Only one survey respondent selected “tech transfer from university” as a reason for being at their current location. But, “university” was one of the top responses to the question concerning types of companies those surveyed worked with, and “hospital” was by far the most common response, probably indicating IU Medical Center.

However, other sources suggest a key weakness in the Central Indiana life science cluster is a low rate of connection to a university among respondents outside of West Lafayette (Purdue University). For example, the data in Table 3 notes the relative lack of “start-ups” and “patents applications filed” from IU ARTI compared to Purdue and other universities outside Indiana (see page 18). The March 2 issue of the *Chronicle of Higher Education* features an article on campus-based incubators. The article provides examples and testimonials to the effectiveness of institutional arrangements with universities that are largely not in place in Indiana. Interview testimony from West Lafayette unanimously gave credit to Purdue’s Research Park incubator for the few life science companies there, while IUPUI observers, including the head of Elanco and ARTI sources, noted the need for a local incubator to build the lagging tech transfer aspect. None of the Indianapolis companies credited innovation from IUPUI, though some Medical School ideas are under independent development. As noted previously, the Lilly Clinic and the IU Medical School enjoy a long and mutually beneficial relationship.

Since tie-ins with university research is biotechnology leader California’s main locational advantage in the industry, lack of such connections is troubling. Purdue’s distinction could be the existence of its incubator and related Gateways programs providing start-ups with services from reduced rate facilities to basic business counseling. Local university specialty areas in the life sciences include analytical chemistry, pharmacy, veterinary medicine, and molecular biology.



Air Transportation Infrastructure Insufficient for Life Science Industry Needs

Lack of direct air service is the prime recurrent complaint, confirmed by the low score it received on the business location factor part of the survey. “You can’t get there from here” causes time delays in transfers, particularly for trips outside the United States by personnel and concerns regarding shipments of goods by air in an industry characterized by numerous high-value, lightweight, time-sensitive, and locationally dispersed components.

A recent study exploring links between growth of high technology businesses and air transport found a statistically significant link between geographic locations with high investment in research and development and the presence of a hub airline location (Kirk 2000). This realization encouraged San Diego’s bioscience community to lobby effectively several years ago for an additional runway at that city’s airport. Indiana’s status as a state experiencing a net decrease in company headquarters in the period from 1992 to 1997 did not brighten the outlook for generating enough traffic to justify greater air traffic connectivity. Growth in the number of small companies still could provide the new dynamism needed (Kirk 2000).

Local Professional Relationships Appear Positive

According to the survey and interview responses, existing businesses were well utilized by respondents, from the 66 percent transacting with a hospital to the almost 50 percent using other life science industry companies and related services (see Table 7 on page 22). As noted previously, at least one of each type of large local business service firm contains a life science/small business specialty section or specialist.

Government’s Role in Location Decisions for Central Indiana Life Science Cluster is Minimal

Only 8 percent of respondents cited an influence on location decisions by a government entity at the state level, 5 percent at the municipal level, and none at the county level. Local actors continue to be seen as playing the strongest role shaping a local cluster creation. State tax policies, from an inventory tax to research equipment abatement, were cited as desirable, but not critical. Some companies connect the lack of such legislation to a legislature seen as still more sensitive to the needs of the Old Economy heavy manufacturing and agriculture interests rather than the New Economy high technology concerns vital to Indiana’s future growth.

States such as California, Massachusetts, and North Carolina, which host large clusters of life science companies, do so as the result of policy initiatives and inducements as well as market forces of a “virtuous cycle” (Prevezer 1998). In 1998, North Carolina State



University opened an incubator facility specifically designed for fledgling biotech companies, particularly those based on inventions coming from its own laboratories. The Massachusetts Institute of Technology, with a focus on applied research that translated into entrepreneurial ventures which led to the Route 128 boom in computer companies presaging the birth of Silicon Valley, recently completed its own large biotech incubator close to the MIT campus. New economic spaces can be created for industries, or new economic activities can create their own spaces (Scott and Storper 1987; Storper and Walker 1989; Walcott 1998).



CONCLUSION

Each region has its own particular characteristics, which must be taken into account and utilized as a base for building an economic strength. Only by identifying the particular dynamics at work can policy-makers provide properly targeted assistance. The four questions addressed by this analysis of Central Indiana's life science cluster provide a focus. The concept of a "cluster" of firms refers to the presence of a number of companies across a range of sizes and types, which are functionally interlinked. Geographically the key locations of Central Indiana's cluster coincide with university centers in Bloomington, Indianapolis, and West Lafayette. The first three research questions concern particular strengths and challenges posed by location in Central Indiana, which can be divided into three areas: labor base, capital, and infrastructure. Paths to address these needs also fall into three categories: support networks, university connections, and government policies.

While industry needs for technically and managerially skilled labor remains high on a national scale, Indiana must combat the flow of skilled labor to the coasts and seek to retain and/or hire back midwestern experienced workers. To do this, an abundance of attractive job possibilities should be available, in a range of companies, so people who choose to come to the midwest can stay here. Capital is attracted to clusters of investment potential—another reason to cultivate a critical mass of core companies. Infrastructure needs presently are focused primarily on better air connections—again, a consequence of a basic volume of traffic, primarily business connected.

