Listening to Biotechnology Leaders: An Interview Study

COMMUNITY COMPASS SPECIAL RESEARCH REPORT NO. 3-9

Hamilton County, Ohio

Community COMPASS

HAMILTON COUNTY
Regional Planning Commission

November 2006

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Regional Planning Commission

Community COMPASS (Hamilton County's Comprehensive Master Plan and Strategies) is a long-range plan that seeks to address mutual goals related to physical, economic, and social issues among the 49 communities within Hamilton County. Through a collective shared vision for the future based on the wishes and dreams of thousands of citizens, Hamilton County now has direction to chart its course into the 21st century.

In developing a broad vision with broad support, Community COMPASS will ensure that trends are anticipated, challenges are addressed, priorities are focused, and our collective future is planned and achieved strategically over the next 20 to 30 years. Through an indepth analysis of all aspects of the County, the multi-year process will result in a comprehensive plan.

Implementation of Community COMPASS

Listening to Biotechnology Leaders: An Interview Study is consistent with Economic Development Objectives and Policies as contained within the 2030 Plan and Implementation Framework for Hamilton County, Ohio. Among the specific objectives related to this study are:

1.3: Develop a globally competitive and diversified economy that is on the cutting edge of emerging technologies, supports emerging industries, encourages entrepreneurial activities, and maintains and strengthens existing business and industry;

1.4: Attract and retain business and industries that provide good paying jobs for a diverse spectrum of County residents; and

1.5: Increase emphasis on and support for university research that leads to new business development.

The Policy Plan for Economic Development Implementation Policies recommends support of regional partnerships, such as the Cincinnati USA Partnership, in developing best practices to improve the business climate.

Abstract

Title:

Listening to Biotechnology Leaders: An Interview Study

Subject:

Analysis of and related policy development for biotechnology firms in Hamilton County, Ohio.

Date:

November 11, 2006

Abstract:

Biotechnology firms make a significant contribution to regional economic development. Recent studies on this industry's local presence used information from secondary data sources such as the U.S. Census and County Business Patterns. This report builds on that data, but goes a step further by conducting in-person interviews with biotechnology CEO's and leaders of 32 firms in Hamilton County. Seven recommendations are presented to retain, expand, and attract biotechnology firms.

Source of Copies:

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LISTENING TO BIOTECHNOLOGY LEADERS IN HAMILTON COUNTY, OHIO: AN INTERVIEW STUDY

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Overview

Background

This project is meant to provide information on biotechnology firms to planners and economic developers in Hamilton County, Ohio, and more generally to academics and development practitioners. The focus on the biotechnology sector stems from its strong contribution to regional development through high average wages, rapid growth over the last decade, and expected continued growth over the next decade. Although several other studies have recently looked at biotechnology in the Cincinnati-Middletown metropolitan area, this study is unique in that it is not based on secondary data. Rather, corporate executives and other biotechnology leaders are interviewed, and their advice on improving the environment for biotechnology firms in the region is solicited.

Methods

An initial list of biotechnology firms in Hamilton County was developed from various sources. The list was revised iteratively as the study progressed. Each of the entities on the list was contacted in Spring 2006 and given a chance to participate. The 32 firms and organizations that agreed to participate represent approximately three fourths of the biotech employees in Hamilton County, hence over 50 percent of the employees in the Cincinnati metropolitan area. Interviews, which were conducted by one member of a team of five interviewers, consisted of 18 open-ended questions. In addition, those interviewed were asked to fill out two one-page survey forms. With a few exceptions, the interviews were recorded; all were written up individually.

Results

Many of Cincinnati's biotechnology firms were started by entrepreneurs already in the region. These "home grown" businesses are experiencing growth, and are not planning to move from the area. The Cincinnati region's locational advantages are its high quality of life, its strong anchor organizations, a dependable skilled workforce, an international transportation hub, and adequate business services. Other than business services, the firms do not buy or sell much in the local area, nor are there strong inter-firm linkages, but the lack of local inputs, markets, and linkages is not a major problem for most. However, the region's major locational disadvantages do primarily stem from its small biotechnology core, which limits some firms' ability to sell to local clients and customers and most importantly makes it difficult to build an upper-level management pool.

Conclusion

Recommendations are to (1) grow biotechnology by focusing on the creation and growth of biotechnology companies; (2) retain existing biotechnology companies partly through improved communication; (3) attract branches of international biotechnology firms; (4) endorse and encourage the recently created CincyTechUSA Executives-in-Residence Program; (5) study further the demand for and supply of space for biotechnology activity; (6) support Cincinnati Children's and U.C.'s Colleges of Medicine, Pharmacy, and Engineering in their efforts to spin off biotechnology firms; and (7) support the Genome Research Institute in its effort to become the primary drug discovery center for the State of Ohio and the region.

Introduction

Biotechnology has become the focal point of many state and regional economic development strategies, and the greater Cincinnati region is no exception. Economic development planners seek information on the current state of biotechnology in the region. They also desire to understand what specific strategies can strengthen creation, expansion, recruitment, and retention of biotechnology enterprises. There have been a number of studies, several of which have involved one or two of the authors of this report, over the past decade that provide information on biotechnology in the region. All are data-driven, and all define the biotechnology sector for the region at least somewhat differently. Nine of those studies are as follows, in reverse chronological order:

- *Cincinnati and Biotechnology, Working Paper*
  (October 2005, Hamilton County Regional Planning Commission)
- *Cincinnati USA Industry Cluster Profile: Biotechnology*
  (August 2004, Economics Center for Education & Research)
- *Identification of Industry Clusters for Guiding Economic Development Efforts in Cincinnati USA* (May 2004, Economics Center for Education & Research)
- *Hamilton County's Comparative and Competitive Advantages*
  (April 2004, Hamilton County Regional Planning Commission)
- *Northern Kentucky New Economy Marketing Strategy—Target Industry Study*
  (October 2003, Angelou Economics)
- *Technology Workforce Assessment of Cincinnati USA*
  (2003, Cypress Research Group)
- *Technology-Based Economic Development Strategy*
  (March 2002, Battelle)
- *Kentucky Clusters: Industrial Interdependence and Economic Competitiveness*
  (June 2001, University of North Carolina)
- *Target Marketing Strategy*
  (March 1999, The Wadley-Donovan Group)

With so many recent studies devoted to this particular sector of the regional economy, *how is it possible that yet another study is needed?* As it turns out, there are two very simple reasons, both related to the problems with secondary data (on which the nine studies above rely) for the biotechnology sector. First, "biotechnology," unlike brewing, for example, is not a single, "self-contained" industry. Beer tends to be produced only by brewers. Moreover, the beer manufacturers tend only to produce beer. Industrial reports and book chapters abound which discuss beer using both industrial-level and firm-level data, without concern that some important industrial segment is being left out or that some large brewers are being ignored. Biotechnology, however, is much more complicated. There are firms in any number of different industries (see the Department of Commerce's 2003 report) that use biotechnology and are referred to as "biotech firms." Meanwhile, firms that can be identified as those producing or supporting biotechnology are not necessarily engaged in those activities alone. Second, "biotechnology" has many private firms. Whereas financial data and data from annual reports are often quite informative for firm-level information, these types of data are not readily available for many (private) biotechnology firms. Indeed, some of the firms that are highlighted in our

study are not public and have no plans to go public. Because of these two problems with secondary data, the nine studies listed above do not, unfortunately, give a complete description of biotechnology in the greater Cincinnati region generally or Hamilton County, in particular. This study is meant to fill an important gap left by the less-than-perfect secondary data for the biotechnology sector. Our approach looks at both public and private firms and looks for biotechnology regardless of in which industry the firm primarily participates.

The study described in this report is *unique* and is meant to complement data-driven studies. Not only do we get around the problems with secondary data for the biotechnology sector, we get answers to questions that secondary data cannot possibly answer by themselves. We conduct 32 comprehensive interviews of biotechnology leaders and corporate executives in the greater Cincinnati area (focusing almost exclusively on those in Hamilton County). We learn first hand about the locational advantages, disadvantages, and problems of those organizations active in the region's biotechnology sector. Although the richness of the responses to our comprehensive in-person interviews cannot completely be captured in the report, we hope that we have done justice to the insights and conclusions of our respondents and have given them a voice as stakeholders in this extremely important industrial sector.

Although the Cincinnati area is not considered a nationally recognized biotechnology center, it does have several large biotechnology employers, including P & G Pharmaceuticals, Ethicon Endo-Surgery, Cincinnati Children's Hospital Medical Center, and the University of Cincinnati which serve as "anchor employers" in the area and as assets to a number of smaller companies and research organizations. These four anchors are briefly described as follows:

- P & G Pharmaceuticals is one of Procter & Gamble's health care divisions that has successfully developed and marketed a wide range of prescription products since the 1980s, including Actonel, Asacol, Enablex, Dantrium, Dantrium IV, Didronel, Macrobid, Macrodantin, Entex, and Ziac. Although P & G Pharmaceuticals has recently closed its Drug Discovery Division, it will continue with its other drug development activities.

- Ethicon Endo-Surgery, a division of Johnson & Johnson, is located in Blue Ash. This company develops devices that enable interventional diagnosis and treatment in the areas of general and thoracic surgery, breast disease, gynecology, oncology, and urology.

- Cincinnati Children's Hospital Medical Center is a member of the elite "Big Six" children's hospitals. Out of all children's hospitals in the United States, CCHMC ranked 2nd in 2005 in research funding from the National Institutes of Health. Its excellent reputation spills over to other businesses and neighboring medical institutions in the Cincinnati USA community. CCHMC conducts research in pulmonology, cardiovascular development, gene regulation, cancer biology, and rheumatology.

- The University of Cincinnati is the region's largest employer, with approximately 15,000 full-time and part-time employees. Its Colleges of Medicine, Pharmacy,

and Engineering are instrumental in the training of a biotechnology workforce and in providing research and educational support to existing firms.

As part of this project, we were able to interview two of the above four large biotechnology organizations in the region, as well as several divisions of a third.

Biotechnology is a new and growing field. Start-up enterprises are also a very important part of the sector. Bio/START is Cincinnati USA's biomedical business incubator. It provides specialized wet-lab space and shared technical equipment for entrepreneurs and start-up companies. Bio/START also offers business counseling, entrepreneurial education, and support infrastructure. A goal is to provide an opportunity for biomedical innovations to be commercialized locally. At the writing of this report, Bio/START has nine biotechnology start-ups, including KeyClone Technologies, NanoLogix Inc., Bexion Pharmaceuticals, NeoCytex Biopharma, Inc., CL Solutions, Siloam Biosciences, CardioEnergetics, Molecular Diagnostic Laboratories, and Phase 2 Discovery. As part of this project, we were able to interview three of the current residents of Bio/START:

- CardioEnergetics, which is working on the development of a heart-assist device to treat congestive heart failure.
- Molecular Diagnostic Laboratories, which produces DNA-based diagnostics for cardiovascular, thrombophilic, pharmacogenetic, and other genetically-linked diseases.
- Phase 2 Discovery, which seeks to acquire and develop early stage pharmaceuticals for treating psychiatric and neurologic disorders.

In Section 2, we describe the firms and organizations that we talked with and their diversity in terms of products and services.

Importance of Biotechnology to Hamilton County and the Greater Cincinnati Region

Before discussing the results of our study, it is important to review the *primary reasons* that this sector is particularly valuable to the region's economy. Before we do that, however, it is first convenient, due to data availability, to determine in which industries most biotechnology occurs. The two core industries identified by the October 2003 Department of Commerce report, *A Survey of the Use of Biotechnology in U.S. Industry*, were NAICS (North American Industrial Classification System) industries 541710 and 3254. Of the 897 respondent biotechnology companies that identified their industry, 333 (37.1%) of them identified 5417, *Scientific Research & Development Services*, as their primary NAICS code. Specifically, we include 541710, *Research and Development in the Physical, Engineering, and Life Sciences*, in the figures in this section. Another 301 (33.6%) of the survey respondents identified 3254, *Pharmaceutical & Medicine Manufacturing*, as their primary industry. Very few respondents identified 3391, *Medical Equipment & Supplies Manufacturing*. However, since a number of firms in the greater Cincinnati region participate in 3391, indeed, one of the region's anchor employers is in this industry, we include 3391 as well in the core set of industries. Medical devices, like pharmaceutical products, go through a Food and Drug Administration (FDA) approval process.

One reason why biotechnology is so important to regional economic development is its high average salary. In 2004, the average national salary across all industries in *2004 County Business Patterns* was $36,967. As shown in the second column of Figure 1 (for the Cincinnati-Middletown Metropolitan Statistical Area) and Figure 2 (for Hamilton County), average salaries were $81,363, $71,794, and $47,215 for *Research and Development in the Physical, Engineering, and Life Sciences* (NAICS 541710), *Pharmaceutical & Medicine Manufacturing* (NAICS 3254), and *Medical Equipment & Supplies Manufacturing* (NAICS 3391), respectively. Since high-income individuals tend to spend more, they contribute more to regional development as they purchase goods and services.

A second argument for targeting biotechnology is its strong growth record. As shown in the sixth column of Figures 1 and 2, pharmaceutical manufacturing employment grew 13.4 percent between 1998 and 2004, while employment in medical equipment manufacturing grew 4.4 percent over this same six-year period. Employment growth in the R & D service industry was an impressive 113.4 percent from 1998 to 2004. Moreover, employment forecasts are quite positive. According to the Bureau of Labor Statistics, employment will grow 26.1 percent in *Pharmaceutical & Medicine Manufacturing* between 2004 and 2014. There is a 12.8 percent employment growth forecast for *Research and Development in the Physical, Engineering, and Life Sciences*, while *Medical Equipment & Supplies Manufacturing* is expected to experience a growth in employment of 2.6 percent over the next decade.

Figure 1

2004 Biotechnology Core Industrial Strength in the Cincinnati-Middletown Metropolitan Statistical Area (MSA)

(NAICS* codes in parentheses)

* North American Industrial Classification System

** According to the *North American Industry Classification System, United States, 1997*, 541710 "comprises establishments primarily engaged in conducting research and experimental development in the physical, engineering, or life sciences, such as agriculture, electronics, environmental, biology, botany, biotechnology, computers, chemistry, food, fisheries, geology, health, mathematics, medicine, oceanography, pharmacy, physics, veterinary, and other allied subjects."

Industry	National Average Salary (2004)	MSA Employment (2004)	MSA Location Quotient (2004)	MSA Change in Location Quotient (1998-2004)	National Employment Growth (1998-2004)	MSA Employment Growth (1998-2004)	MSA Less National Growth (1998-2004)
R&D in Physical, Engineering, & Life Sciences ** (541710)	$81,363	7,639	1.65	+1.26	+113.35%	+883.14%	+769.79%
Pharmaceutical & Medicine Mfg (3254)	$71,794	1,614	0.83	+0.05	+13.44%	+30.27%	+16.83%
Medical Equipment & Supplies Mfg (3391)	$47,215	1,620	0.66	+0.06	+4.35%	+23.95%	+19.60%

Source: 2004 County Business Patterns

Figure 2

2004 Biotechnology Core Industrial Strength in Hamilton County

(NAICS* codes in parentheses)

* North American Industrial Classification System

** According to the *North American Industry Classification System, United States, 1997*, 541710 "comprises establishments primarily engaged in conducting research and experimental development in the physical, engineering, or life sciences, such as agriculture, electronics, environmental, biology, botany, biotechnology, computers, chemistry, food, fisheries, geology, health, mathematics, medicine, oceanography, pharmacy, physics, veterinary, and other allied subjects."

Industry	National Average Salary (2004)	County Employment (2004)	County Location Quotient (2004)	County Change in Location Quotient (1998-2004)	National Employment Growth (1998-2004)	County Employment Growth (1998-2004)	County Less National Growth (1998-2004)
R&D in Physical, Engineering, & Life Sciences ** (541710)	$81,363	5,660	2.25	+1.73	+113.35%	+710.89%	+597.54%
Pharmaceutical & Medicine Mfg (3254)	$71,794	1,230	1.17	+0.08	+13.44%	+5.94%	-7.50%
Medical Equipment & Supplies Mfg (3391)	$47,215	1,148	0.87	+0.15	+4.35%	+10.07%	+5.72%

Source: 2004 County Business Patterns

Status of Biotechnology in Hamilton County and the Greater Cincinnati Region

Although not in the same league as San Diego, Seattle, or Raleigh-Durham-Chapel Hill, the Cincinnati region generally, and Hamilton County in particular, have made significant progress in biotechnology employment over the last six years. In the metropolitan area, employment growth in all three industries outpaced national employment growth over the period 1998 – 2004. In fact, the last two columns of Figure 1 show that growth in regional R & D employment was 883.1 percent, exceeding the national growth rate by 769.8 percent. However, some of the increase at both the regional and national levels is undoubtedly spurious. In the *1998 - 2002 County Business Patterns* reports, corporate, subsidiary, and regional managing offices were tabulated in NAICS Sector 55, *Management of Companies and Enterprises*. All other auxiliaries were tabulated in NAICS 95. Starting with 2003, corporate, subsidiary, and regional managing offices are still published in NAICS Sector 55, but the other auxiliaries are tabulated in the industry of the service, including 5417, performed. Regional employment growth exceeded national employment growth in pharmaceutical manufacturing and medical equipment manufacturing by 16.8 percent and 19.6 percent, respectively. The last two columns of Figure 2 tell a similar story for Hamilton County, except that national employment growth in pharmaceutical manufacturing exceeded the county employment growth of 5.9 percent.

Not only have the region and its largest county experienced employment growth in the three biotechnology industries, but the region and county have also become more specialized in biotechnology between 1998 and 2004. A location quotient (LQ) measures the share of a region's employment in a particular industry divided by the national employment share in that industry. A location quotient exceeding 1 signifies that the region is specialized in the industry. Figures 1 and 2 indicate that both the Cincinnati region and Hamilton County are specialized in R & D. While the region has an LQ = 1.65, the county's LQ = 2.25. Moreover, Hamilton County is specialized in pharmaceutical manufacturing with an LQ in 2004 of 1.17. For the region as a whole, an LQ = 0.83 indicates that pharmaceutical manufacturing is less concentrated in the region than nationally. Neither the city nor the region is specialized in medical equipment manufacturing. Location quotients are 0.66 and 0.87 for the region and Hamilton County, respectively. Each of the three industries in each of the geographic areas has had an increase in location quotient from 1998 to 2004.

Figure 3 shows how the Cincinnati-Middletown Metropolitan Statistical Area compares with the other six MSAs in Ohio. According to the *2004 County Business Patterns* data, the Cincinnati region is doing relatively quite well. It is certainly not the case that other areas in Ohio are leaping ahead of Cincinnati in biotechnology. Of the seven Ohio metropolitan statistical areas, Cincinnati has both the highest number of employees and the highest degree of specialization (highest LQ) in *Research & Development in the Physical, Engineering, and Life Sciences*. The same is true for *Pharmaceutical & Medicine Manufacturing*, though none of the areas is specialized in this industry; all location quotients are less than one. In the case of Medical Equipment & Supplies Manufacturing, the Cleveland-Elyria-Mentor Metropolitan Statistical Area has, by far, the highest number of employees (close to 5,000) among the Ohio MSAs and an LQ = 1.93. According to the *D & B Million Dollar Database*, accessed through the University of Cincinnati, the Cleveland area is home to at least four large (500+ employees) medical device companies: STERIS Corporation, Invacare Corporation, Philip Medical Systems, Inc., and Scott Fetzer Com-

pany. In this industry, the Cincinnati region trails Columbus as well; there are 1,620 employees in the Cincinnati region compared to 1,762 in Columbus. Neither Cincinnati nor Columbus has an LQ exceeding one, however.

Figure 3

2004 Biotechnology Cross-Region Comparisons

Metropolitan Statistical Area	R & D ** (NAICS 541710)		Pharmaceuticals (NAICS 3254)		Medical Equipment (NAICS 3391)	
	Employment	LQ	Employment	LQ	Employment	LQ
Akron	1,310	0.86	8	0.01	775	0.97
Cincinnati-Middletown	7,639	1.65	1,614	0.83	1,620	0.66
Cleveland-Elyria-Mentor	2,665	0.55	1,124	0.55	4,925	1.93
Columbus	4,992	1.24	1,087	0.65	1,762	0.83
Dayton	2,266	1.24	200	0.26	665	0.69
Toledo	1,291	0.87	0	0.00	461	0.59
Youngstown-Warren-Boardman	23	0.02	97	0.21	361	0.63

Source: 2004 County Business Patterns

(NAICS* codes in parentheses)

* North American Industrial Classification System

** According to the *North American Industry Classification System, United States, 1997*, 541710 "comprises establishments primarily engaged in conducting research and experimental development in the physical, engineering, or life sciences, such as agriculture, electronics, environmental, biology, botany, biotechnology, computers, chemistry, food, fisheries, geology, health, mathematics, medicine, oceanography, pharmacy, physics, veterinary, and other allied subjects."

Description of Study

From March through June 2006, a team of two faculty members and three graduate students conducted in-person interviews with biotechnology leaders in the Greater Cincinnati Region, all but one in Hamilton County. Each of 32 interviews was conducted by one of the team members. Interviewees were primarily executives of biotechnology companies, though some public-sector individuals were interviewed as well. The shortest interview was 20 minutes by phone, and the longest lasted over three hours in person; the length depended on the amount of time the interviewee could spare. The interviews were taped, then summarized in written reports which were submitted to the Hamilton County Regional Planning Commission within a few days following the interview. This report is based on the results in the 32 interview summaries. The next section gives a general description of the organizations that we visited.