Possible remedies fall into manageable areas, many of which are already in place but insufficiently developed, particularly in comparison to more competitive locations nationally, and in comparison to Indiana's need to combat its locational disadvantages. Support networks should be made more visible, and encouraged through more aggressive mentoring by successful, relatively established firms and individuals. University connections should be strengthened, and focused on establishing a bioscience incubator in Indianapolis, followed by an intermediate stage business park as in other cities serving as earlier pioneers in the area of planned economic development. Government policies should focus on supporting this growth by removing impediments, so growth can occur as a market process.

The fourth question considers the current state of health of Indiana's life science cluster. A snapshot of this industry in Central Indiana reveals a small handful of companies in two tiers—established global giants and smaller entrepreneurial start-ups, including those formerly affiliated with the local giants and founders linked to local universities with health specialties. Key to nurturing the latter are networking organizations founded by the former group of established companies. As numerous studies point out, the key to successful innovative regions lies in the amount of interaction between cluster constituents—beyond even the number and type of companies, institutions, resources and individuals. Dynamic leadership should actively promote all network avenues leading to the creation and survival of more companies and more interactions for idea interchange in this critical component of Central Indiana's economic health.





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APPENDIX A: METHODOLOGY

Results of the survey sent to 150 members of Central Indiana's life science cluster were combined with extended interviews conducted with 15 leading cluster companies including pharmaceutical, medical device, research institutions, and industry sector network companies. The survey follows this description of the methodology. Responses to questions are aggregated in the analysis section of the report. Combined with the 52 responses from the survey, a total of 67 firms and individuals have been consulted. Insights from the interviews in particular permit construction of a dynamic picture concerning the establishment and operation of local life science cluster networks. Interviews were conducted both in person and by telephone, covering the same general research questions posed in the written surveys.

The more extended and flexible nature of open-ended conversations allowed exploration of the background and involvement of the interviewee in the industry, and their particular experiences in this region. Other insights expressed without attribution furnished background for understanding operations and interactions, or their lack, in this region. Discussions concluded with a request for information on relevant topics not covered, and names of others to contact.

Additional areas of inquiry focused on structures supporting or retarding the growth of small firms and the role of knowledge generated by means of patents within regions. The major data sources used in this research to place companies in the region (County Business Patterns, Dun & Bradstreet) rely on "establishment" data which assigns a classification to a location reflecting the predominant economic use of that location. Firm-level data come from both survey and interview material. This study also explores the Central Indiana cluster for signs of firm birth and growth at a variety of scales. Various studies (Audretsch and Stephan 1996; Llobera et al. 1999) suggest that the presence of small firms indicates a more lively and healthy environment for businesses, since small firms indicate new ideas are being generated and sustained by financing in this innovation-dependent sector. Development of a "critical mass" of related companies aids attraction and retention of employees to all related companies in an area. As confirmed in interviews, prospective employees are more likely to come to a region if they feel alternative jobs are available should their current prospect not work out, obviating the need for expensive and uncomfortable family relocation.

Knowledge spillovers from both university and industrial research contribute to innovations fueling the economy, and can be measured by patent citations, which are utilized by company and by product (Jaffee et al. 1993; Zucker et al. 1994). Measuring patents granted both to individual companies in the Central Indiana region and as classified by type of patent constitutes a measure of the concentration of research and development as a whole in the region (Jaffee et al. 1993).



APPENDIX B: SURVEY

CENTRAL INDIANA LIFE SCIENCE INDUSTRY COMPANIES

In the space provided, please indicate all factors that apply to your company, including any further information that would aid in understanding your responses.

1. How long has your business been located in Central Indiana?

- 1–5 years 6–15 years 16–25 years 25+ years

2. Why is your company at its current location? Please rate from 1 (very important) to 3 (least important):

- _____ Proximity to another company with whom we do business
_____ Proximity to a major market _____ Suitable office and other facilities
_____ Access to airport _____ Access to highway
_____ Management preference _____ Quality of life
_____ Tech transfer from university _____ Business incubator
_____ Available labor market
_____ Other: _____

3. Did any governmental entity affect your decision to choose your present location(s) in Indiana? Yes No

If so, circle the appropriate level and describe the factor: State City County

4. With what types of company in Indiana do you do business?

- Pharmaceutical Medical device Chemical University
 Hospital Research Testing Electronic
 Distribution Legal Accounting Computer services
 Specialized consulting Other information technology
 Other (please indicate type): _____

5. Please list 3-to-5 benefits of being located close to another firm in a related field?

6. The presence of what additional type of company or service would be most useful to your business? _____



7. Is the commute to work a problem for:

Employees? Yes No

Management? Yes No

8. Do you have difficulty finding the labor needed for your company? Yes No

If so, please circle the skill level(s) most difficult to hire:

Basic Technical Highly Skilled Managerial

9. Approximately how many employees does your company have?

1–20 21–50 51–100 101–500 Over 500

10. What are the addresses of your facilities in Indiana? Please note below, and indicate the type of activity at the facility:

Address _____ City _____

Production? _____

Management? _____

R&D? _____

Distribution? _____

Other? _____

11. Please indicate your firm's PRIMARY business product:

Pharmaceutical Medical device Chemical

Hospital Research Testing

Electronic Other (please note): _____

Thank you for quickly completing and returning this survey.