The primary purpose of the interviews was to determine the locational advantages and disadvantages of Hamilton County from the point of view of the firms that are currently in the area. As a byproduct, of course, the interviewers hoped to come up with recommendations for encouraging the growth of the biotechnology sector in Hamilton County, through creation, expansion, attraction, and retention of biotechnology firms and biotechnology-support firms and organizations. Besides the interview questions, which we present in Figure 4, the people interviewed were asked as well to fill out two forms at the end of the interview. The first, in Figure 5, is a list of regional characteristics. The interviewee was asked to check whether the feature was a locational advantage or disadvantage. When the person didn't know or was ambivalent, he or she left that characteristic line blank. The second, in Figure 6, solicits information on where the firm's products are sold as well as information on where the firm's inputs come from in order to get an idea of how spatially linked the interviewee is with clients/customers and/or suppliers/vendors.

Interview Questions

Figure 4

1. Please tell me the history of your firm.

   When was it founded?
   Was it founded as an "incubator" company? At a university? Other?
   How did it get "up and running"? (Personal investment? Bank loans?)
   Has it always been in the Cincinnati region? Why here?

2. Is this establishment an independent firm or a subsidiary of larger company?
   Do you have branch plants? Where?

3. Does your firm have any subcontracting, joint production ventures, licensing agreements with other firms that are either in the Cincinnati region or elsewhere?

4. Please tell me about your company today.

   Do you consider your company to be in the biotechnology sector? Explain.
   What do you consider your primary line of business?
   How many employees work here?
   Do you plan to hire more employees in the near future?

5. What products and/or services do you produce at this location?
   Where are your customers located?
   With which other local firms do you interact?

6. What are your major inputs (both material inputs such as chemicals and key services such as legal, for example)?
   Where do these inputs come from?
   With which other local firms do you interact?

7. Who are your major competitors?
   Are they in the Cincinnati region?

8. What are the advantages and disadvantages of this facility being in the Cincinnati region?

9. Is the local/regional workforce adequate for this operation?
   Do you have specific labor skill needs?
   How could the local workforce situation be improved?

10. Is the local/regional physical infrastructure (transportation, utilities, and so forth) adequate for this operation? How could the situation be improved?

11. Is the local "intellectual infrastructure" (local/regional colleges and universities, professional societies, etc.) adequate for this operation?
    How could the situation be improved?

12. How important is it to you to be located near other firms that make similar products or services?
    With which other local firms do you interact?

13. How important is it to you to have a local or regional organization such as a regional "trade association" that serves your specific needs as a biotechnology company?

14. If you could easily move this facility, where would you put it? Why?

15. From your perspective, what types of firms should Hamilton County target to attract to the region?

16. Are you aware of any trends that will impact future growth and location decisions of local biotech companies?
    What are your or your industry's current and future needs?

17. Can you suggest other firms we should interview?
    Who should we contact?

18. Is there anything that Hamilton County, in particular, can do to assist biotech businesses?

Locational Advantage & Disadvantage Survey

Figure 5

Local Attribute	Relative Advantage	Disadvantage
Skilled Labor Availability		
Labor Costs		
Labor/Management Relations		
Management Availability		
Management Skills		
Management Costs		
Access to Markets, Customers (regional, global)		
Local Market Size		
Access to Input Materials (regional, global)		
Access to Local Input Materials		
Access to Business Services (regional, global)		
Access to Local Business Services		
Intellectual “Climate”		
Culture, Amenities		
Industry “Networking”		
Quality of Life		
Gas Service		
Sewer Service		
Utility Costs		
Taxes		
Cost of Industrial Land		
Availability of Industrial Land		
Sizes of Available Land Parcels		
Zoning, Land Use Controls		
Environmental and Site Permits		
Topography, Soils, and Foundations		
Transportation Services, Availability and Access		
Location Relative to Other Facilities Within Your Company		
OTHER		

Figure 6

Location of Clients / Customers and Suppliers / Vendors

Please list the *major* MATERIAL or SERVICE INPUTS to your facility at this location.
Then, for each input, estimate the percentage that comes from (a) within the Cincinnati region, (b) within the Midwest (e.g., within about 400 miles from Cincinnati), and (c) within the USA.

Major Product or Service Input	Percent from Within the Cincinnati Region	Percent from Within 400 Miles of Cincinnati	Percent from Within the USA

Please list the *major* PRODUCTS or SERVICES you DELIVER to customers from your facility at this location.
Then, for each output, estimate the percentage that is delivered to (a) within the Cincinnati region, (b) within the Midwest (e.g., within about 400 miles from Cincinnati), and (c) within the USA.

Major Product or Service Output	Percent Delivered Within the Cincinnati Region	Percent delivered Within 400 miles of Cincinnati	Percent Delivered Within the USA

Industrial Clusters

Most of the data-driven reports either explicitly identify a biotechnology cluster in the region and/or assume a cluster-targeting approach (as opposed to, say, an economic-base approach) to economic development. The cluster approach assumes that development efforts targeted toward firms in one industry in the cluster will have positive spillover effects (through vertical or horizontal inter-industry linkages) on other industries in the cluster. One might guess, for example, that helping a biotechnology firm might indirectly help its chemical suppliers in the area. In our study, we do not assume a particular approach to economic development, but we do collect enough information to give an answer to whether regional biotechnology should be considered a cluster or simply a group of essentially independent, nonlinked biotech firms. The answer turns out to be somewhat complex and lies between these two extremes.

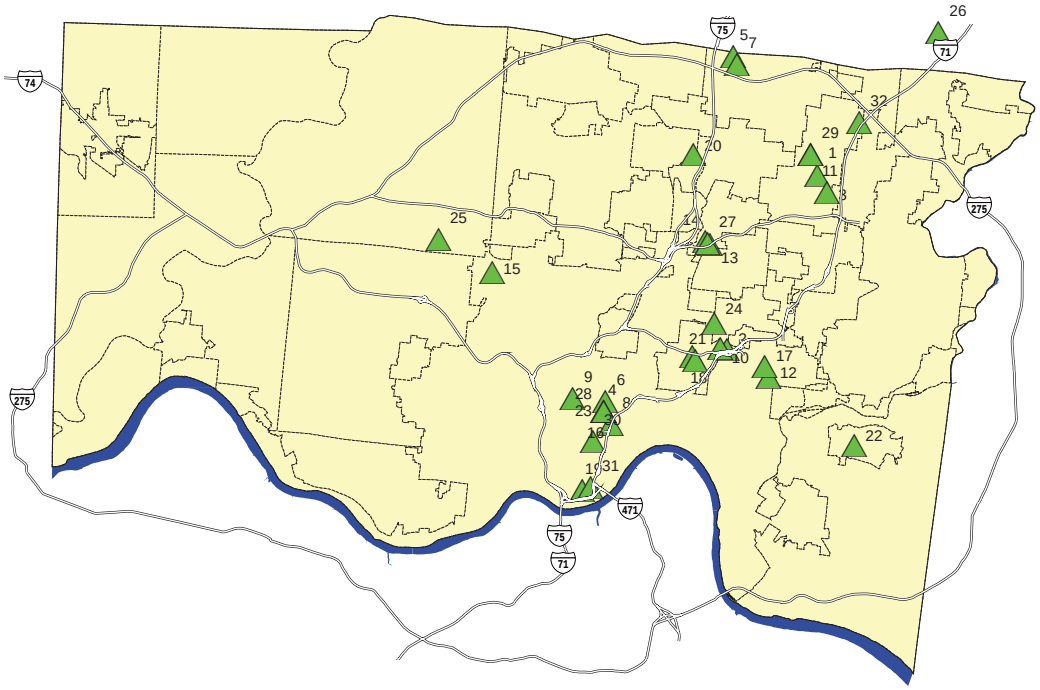
Description of Interviewed Enterprises

The companies we interviewed vary substantially in line of business, size, age, and so forth. Some companies are independent; some are subsidiaries of larger companies, whose parent company might be from the region, or from some other location in the United States or abroad. While these differences have an impact on the shape of the relationships the interviewed companies have locally, there still are many similarities among their responses to the questions asked of them.

Figure 7 is a map of Hamilton County which shows the locations of the 32 firms and organizations interviewed. Note that not quite all the locations show up distinctly. There were three interviews, for example, that occurred at Bio/START; all firms in Bio/START have the same address. Moreover, there were several interviews that took place at enterprises at the corner of Galbraith and Reading Roads.

Map of Biotechnology Firms and Organizations Interviewed

Figure 7



1. C T I Clinical Trial & Consulting Services
2. Barr Laboratories
3. Camargo Pharmaceutical Services
4. CardioEnergetics, Inc.
5. Celsus Laboratories, Inc.
6. Cincinnati Children's Hospital Medical Center
7. Cincinnati Sub-Zero Products, Inc.
8. CincyTechUSA
9. Clinical Research Consultants, Inc.
10. EMD Chemicals
11. E-Prime LLC
12. Forest Pharmaceuticals, Inc.
13. Genome Research Institute
14. Girindus U.S.A.
15. Harrison Clinical Research, USA
16. Hoxworth Blood Center
17. Integra
18. KATZEN International, Inc.
19. Kendel International, Inc.
20. Mar-Test, Inc.
21. Medpace, Inc.
22. Meridian Bioscience, Inc.
23. Molecular Diagnostic Laboratories
24. Molecular Research Center, Inc.
25. National Research Labs, LLC
26. P&G Pharmaceuticals, Inc.
27. Patheon, Inc.
28. Phase 2 Discovery, Inc.
29. SpineForm
30. Sterling Research Group, Ltd.
31. Triathlon Medical Ventures
32. UMD, Inc.

While manufacturing employment has declined by 1.3 percent since 1987, health care and other service industries continue to gain in numbers.

The heterogeneity in what the firms we interviewed actually do is *overwhelming*, and caused the interviewers to appreciate the difficulty that the government and/or private databases will have in collecting good secondary data about the sector. One organization that we talked to produces the following: basic biomedical, biological research; drug discovery research (target identification and validation); early "hit" identification (compound screening); and pre-clinical drug candidates. It hopes soon to be involved in early drug lead optimization. A second organization produces economic development services and infrastructure development for technology companies. The term "contract research organization" (CRO) applies to a type of organization that offers its clients a wide range of pharmaceutical research services, including product development and formulation, clinical trial management, central laboratory services for processing trial samples, data management services for preparation of an FDA New Drug Application (NDA) or an Abbreviated New Drug Application (ANDA), and many other complementary services. One CRO in this study provides clinical trial and commercial expertise to clients developing therapies for solid organ transplant, hepatitis, infectious disease and hematology/bone marrow transplant. Its services span the entire lifecycle of the product from drug development pathway design, clinical trial design, strategic marketing plan development, product management, and sales. It can manage all phases of the clinical trial process for its clients. Another larger, less therapeutically specialized CRO similarly delivers complete clinical development solutions from first-in-human studies through market launch and surveillance. One manufacturing firm in the region offers a total systems approach to patient temperature management. Products include core body temperature regulation, cardiovascular/blood cooling and heating, and cold therapy and heat therapy needs. This same firm, through a different division, offers shelf-life validation for sterile products. Another company produces heparin biomedical coatings as well as injectable-grade heparins. Yet another firm produces three primary product lines in its Cincinnati location, including oligonucleotides, small molecules, and active pharmaceutical ingredients. To sum up, 32 different interviews yielded 32 different responses to Questions 4 and 5 from Figure 4: "Please tell me about your company today" and "What products and/or services do you produce at this location? …"

The firms compete in individual market segments. For example, the firm that manufactures devices that are used for temperature control participates specifically in the localized cold therapy and localized heat therapy segments, among several other segments. One of the CROs is specialized by therapeutic class including solid organ transplant, hepatitis, infectious disease and hematology/bone marrow transplant. Furthermore, several of the drug manufacturers in the area have very specialized facilities capable of producing particular pharmaceutical ingredients in particular quantities.

Nevertheless, despite the wide differences among the regional biotechnology firms, the interviewers made an attempt to group the firms and organizations according to the biotechnology functions in which they are involved. Figure 8 depicts the biotechnology functions (discovery, development, manufacturing, testing, support, and input supplier) performed by each of the organizations interviewed. Thirteen organizations are involved in the discovery, development, and/or manufacturing of pharmaceuticals. Six entities are involved in the discovery, development, and/or manufacturing of medical devices. Nine firms provide drug-testing or device-testing services to drug or device manufacturers, while seven organizations provide other types of services. However, again we stress that the broad categories in Figure 8 are not how the interviewees view their businesses. They describe their business as taking place in much narrower market segments.

Figures 9 and 10, respectively, found on page 15, show the size distribution and the age distribution for the firms and organizations interviewed. Ten of the 32 interviews occurred in firms or organizations with fewer than ten employees. In fact, three of the firms reported a single employee (presumably the person we talked to) in the Cincinnati area. Two very small firms are in the Bio/START incubator. Another eight firms had at least ten but fewer than 50 employees. We had interviews at 10 "mid-sized" firms or those with between 50 and 499 employees. In total, there were four interviews at "large" companies, those with at least 500 employees. Along with visiting a range of companies from very small to very large, we interviewed companies at different ages as well. There were some that were fairly new to Hamilton County as well as some that had been in the area for a long time. We interviewed five firms that have been in Hamilton County for less than five years and another eight that have been in the area between five and nine years. Figure 10 shows that there are 12 firms that are 20 years old or older; four firms that are at least 50 years old; and one that has a history in the area of over a century.

Biotechnology Functions Performed By Each Organization Interviewed

Figure 8

Firm	Discovery	Product Development		Manufacturing		Testing	Support	Supplier
		Drug	Device	Drug	Device			
1	x							
2	x							
3	x						x	
4	x	x		x				
5		x						
6		x						
7		x						
8		x		x				
9		x				x		
10			x					
11			x					
12			x		x			
13			x		x			
14			x		x	x		
15				x				
16				x				
17				x				
18				x		x		
19						x		
20						x		
21						x		
22						x		
23						x		
24						x		
25							x	
26							x	
27							x	
28							x	
29							x	
30							x	
31								x
32								x

Figure 9

Breakdown of Interviewed Firms by Number of Employees in the Cincinnati Region

1-9	10-49	50-99	100-249	250-499	500-999	> 1000
10	8	4	2	4	2	2

Figure 10

Breakdown of Interviewed Firms by Years in the Cincinnati Area

1-4	5-9	10-14	15-19	20-49	50-99	> 100
5	8	2	5	8	3	1

Finally, our firms and organizations are characterized by a number of different primary NAICS codes, showing that activity in biotechnology is not restricted to just the three industries described in the introduction. Twenty-four of the interviewed firms could be found in the *D & B Million Dollar Database*, accessed through the University of Cincinnati. A third of those found in the database (eight firms) had a primary NAICS code of 541710 (*Research and Development in the Physical, Engineering, and Life Sciences*) or, curiously, 541720 (*Research and Development in the Social Sciences and Humanities*). Another third (eight) of the firms have a primary NAICS code of 3254 (*Pharmaceutical & Medicine Manufacturing*). One firm had a primary NAICS code of 3391 (*Medical Equipment & Supplies Manufacturing*). The other seven firms are classified as follows: 325998 (*Miscellaneous Chemical Product & Preparation Manufacturing*), 327992 (*Ground or Treated Mineral & Earth Manufacturing*), 541330 (*Engineering Services*), 541611 (*Administrative Management & General Management Consulting Services*), 541618 (*Other Management Consulting Services*), 541690 (*Other Scientific and Technical Consulting Services*), and 621991 (*Blood and Organ Banks*).

Our strategy was to conduct interviews at as many biotechnology enterprises in Hamilton County as possible in Spring 2006. We started with a list of firms that had been put together several years ago for the Cincinnati USA Regional Chamber, and contacted individuals at companies on this list. However, the list evolved as the interviews occurred and we asked those we talked to about others to whom we should speak. Generally, we did not interview biotechnology firms outside Hamilton County. Hence, for example, Xanodyne Pharmaceuticals, Inc., in Kentucky and Accutek, Inc., in Butler County are not in our sample. Moreover, there were several firms that, despite our best attempts to secure an interview, did not want to participate. After talking to other firms on the original list, we mutually decided against an interview since they were not "biotechnology firms" according to our working definition, perhaps best illustrated in Figure 8. If an enterprise could not be put into the Figure-8 grid with at least one check mark, then we did not meet with that company. To the best of our knowledge, we did end up talking to all but one of the large biotechnology firms in Hamilton County and most of the mid-sized and small companies.

Cincinnati Area Attributes

This section describes the general business environment for biotechnology firms in Hamilton County. The next two sections label some of the region's features as either locational advantages or disadvantages with respect to other regions where the firms might have settled.

Human Resources

Human resources are an essential input to any enterprise. The companies interviewed responded to employee-related questions with specific regard to their staffing experiences and with regard to their short-term staffing needs. They differentiated between unskilled to skilled production labor, research & life-sciences labor, and management. Most of the companies interviewed expect moderate to significant new hiring if qualified persons can be found. Biotech firms are not identical in their human-resource demands. Depending on the nature of the organization, of course, there were different requirements for these three types of individuals, as well as different overall labor intensities (labor requirements relative to material and capital inputs). For example, labor resources are essentially the only resources used by the contract research organizations (CROs) and support organizations. Moreover, the discovery phase in pharmaceutical and device production is also highly labor-intensive. On the other hand, the manufacturing establishments are somewhat less dependent on labor and must balance their human-resource needs with material and capital requirements in their production and location decisions. For many of the firms interviewed, all of their operations are in the Cincinnati area, but other firms have significant operations in other places. As shown in Figure 9, some of the organizations interviewed have very few employees, while two have more than 1,000 employees in the Cincinnati region.

There appeared to be general agreement that unskilled-to-skilled production labor is available, priced fairly, and is reliable. Seventeen firms listed the availability of skilled labor as an advantage of locating in the greater Cincinnati area; only two firms said that the skilled labor pool was a disadvantage. Besides skilled labor availability, labor costs were characterized as an advantage for 20 of the firms interviewed (and as a disadvantage for only one). Labor-management relations were an advantage for 14 firms (and a disadvantage for two). To quote one of the individuals interviewed, "The workforce situation is fine, actually very good. All employees have been recruited locally … There are a lot of really good people in the area." Another mentioned, "It is important to keep the labor pool as strong as it is; we cannot lose well-educated people to other regions." Finally, one firm mentioned a specialized labor pool in contract pharmaceutical research that has been developing in the greater Cincinnati area and from which CROs can draw. Two manufacturing firms reported hiring 100 percent of their employees (with high-school, undergraduate, or graduate degrees) locally. One contract research organization has hired 80 percent of its employees locally. One specific bottleneck occupation mentioned was *clinical research associate*, while other firms mentioned difficulty in finding individuals in the area of quality assurance.

Evidence is mixed concerning the scientific & research workforce. When asked directly about this labor pool, it was rated as excellent by one firm, reasonable but not optimal by three, and in short supply by three others. Other firms spoke to pockets of excellence in

various fields such as, for example, transplantation and cardiovascular diseases. Nevertheless, national searches were common, and bottleneck occupations, such as *medicinal chemist* and *industrial pharmacist*, were mentioned. Respondents were asked how the scientific work force situation might be improved, and also about their perceptions of local "quality of life" and "intellectual climate" since these two attributes are of significance to the scientific community. The region's quality of life is viewed as a relative advantage by 21 of the respondents (the highest-frequency advantage in Figure 11), while none viewed it as a disadvantage. The local intellectual climate is in general viewed from modest to very good by the firms that were interviewed; Figure 11 indicates that 16 considered it an advantage to locating in the area (one firm mentioned specifically that the number of local universities was a factor in its location decision), while six considered it to be a disadvantage. Many of those interviewed either received a college or graduate degree from the University of Cincinnati or taught in the College of Medicine or College of Pharmacy before joining the private sector. The quality of local public schools was of concern to some respondents since good schools are demanded by highly-educated scientific workers. Other than strengthening area schools, colleges and universities, there were no concrete suggestions on how to improve the scientific workforce situation.

Figure 11

Summary of Responses to Locational Advantages / Disadvantages Survey

Local Attribute	Advantage	Disadvantage
Skilled Labor Availability	17	2
Labor Costs	20	1
Labor/Management Relations	14	2
Management Availability	11	9
Management Skills	16	3
Management Costs	17	2
Access to Markets, Customers (regional, global)	12	5
Local Market Size	7	12
Access to Input Materials (regional, global)	12	1
Access to Local Input Materials	8	1
Access to Business Services (regional, global)	13	3
Access to Local Business Services	17	1
Intellectual "Climate"	16	6
Culture, Amenities	16	3
Industry "Networking"	9	10
Quality of Life	21	0
Gas Service	9	1
Sewer Service	8	3
Utility Costs	10	3
Taxes	11	7
Cost of Industrial Land	12	2
Availability of Industrial Land	11	2
Sizes of Available Land Parcels	10	2
Zoning, Land Use Controls	8	1
Environmental and Site Permits	8	1
Topography, Soils, and Foundations	6	1
Transportation Services, Availability and Access	17	5
Location Relative to Other Facilities Within Your Company	10	1
Local FDA Office *	0	1
Air Transportation Cost *	0	2

*Characteristics added as "OTHER" in Figure 5

There is almost universal agreement that *experienced, upper-level biotechnology managers are in very short supply*. For these positions, a national search is almost always necessary. This observation is complemented by the responses in Figure 11. There were nine respondents who mentioned management availability as a disadvantage for the Cincinnati region. (Management skills and costs were not considered disadvantages by many firms.) With respect to managerial positions, many companies claim that it is hard to find individual talents that will have a positive impact on the company. Although this shortfall can be overcome by national recruiting campaigns, such an effort will be successful only for companies that are large enough to afford it and that have a power of attraction. Indeed not only is it difficult to find local talent, but it was mentioned frequently that it is hard to attract out-of-region talent as well because of the lack of critical mass of managerial opportunities in the biotechnology industry for top managers, which makes it riskier for them to come to the region in terms of back-up opportunities and career advancement. CincyTechUSA hopes that its proposed executives-in-residence program will go some way towards establishing a critical mass of top-level managerial opportunities in the greater Cincinnati Area.

Physical Capital, Material Inputs, and Business Services

Most equipment is *not* purchased locally. One of the device-testing firms buys all of its testing equipment from a single out-of-town manufacturer of testing machinery. A second firm manufactures its own testing equipment, which it then uses for contract device testing. Of the other equipment that this firm requires, approximately 25 percent is purchased from firms in the greater Cincinnati area, 35 percent within 400 miles of Cincinnati, and 65 percent domestically.

More, but, by no means all, material inputs are purchased from nearby firms. Note that capital equipment represents investment in physical capital for the firm while material inputs are "used up" in the production process. At least two manufacturers (one device and one chemical supplier) purchase over 50 percent of their materials locally. Two drug manufacturers, on the other hand, purchase none of their chemicals locally. Some of their specialized chemicals are purchased from overseas vendors. Another drug manufacturer reports that five percent of its raw materials, along with 10 percent of its packaging materials, is purchased locally. Due to rather low transportation costs for the materials generally, none of the biotechnology firms interviewed mentioned the "need," even "desire," to be located nearer to its input materials. One respondent said, "We get many of our material supplies from DHL overnight service. … Transportation costs are not a problem." Another firm commented, "There are two ways that I get material inputs: searching on-line for cheap prices and through networking. I do not care where inputs come from. If the materials are very specialized, I will buy them from vendors recommended by friends. The internet really has changed our way of working …" The Cincinnati region does not have unique material inputs that explain the growth of the industry in the area. None of the firms has located specifically in the Cincinnati region in order to have special access to critical material inputs; in other words, the firms are not locationally "materials-oriented." Figure 11 shows the rather low level of interest in local input materials. There were only nine respondents to the local-inputs questions; out of those nine, eight felt at an advantage in the Cincinnati area. In terms of accessing inputs nationally or internationally, 12 felt at an advantage in the region.

Finally, business services (accounting, advertising, printing, engineering, equipment service & repair, and environmental services) and utilities (water, sewer, gas, and electric) are almost 100 percent local purchases. One firm did not purchase its chemical waste removal locally. Furthermore, although generally sourced locally, legal services might be purchased outside the area. One respondent said, "One of our patent lawyers is in Michigan and we even haven't met each other. I prefer getting service from large law firms because I can negotiate prices with them and they are full service." For one company about 50 percent of information technology and software is obtained in the Cincinnati region; the rest is sourced outside the region. The overall picture is that many standard business services are sourced locally, but these generally are the types of services readily available in any large metropolitan area. As shown in Figure 11, 17 respondents thought that a Cincinnati location was an advantage for local-business-service access, while only one thought the location was a disadvantage. Thirteen organizations felt that access to regional and global business services was an advantage for Cincinnati, while three felt that the Cincinnati location put them at a disadvantage. Fewer respondents had a strong opinion (that is, more were "neutral") on gas service, sewer service, and utility costs. Three firms did think that sewer service was a locational disadvantage, and three felt the same way about utility costs.

Universities and Research Hospitals

There is almost universal agreement that the strength of the biotechnology sector in the Cincinnati area is closely connected to local universities, associated research institutions, and research hospitals. These are the organizations at which basic research is performed; at which new researchers are trained; and at which individuals in the private sector can seek advice or use laboratory facilities as needed. Universities and research hospitals serve the following four specific functions in establishing the foundation for a strong biotechnology sector in the region (functions in addition to providing basic undergraduate education to enhance the area's skilled labor force):

- They provide basic research that can be commercialized, either by the researchers themselves (turned entrepreneurs) or through licensing arrangements with established firms.

- They provide consulting services (technical and/or managerial through, say, the UC College of Business), laboratory services, and testing services (as in clinical trials for drug development) for private-sector biotechnology companies.

- They train researchers through clinical and graduate life-sciences programs.

- They create a reputation in the wider biotechnology community for the Cincinnati region, attracting yet other researchers and/or entrepreneurs to the area.

Mentioned most frequently by the respondents were the Cincinnati Children's Hospital Medical Center (alternatively, the Children's Hospital Research Foundation) and the University of Cincinnati (specifically the Colleges of Medicine, Pharmacy, and Engineering). Many of the respondents mentioned Cincinnati Children's as a strong regional

advantage. A respondent at a medical device company commented, "I think that Cincinnati Children's Hospital is one of best children's hospitals in the world, probably tied with Boston Children's. It is growing very fast, with more buildings, much practical research, and top researchers. I think this is a tremendous asset …" Other universities noted were Northern Kentucky University, the University of Kentucky, and Miami University.

With one or two exceptions only, each of the firms interviewed interacts with at least one of the region's universities in either an educational or applied research context or both. A number of firms actively participate in the University of Cincinnati's (UC's) undergraduate engineering and business student cooperative programs, while at least one firm provides student scholarships and adjunct teaching to UC's new Master's Degree Program in Drug Development in the College of Pharmacy. As far as research and development are concerned, there are three types of interaction. A number of firms indicated joint projects (including, in one case, the acquisition of capital equipment) of university faculty and private-sector investigators. A second type of interaction is the provision of product (small quantities of active pharmaceutical ingredients) or service (device testing) to university clients. Many of the manufacturing firms regularly or periodically supply their products to regional universities. Finally, one of the contract research organizations (CROs) interviewed relies heavily on UC and Children's to provide clinical trial sites, while others make occasional use of physicians at the two regional research hospitals in similar roles as clinical-trial investigators.

Bio/START, the Ohio Edison Program incubator for start-up biotechnology firms, is very highly regarded generally by the respondents. Indeed, three of the firms interviewed are current residents of Bio/START, and one is a recent "graduate" still in the Cincinnati area. Bio/START, located near the University of Cincinnati campus, provides laboratory space and equipment and legal and financial counseling to those university researchers wishing to commercialize their research ideas. Bio/START provides a strong incentive to university faculty who wish to pursue commercialization as a full-time or part-time activity. Furthermore, both the Genome Research Institute (GRI) and CincyTechUSA are examples of university-firm partnerships, which through completely different avenues, are serving to strengthen biotechnology in the greater Cincinnati area. Both are approximately five years old. GRI, a part of UC, provides infrastructure for biomedical research including drug discovery and early drug development. It partners with Cincinnati Children's Hospital Medical Center and P & G Pharmaceuticals, among other entities. CincyTechUSA, founded originally as part of the Cincinnati USA Regional Chamber, now gets almost half its over $1 million in annual funding from UC and Cincinnati Children's combined. Its goal is to develop infrastructure to support technology companies, including biotechnology firms. It also supports the commercialization of ideas generated at the region's universities.

At least half of the individuals interviewed either had a degree from UC or had held a faculty position at UC. The expectation is that these individuals have (on average) a high comfort level with university interaction and pursue linkages that are mutually valuable. One impediment, mentioned during the interviews, however, are intellectual property regulations at UC that cause some types of potentially desirable interactions to be avoided in order to preserve private sector property rights.

In summary, the region's two research hospitals are very strongly linked to biotechnology firms in the greater Cincinnati area, while other regional universities are somewhat

linked. Economic development efforts focused on the research hospitals and universities should benefit biotechnology firms in the area, and vice versa to some extent.

Customers and Clients

Although the products of biotechnology are ultimately used by patients in hospitals, nursing homes, clinics, or even veterinary offices, the firms interviewed are not consumer firms, at least in the context of this study (Cincinnati Children's Hospital Medical Center and University Hospital do serve patients in their clinical role). Each one sells an intermediate product, a capital product, or service to other businesses. As such, each is in a derived-demand situation in which the growth or decline in demand for the buyers' products affects demand for its goods or services. As such, the firms interviewed are linked very tightly with their customers (in the case of manufacturing firms) or clients (in the case of service businesses). Moreover, all else the same, local buyers are to be preferred to regional, and regional to national, since interfirm relationships are easier to maintain with geographic concentration. Several of the firms have set up small offices in other locations (nearer the coasts) to be nearer to their buyers. Several other firms are "outposts" of international companies, set up to be closer to buyers in North America. The firms' financial well-being is tied tightly to that of their buyers. These buyers are spread out geographically, implying both the need for excellent transportation services and the desire to pursue and develop local strength in buyer markets to keep transportation costs down.

However, at the writing of this report, most customers and clients are *not* local. In fact, local market size was cited as a disadvantage by 12 out of 19 respondents (note that this is one of only two local attributes which were considered a disadvantage by more respondents than considered them as advantages). A very small proportion of the manufactured products or other outputs of the firms interviewed are sold or consumed in the greater Cincinnati region. Diverse outputs such as reagents, test kits, design and consulting, regulatory compliance, clinical testing and strategic planning all have less than five percent of their market in the local area, and the larger Midwest region is market to a maximum of 25 percent for these outputs. There is only one firm with a relatively large local market, a firm that provides consulting services for pharmaceutical companies and organizes outsourcing via subcontractors. This firm provides about 60% of its services and 10% of its training locally. Except for this firm and one or two others, there is very little contact with local "client" companies.

Indeed, almost all of the firms interviewed are global businesses; that is, each does business with at least some international clients or customers. The firms reported the international share of their business to be between ten percent and 60 percent, with an average of about 20 percent. International customers and clients can be found on all continents except Antarctica. Because of these global links, several interviewees mentioned the advantage of having a large international airport with convenient overseas flights. Indeed, since the remaining business of the firms is primarily national rather than regional (within 400 miles of Cincinnati) or local (within the greater Cincinnati region), the airport takes on even more importance. On average, between 70 and 80 percent of the firms' business is national.

Regional Networking Opportunities

A basic hypothesis of the "cluster" model in regional economic development is that formal and informal interactions between firms and especially the creative people there employed create a positive local intellectual and business climate where participants keep up with developments and trends in the industry, and learn of market, employment and collaborative opportunities. These networking-information exchanges can be provided by participation in formal organizations or by more informal interactions among people in the same and related industries. Although there are opportunities in the Cincinnati area for such networking, we are not finding that the firms are taking advantage of these particular opportunities. At the same time, when we talk with them about the potential of networking, they seem quite interested in strengthening inter-firm communications.

There are two formal networking opportunities (Omeris and OVALS) for biotechnology firms and organizations in Ohio. Omeris, founded in 1987 as Edison BioTechnology Center, is a non-profit organization designed to build and accelerate bioscience industry, research, and education in Ohio. Almost all of the organizations interviewed belong to Omeris according to the Omeris website directory. However, none reported being an "active member," and a number of those interviewed apparently didn't know they were members. According to its website, at http://www.ovalsgroup.org/concept.asp, OVALS, Ohio Valley Affiliates for Life Sciences, has the cumulative capability to become a nationally recognized center for life sciences and biotechnology. The University of Cincinnati, University of Kentucky, University of Louisville, Wright State University and the Air Force Research Laboratory at Wright-Patterson, along with their regional economic development partners, have formed a partnership to grow and develop this industry sector. None of the organizations interviewed mentioned any active involvement in OVALS. The Cincinnati USA Regional Chamber, Bio/START, CincyTechUSA, TechSolve, and the University of Cincinnati's "Cincinnati Creates Companies" also serve as formal networking opportunities. Several of the firms mentioned benefiting from one or more of these latter organizations. If the company is small or at a developing stage, the support is often quite appreciated. The support is less necessary for larger, more mature organizations.

For the most part, the companies interviewed did not mention either the existence of, let alone the taking advantage of, opportunities for local informal networking. They sometimes mentioned that it would be nice to feel more activity from the local professional organizations, and to see more business aggregations of people with similar interests. They suggested that a reason for this low level of activity is the absence of a critical mass of biotechnology activity in the area. One company mentioned informal networking opportunities through the internet and the websites of national professional societies. Most respondents indicated that national and international professional conferences are where they interact with peers, and that they utilize the world wide web and operate to some significant extent in a "virtual society." Since the buyer markets in which the firms participate are so diverse, there is little to no direct competition among the firms interviewed. Hence, on the one hand, regional networking would not lead to the giving away of trade secrets to direct competitors. On the other hand, though, with little in common, the firms may not benefit much from networking either. What does a well-established

firm that manufactures and tests medical devices have in common with a firm that provides venture capital to start-up firms? Each of the firms is active in its *own* relevant trade associations and professional organizations. In terms of horizontal projects with competitors, most companies said they do not interact with their competitors and that this is not a strong need. They acknowledge that it would be beneficial for them if there were more biotechnology activity in the area, but at the same time it does not bother them that the competitors are not closely located.

A question designed to get at informal interactions was to find out if the firm interacts with other local biotechnology companies. In response to this question, however, only consulting and contract research companies reported serious local interactions, but these were of a supplier-client nature rather than of a collaborative sort. Firms were also asked if it is important to be near other firms that make similar products. Here again, most firms did not consider it to be important. Locating near potential competitors was important only with regard to specialized labor pools from which several firms could draw. In some cases, being located near competitors is also important in the sense that it improves the quality of service of subcontractors and other local resources they need to run their businesses. They were not interested in networking with each other *per se*.

In summary, it appears that there is sentiment that both local formal and informal biotechnology networking is "nice," but for the majority of firms it seems not to be important. Networking is done, by in large, at national and international conferences. Based on our interviews, it is difficult to make a case that the Cincinnati region has any outstanding strength in biotechnology networking. In fact, ten firms report local networking as a disadvantage to locating in the region, while only nine firms say it is an advantage. However, it also is difficult to argue that the region would be significantly stronger if networking was better developed, at least at this point in the sector's regional growth. In other words, it's not obvious that simply providing more networking opportunities would entice the firms interviewed to become active participants.

Nevertheless, based on all the conversations with respondents at these organizations, our sense is that *all* of them have at least some interest in both community/regional development and development of the biotechnology sector in particular. They realize that they are individual pieces in a biotechnology cluster that is growing. They all expressed interest in our conversations with other firms regardless of the relevance of the information to the particular market segments they served. Our respondents need to be given an opportunity to exchange ideas with other respondents and anyone interested in a strong biotechnology sector in the region.

The Public Sector

Government is extremely important to biotechnology firms. Both pharmaceuticals and medical devices must be approved by the Food and Drug Administration (FDA). Furthermore, manufacturing firms face strict environmental regulations, involving the Environmental Protection Agency (EPA). Entities pursuing drug discovery (the University of Cincinnati, the Genome Research Institute, and Children's Hospital) seek federal funding, particularly from the National Institutes of Health (NIH). Interactions with the FDA, EPA, and NIH were, for the most part, considered "part of doing business" in the biotechnology sector. The Ohio state government is another source of potential funding for biotechnology through its Third Frontier program, and Ohio has earmarked some venture-capital funds for start-up firms in the State. One firm mentioned receiving training grants and hiring incentives from the State.

At the local level, there is confusion among those interviewed about who (city or county) is responsible for what. At one of the interviews, it was mentioned that the City of Reading is developing an eight-to-ten acre biotechnology park at the corner of Reading & Galbraith, which will complement the other activity (two pharmaceutical manufacturers along with the Genome Research Institute) at that particular corner. Another respondent (who did not know about the proposed park at Reading & Galbraith) strongly recommended that a biotechnology park be established somewhere in Hamilton County, perhaps north on Reading Road, "behind General Electric." Several other respondents thought that establishing a biotechnology park was a good idea. At the least, the county or city could convert some old facilities, such as hospitals, into homes for biotechnology companies --- for those that are outgrowing an incubator, such as Bio/START. Two firms mentioned being landlocked and having to move for expansion; space is a general problem.

Tax-incentive packages constitute a widely-recommended strategy, among those interviewed, for attracting biotechnology firms, especially smaller ones. Moreover, the county could identify wealthy private citizens who might be willing to donate to biotechnology organizations, especially those in discovery, where private funding is scarce. It could also help to put pressure on the State of Ohio with regard to its funding priorities, and it could help encourage more venture capital in the region. At this point, neither the county nor most of the cities are viewed as positive forces in economic development. One interviewee said, "There does not seem to be an established process in the Cincinnati area for attracting biotech companies." Another said, "Hamilton County's economic development is disorganized; and the county has no systematic plan to nurture existing companies."

Neither the Ohio State nor local-area governments are currently viewed by biotechnology firms as positive forces in economic development. Biotechnology development efforts in the greater Cincinnati area are viewed as disorganized and sluggish, leaving lots of room for improvement in private-public-sector interaction in this industrial sector.

There were at least three mentions of concern for neighborhood crime (driving some firms to the suburbs as opposed to a more central Hamilton County location). At least four respondents expressed the need to improve the quality of public schools, several mentioned the Metropolitan Sewer District (MSD) as having problems, and one mentioned less-than-adequate public transportation. However, with these exceptions, the general feeling seems to be that the region's overall business climate is very good. Some respondents mentioned the good balance of personal and professional life that one can obtain in the area.

Horizontal Ventures

Companies interact with other organizations along both "vertical" and "horizontal" lines. The vertical connections are most often with suppliers of materials for production and with customers or clients who purchase the product or service; these are the "supply chain" linkages and have already been discussed. Horizontal linkages include general utilizations of an area's attributes and also explicit arrangements with other companies. In this section we discuss the latter, specifically the following:

- Joint Ventures
- Subcontracting
- Strategic Partnerships
- Financial (Venture Capital) Partnerships

None of these types of arrangements is common among those interviewed. Furthermore, more often than not, the arrangements are with companies outside the greater Cincinnati region.

As far as joint ventures are concerned, one firm has a manufacturing partnership with a firm in another state; together they supply laboratory kits (with reagents and proteins) to biotechnology, pharmaceutical, and academic buyers. Another firm is currently developing international joint ventures with firms in western Europe, with plans for later expansion into Japan and Australia. Before making this decision, it considered the advantages and disadvantages of "going global" in this manner as opposed to opening subsidiaries overseas. A pharmaceutical company reported at least three joint production ventures; a drug development company reported a joint development agreement with a global company; and a major global company claimed to have hundreds of joint ventures all over the world. An exception to the non-local nature of joint ventures is a consulting company, which has joint ventures with 14 other local organizations.

Several companies mentioned subcontracting arrangements if demand exceeded local capacity. One firm interviewed sent "overflow" work to a firm in northern Ohio. Moreover, we found that laboratory tests were routinely subcontracted as biotechnology firms focused their efforts on drug discovery and development. Similarly, medical device companies subcontracted parts of the manufacturing process. In almost none of the cases, however, was subcontracting done within the region.

One firm, specialized in support for Phase II – IV clinical trials, mentioned the establishment of key local strategic partnerships with firms in the area that do pre-clinical and Phase I drug development, in order better to serve its clients. In fact, this firm already partners with Children's Hospital if a client needs a laboratory; it is currently partnering with Hoxworth Blood Center on behalf of an international client. Because of the segmentation in this firm's particular business, it refers clients informally to other firms in the area that are "loose" competitors when the clients' interests to not match up with the firm's expertise.

Since venture capital is mentioned so often as crucial to the biotechnology sector, we sought to determine how important it is or was to our respondents, that is, to determine the importance of "financial partnerships." Although some of the biotechnology firms interviewed did receive some venture capital in their incipiency, they were largely self-financed and represented spin-offs of activities previously engaged in by the entrepreneurs.

Several began as very small-scale operations in an entrepreneur's home or garage and then outgrew these confines to move to a freestanding plant in Hamilton County. They saw both the advantages and disadvantages of venture capital, including the loss of control over business decisions with venture capital and outside financing generally. Since many of those interviewed did not have experience with obtaining venture capital in the region, there were few respondents with an opinion on this important resource. However, several respondents were adamant about the lack of available financing in the area, indeed, in the Midwest generally, which discouraged local start-up activity and discouraged movement into the area of start-up companies. One of those who felt strongly about the lack of available venture capital had himself started a biotechnology firm, using venture capital, in California. Although it is theoretically possible for firms to obtain funding from non-local investors, the latter tended to favor firms located nearer to them. One medical device startup company did comment that "the (local) investment communities have been listening to us," arguing that the situation may be improving somewhat. The single venture capital firm interviewed has projects in other Midwest cities but none currently in Cincinnati (although this situation likely will soon change).

In summary, nonfinancial horizontal ventures are not driving the location of biotechnology firms. As needed, firms enter into joint ventures or subcontracting arrangements with other firms on a national or international level. Since many of the firms interviewed do not rely on venture capital, they may be less sensitive to its importance than a potential entrant into the area. Hence, based solely on our interviews, it is not clear whether the absence of venture capital is discouraging biotechnology growth in the region. In the absence of a clear conclusion, however, we would recommend viewing financing as a problem and, hence, encourage the growth of local financial opportunities.

Summary of Locational Advantages

In each interview, respondents were asked a direct question: "What are the advantages and disadvantages of this facility being in the Cincinnati region?" Additional insight into the region's strengths and weaknesses was sometimes elicited by the question "If you could easily move this facility, where would you put it?" To supplement and quantify the information obtained in the conversations, at each interview respondents also were asked to indicate on a form, for their firm or for the biotechnology sector in general, those attributes of the greater Cincinnati metropolitan region in which the region is either advantaged or disadvantaged relative to reasonable alternative locations. The list of attributes was predetermined, and was the same for each firm. The form was filled in at the end of the interview. Respondents were asked for their perceptions, and they could leave a category blank if they were neutral or had no opinion. A tally of all of the responses is shown in Figure 11. There are a total of 28 possible responses for each attribute, since a form was not completed at a few of the interviews.

High Quality of Life

Twenty-one (three-fourths of the) respondents thought that "quality of life" was an advantage for a firm located in the region. To quote one interviewee, "people might not know how good they got it here." This region is regarded as a very attractive one for business people in general and for people working in the biotechnology sector in particular. The high quality of life includes a strong social infrastructure, good entertainment and leisure activities, strong professional sports, pleasant recreational areas, and a fairly mild climate. The region is viewed as family-friendly, with a relatively low cost of living, especially compared to the coasts, and the central geographic location helps individuals maintain ties with their extended families across the country. To summarize, the area provides a good balance between prosperous business activity and personal fulfillment.

Strong Anchor Organizations

Over and over again, throughout the interviews, Cincinnati Children's and the University of Cincinnati Colleges of Medicine, Pharmacy, and Engineering came up as important to private-sector biotechnology firms in both their research and teaching capacities. Also mentioned as strong local anchors were P & G Pharmaceuticals and Endo-Ethicon, the region's largest medical-device employer. For many of the firms, a primary reason for being in Cincinnati is that the founder of the company was already in the area when the company started --- perhaps an employee of or student in one of the anchor organizations. This implies that a strength of the local region is its employment in "anchor" organizations of entrepreneurial persons who then spin off operations of their own. The spawning anchor entities are an important regional asset.

Highly-Skilled, Loyal, & Inexpensive Labor Force

With the exception of a very few bottleneck occupations, the respondents were extremely positive about the greater Cincinnati workforce. They were able to find essentially all nonscientific production workers locally, and found them to be loyal, conscientious, and hard workers. They were also relatively inexpensive when compared to the major coastal biotechnology centers, in, for example, San Diego or Boston. Many respondents praised the local workforce. As mentioned, one person said, "The workforce situation is fine, actually very good. All employees have been recruited locally … There are a lot of really good people in the area." Another mentioned, "It is important to keep the labor pool as strong as it is; we cannot lose well-educated people to other regions."

Excellent Transportation Hub

An especially important local advantage is that Cincinnati is a very complete and exceptionally well-located transportation hub (for rail, truck, and air transport). Materials can easily be brought in and products shipped out, important considerations since most of the firms import most of their materials from outside the region, and an even larger proportion of products and services is destined for other domestic and foreign markets. The excellent domestic and foreign air connections offered at the Greater Cincinnati International Airport are a frequently noted regional asset. There was some ambivalence, however. Several respondents noted the tradeoff between convenience and cost since flights from Cincinnati tend to be very expensive. One firm made frequent use, in fact, of the Dayton International Airport to save on air costs. There are several attributes in Figure 11 that speak to accessibility generally and transportation specifically. Seventeen respondents noted that "Transportation Services, Availability and Access" was a locational advantage, while five felt it was a disadvantage for the region. (Several of the firms that checked "disadvantage" mentioned the high cost of passenger travel from the Delta Hub.) Twelve felt that "Access to Markets, Customers (regional, global)" was an advantage, while five felt it was a disadvantage. Twelve respondents felt that "Access to Input Materials (regional, global)" was an advantage, and 13 felt that "Access to Business Services (regional, global)" was an advantage, with one and three dissenting (felt it was a disadvantage), respectively.

Adequate Business Services

Almost all of the business services were sourced locally. Although praised somewhat less consistently than the labor force, nevertheless the biotechnology businesses relied on local companies for many and various business services including accounting, advertising, printing, equipment service and repair, legal advice, engineering and environmental services. One company mentioned that it is currently working with a local engineering company for a large capital-investment project. For all "routine" parts assembly and services, this firm uses local vendors. For the most part, biotechnology firms are finding the local services adequate for their needs. Indeed, 17 respondents (Figure 11) indicate that "Access to Local Business Services" is an advantage of a Cincinnati location; only one said that it was a disadvantage.

Summary of Locational Disadvantages & Concerns

Overall, the attributes of the greater Cincinnati region that influence industrial location are viewed positively by those interviewed. At the same time, the region is not an especially well known area for the biotechnology industry and, compared to some other places on the east and west coasts, it does not have attributes that make it a place that finds attraction of biotechnology firms easy. However, the region appears to be a perfectly acceptable place to nurture and grow a biotechnology company. Cincinnati is centrally located within the nation, has a good transportation infrastructure, possesses all of the normal, and necessary, facilities and services of a metropolitan region, and has some basic and applied research operations of sufficient size to continue to build the local industry.

In light of these characteristics, it is understandable that the current firms in the Cincinnati metropolitan region did not seek out the place to locate their business; rather they are creations of entrepreneurs already in the region. Once they have created their businesses in Cincinnati, they find it a good place to be. When asked where they might rather be located, the respondents had difficulty in conceiving of alternative places, and when they did often justified the "selection" on the basis of personal preferences (e.g., near the ocean and mountains) rather than business reasons (e.g., in the heart of the U.S. biotech industry). Most telling was that all said they were not moving; they were staying in the region.

Since our study is limited by interviewing only firms located in the greater Cincinnati region, we expect the firms interviewed to be generally positive about the area. Hence, we are not surprised by the fact that Figure 11 stresses the positive aspects as opposed to the negative ones. After all, the firms that are already in an area will view as less important aspects of the area that may indeed be not attracting or may even be discouraging potential entrants (it would be interesting to have the perceptions of outsiders, but this is beyond the current study). But this does not mean that there are no negative regional attributes as seen by currently resident firms; indeed, even for the generally positively viewed attributes there are some who perceive them as locational disadvantages. With the general local bias in mind, then, it becomes critical to focus on those attributes that many firms do think are locational disadvantages. The first two of these, the small current size of the local biotechnology industry, and the shortage of local upper-level biotechnology managers, are viewed as most serious.

Small Biotechnology Core

As mentioned in the introduction, core biotechnology activity, as defined in this report, consists of researching, development of, manufacturing, and testing pharmaceutical products and medical devices. Although we have some activity in each of these areas, we do not have a lot. Hence, it is not surprising that the testing and contract manufacturing (manufacturing support) firms have very *few local clients*. There simply aren't many pharmaceutical and medical-device companies in the area. Twelve firms cite *local market size* as a disadvantage. The small local market is also evident in the miniscule amount of product (*output*) from the local biotechnology companies that is sold in the region. Although one could argue that

the lack of *networking* in the region is a separate disadvantage, it is our opinion that this disadvantage is related to the small biotechnology core and will "take care of itself" as the sector grows. Cincinnati is not a major, already established hub for the biotech or life science industries. Relative to established hubs, Cincinnati is limited in *spin-off* start-up firm potential and is somewhat lacking in industry managerial talent.

Small Upper-Level Management Pool

A direct consequence of a relatively small local biotechnology core is that there is not a sufficiently deep pool of available top level management for the local biotechnology/life sciences industries. Firms are forced to go outside the area, most often to east coast centers like Philadelphia, New York, and Boston, to recruit senior executives. Attracting and retaining these in-demand executives is time-consuming and difficult. In addition to recruitment difficulties, there are short-term operational implications. Even when innovations and capital are available, forward progress is too often hampered by lack of experienced managers already in place and prepared to act quickly; senior management is sometimes stretched too thinly. Among the interviewed firms most concerned with the growth of the local biotechnology industry, the need to recruit and develop upper-level management was often noted and strongly argued.

Limited Support for Science-Based Entrepreneurship

There is debate on the degree to which the Cincinnati region is supportive of science-based industries in general and of biotechnology in particular. On the negative side, limited access to venture capital was mentioned several times; however this is in conflict with evidence from a local biotechnology *venture capital* firm that currently has all of its investments outside of the Cincinnati region and is still looking for local opportunities. The lack of local venture capital does not appear to be a significant regional disadvantage, but for some it is real, and furthermore may be a sign of an *immature region*. There are some other signs of a region that is not perceived as especially supportive of science-based entrepreneurship. One respondent stated that science in general is not viewed positively in the local area. Also, a relatively poor regional *intellectual climate* is perceived as a disadvantage by six of those interviewed, and only half of the respondents actively viewed it as a positive local attribute.

The Public Sector: Crime, Public Education, and Government

As previously noted, the respondents had general praise for the region's *quality of life*. However, there are some aspects that are seen as troublesome and in need of improvement. One concern is with levels of *crime*. This is most often expressed as a neighborhood issue with respondents worried about employee safety, especially walking to parked cars at night, and vandalism and thefts that require costly safety measures such as guards and fences. Another issue discussed by some was the poor state of *public education*, particularly at the elementary and high school levels; this is a worry for neighborhood stability and for the longer term levels of workforce competence. There also is concern in particular about the inability of the

City of Cincinnati and Hamilton County *governments* to collaborate productively. Beyond this, there is widespread ignorance of what governments and quasi-government agencies do and can do. Local and regional economic development and planning activities are a mystery to our respondents. The services of organizations such as the Hamilton County Regional Planning Commission, local Chambers of Commerce, OVALS, OMERIS, and even the relatively high profile Hamilton County Development Company and Bio/START are too little known and are underutilized.

Conclusions

We picked up on three general themes from our many interesting interviews. A number of the biotechnology experts discussed these themes, and this section is our attempt to summarize their thinking.

The biotechnology sector is an excellent target for regional economic development and deserving of public-sector resources for this purpose.

While the secondary data (some of which were presented in Section 1) certainly point to this conclusion, the in-person interviews *validated* it. All of the people interviewed were very excited about what they do, and as none of the interviewers had a natural science background, each scientist explained in nonscientific terms the role its company played in biotechnology. One of the scientists, who has received several grants from the National Institutes of Health, walked the interviewer through his particular discoveries as well as the history of the relevant therapeutic drug class to which his work contributes. Another scientist took the time to explain the entire drug discovery process from identification and validation of drug targets, to the screening of compounds, lead compound identification, pre-clinical development, and clinical development. He also explained the funding (both public and private) requirements for each of these stages. A third individual, at a manufacturing firm involved in the development and testing of medical devices, gave the interviewer a tour of the facilities so she could appreciate the various stages in the manufacturing process as well as the various submarkets in which the firm participated. In other words, after many such interviews, the interviewers came to the conclusion that biotechnology is a rewarding field. People like what they do and appreciate that what they do is meaningful. Besides interviewee excitement, biotechnology seems like a promising target since almost all of the organizations interviewed have grown recently and are growing currently, both in the number of people and in physical plant. Finally, *these experts in biotechnology said that the area should concentrate on growing the biotech sector*. In the words of one expert, “It is necessary to increase the effort on the attraction, formation and development of high-technology companies. This would be extremely beneficial to the region as the high-tech industry has a lot of potential to offer in terms of economic growth … we did not take enough advantage of the computer boom; now we should not miss the biotech boom.”

The Cincinnati-Middletown Metropolitan Statistical Area does not have enough biotechnology activity at the writing of this report to be considered a "biotechnology center".

Noteworthy "biotechnology centers" are San Diego and the Raleigh-Durham-Chapel Hill region. Several people interviewed said that the greater Cincinnati region has not reached a critical mass of biotechnology employment or output. Hence, the region is not yet at a point where it can take advantage of development benefits that stem specifically from being considered a biotech center. In other words, *not* being a center means that the region must work harder to attract scientific workers. At this point, the job markets for biologists and chemists are stronger in Boston, New York, and many other coastal cities generally than in the Cincinnati region. Midwestern cities, including Cincinnati, are at a disadvantage in attracting top life-sciences employees so must push harder to acquire and retain such workers. *Not* being a biotechnology center also means that the region must work harder than many coastal cities to attract managerial talent. As one of our experts said, "After all, on the coasts, if a company fails, the executives can move easily to another firm, whereas, in the Midwest, it's not obvious where they can go. They don't have a fallback position." Finally, not being considered a center means that venture capital is harder to find in the Cincinnati region. An individual with a new idea that has high commercial potential will, at this point in time, find it much easier to locate investors in Boston, San Diego, and other areas considered biotech centers. These observations suggest that regional developers must work especially hard now while biotech activity is sparse. However, they suggest as well that if the developers can push the sector above some minimum activity threshold, further sector growth will be helped along naturally as more scientists, managers, and venture capitalists gravitate toward biotech centers.

Interfirm linkages within the Cincinnati region's biotechnology cluster are not significant.

The industrial cluster approach to economic development has been very popular over the last decade, including in the greater Cincinnati region. There are many different definitions of clusters. PORTER, 1998, defines clusters as follows:

Clusters are geographic concentrations of inter-connected companies and institutions in a particular field. Clusters encompass an array of linked industries and other entities important to competition. They include, for example, suppliers of specialized inputs such as components, machinery, and services, and providers of specialized infrastructure. Clusters also often extend downstream to channels and customers and laterally to manufacturers of complementary products and to companies in industries related by skills, technologies or common inputs. Finally, many clusters include governmental and other institutions --- such as universities, standard-setting agencies, think tanks, vocational training providers, and trade associations --- that provide specialized training, education, information, research, and technical support. (p. 78)

Hence, we were interested in knowing how strongly the firms were linked to each other as well as how strongly they were linked to biotechnology organizations and other institutions in the area. Questions 5 and 6 from the interview, Figure 4, as well as the written survey in Figure 6, were meant to obtain interfirm linkage information. For convenience,

Questions 5 and 6 are repeated below:

5. What products and/or services do you produce at this location?
   Where are your customers located?
   With which other local firms do you interact?

6. What are your major inputs (both material inputs such as chemicals and key services such as legal, for example)?
   Where do these inputs come from? With which other local firms do you interact?

As it turns out, biotechnology firms in the greater Cincinnati area do most of their business (both buying and selling) outside the area. Although this conclusion may change as the sector gets bigger, it may not. The biotechnology sector is so segmented, and the firms so heterogeneous, interfirm linkages in the area may never be that strong. On the other hand, with very few exceptions, all firms were linked with either UC or Children's Hospital. These two research organizations can be considered the *hub* of biotech activity in visualizing the current regional biotechnology cluster.

Recommendations

The last four questions that we asked those interviewed (from Figure 4 and listed here again for convenience) were meant to elicit from the regional experts their opinions on what could/should be done for biotechnology in Hamilton County:

15. From your perspective, what types of firms should Hamilton County target to attract to the region?

16. Are you aware of any trends that will impact future growth and location decisions of local biotech companies? What are your or your industry's current and future needs?

17. Can you suggest other firms we should interview? Who should we contact?

18. Is there anything that Hamilton County, in particular, can do to assist biotech businesses?

We heard many different answers to these questions and various ideas for strengthening biotechnology in the region. In this section, we make seven recommendations based on observations from Sections 3-5, conclusions from Section 6, the interview answers to Questions 15 – 18, and the authors' expertise in regional economic development.

Grow Biotechnology by Focusing on the Creation and Growth of Biotechnology Companies

Most of the people we interviewed suggested that the benefit/cost ratio of the creation-and-growth strategy exceeded that for an attraction strategy. In other words, most experts felt that it was a better use of time and resources to help scientists and engineers commercialize their ideas and to help start-up companies expand rather than to put a lot of energy, say, into getting Pfizer to move its headquarters from New York City to Cincinnati. In any case, because of consolidation in *Pharmaceutical & Medicine Manufacturing*, one respondent said that "it would be hard to attract a large pharmaceutical company to Hamilton County." Since most of the companies interviewed had "been born" in Cincinnati rather than attracted to the region from another location, the internal-growth strategy seems to make a lot of sense. Those who *were* in favor of attraction from outside the area favored attracting small, mobile biotech firms. One respondent said that the county should go after "small biotech firms (still fairly mobile as opposed to bigger, more mature firms) with between three and 20 employees."

This creation-and-growth strategy requires the following action plans:

1. Make sure the companies have the amount and type of space they need until they are strong enough to "go it alone."

2. Ensure adequate investor capital for the company.

3. Use tax incentives as necessary to attract biotechnology firms to the region.

4. Help small firms with utilities, IT services, health insurance programs, rents and leases, regulatory and environmental requirements, and other small-business issues.

Consistent with this recommendation, some initiatives are already in place and were mentioned by the interviewees. For example, Cincinnati Creates Companies is a program that helps entrepreneurs to set up a business. The University of Cincinnati, Cincinnati Children's, the Hamilton County Business Center, Bio/START, Emerging Concepts, and CincyTechUSA also help with the creation and growth of new businesses in the region.

Retain Existing Biotechnology Companies

As described in Sections 4 and 5, the firms we interviewed thought Cincinnati had many more locational advantages than disadvantages. Some firms had been in the region for many years, but even those that were relatively new to the area thought that the Cincinnati location was a good one. None of the interviewees mentioned any plans to leave. Nevertheless, current biotechnology firms should not be taken for granted. Since the primary objective is to reach an employment and output threshold and become a biotechnology center, significant effort should be devoted to retaining the firms that do call Hamilton County "home."

Here, we primarily recommend additional communication as follows:

1. Public-sector entities and biotechnology organizations are encouraged to maintain a current list of biotechnology companies in the area and to communicate with them on a regular basis on topics of interest to the companies.

2. Public-sector entities and biotechnology organizations are encouraged to communicate exactly the services they can provide to biotechnology companies.

3. The Cincinnati USA Regional Chamber and the Hamilton County Regional Planning Commission need to have focused, ongoing conversations with these same biotechnology leaders whom we interviewed, either in formal meetings or informal settings.

4. It would be beneficial to have the regional media profile biotechnology firms in their publications and other broadcasting activities. It would not only help educate the general public about the benefits biotech firms bring to the community but would also show some appreciation for the companies' contributions to economic development.

5. We also recommend a "one-stop" comprehensive website for a biotech firm. The new CincyTechUSA's TechConnect website is a good start: *http://www.cincytechusa.com/techconnect.asp*

Attract Branches of International Biotechnology Firms

Although not mentioned by as many respondents, there were several strong arguments made for trying to attract branch plants or offices of foreign biotechnology firms, especially those that are already doing business with firms in the Cincinnati region. One of the firms that we interviewed mentioned the steep rise over the last two years in the amount of business it does with small biotech firms in other countries. These types of firms might be drawn to the Cincinnati area to set up U.S. headquarters where their vendors and partners are already located. From the point of view of the international firms, Cincinnati is centrally located for the North American market. It has excellent rail, truck, and air transportation services, indeed an international airport hub. Several of the people interviewed were at North American branches of European companies. They cited both the central Midwestern location and good transportation as key reasons for their Cincinnati location.

Endorse and Encourage the Recently Created CincyTechUSA Executives-in-Residence Program

CincyTechUSA, a joint initiative of the Cincinnati USA Regional Chamber, the University of Cincinnati, and Cincinnati Children's, which aims at promoting the creation and growth of regionally based technology businesses, has launched an executives-in-residence program this year. This program aims at connecting experienced entrepreneurs with professionals from start-up companies. The mentoring of new entrepreneurs is meant to compensate for the regional shortfall in the upper-level management pool. CincyTechUSA mentioned the executives-in-residence program as its primary objective for the year 2006. According to its 2005 Investor Report, its goal is to "develop a portfolio of 20 high-growth-potential technology companies for focused assistance from CincyTech's executives-in-residence program." Specifically, the program is seeking entrepreneurs who want to have a company with at least $20 million in revenues within five years. This program is high-cost but has the potential of pushing the regional biotechnology sector to the critical employment and output threshold.

Study Further the Demand For and Supply Of Space for Biotechnology Activity

Not all of the people we interviewed were concerned about facilities and space. However, those that were, were adamant that space be adequate should a start-up company need to grow or move into the region from out of the area. Unfortunately, our study alone is not sufficient to recommend a specific action plan. Plans to be considered would include a dedicated biotechnology park in Hamilton County. A possible location, mentioned by one of the respondents, is on Reading Road, north of the Reading-Galbraith "biotech intersection." The park would provide an obvious first location for a new biotechnology firm and would create community spirit around biotechnology. Further, there would be economies of scale in, for example, meeting safety regulations. Another possibility would be to convert old hospitals and other buildings to biotech space. At this point, our recommendation is to do a thorough inventory of space in the region to make sure that growth of biotech is not hampered by space constraints.

Support Cincinnati Children's and UC's Colleges of Medicine, Pharmacy, and Engineering in Their Efforts to Spin Off Biotechnology Firms

A number of firms that we interviewed had their roots at UC or Children's. One was started by someone who used to work for Endo-Ethicon. Moreover, with the closure of P & G's Drug Discovery Division, some of the former employees may indeed look to start their own biotechnology businesses in the region. The anchor biotechnology organizations in the area are invaluable for a number of reasons, including their being a source of potential spin-off companies over time. They are also a draw for support companies and vendors. As individuals leave UC or Children's, or even P & G or Endo-Ethicon, it is hoped that they will stay in the area and continue to contribute to the area's economy. Working with these organizations to assure easy transitions of this sort is mandatory.

Support the Genome Research Institute in its Effort to Become the Primary Drug Discovery Center for the State of Ohio and the Region

GRI functions as a bridge between academic biomedical research, biotechnology/drug discovery and translational medicine. It is positioned to become the glue for a strong Cincinnati biotechnology industrial cluster. It is a publicly funded organization that partners with other public entities (such as Wright Patterson Air Force Base and other universities) and private companies. It has the potential to be a tremendous force in economic development. It is growing, and, as it does, there is growth in the highly-educated, high-salary part of the Cincinnati area workforce. It increases the desirability of the region as a location for biotechnology and technological support firms. Its location, already synergistic with that of Girindus and Patheon, will help the growth of small companies on the Reading-Galbraith corner. To achieve its full potential, GRI must compete successfully for publicly available funds. Hamilton County and other public entities in the region should do all they can to help in this effort.

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Acknowledgements

We gratefully acknowledge the participation of the following biotechnology firms and organizations:

Barr Laboratories
C T I Clinical Trial & Consulting Services
Camargo Pharmaceutical Services
CardioEnergetics, Inc.
Celsus Laboratories, Inc.
Cincinnati Children's Hospital Medical Center
Cincinnati Sub-Zero Products, Inc.
CincyTechUSA
Clinical Research Consultants, Inc.
EMD Chemicals
E-Prime, LLC
Forest Pharmaceuticals, Inc.
Genome Research Institute
Girindus U.S.A.
Harrison Clinical Research, USA
Hoxworth Blood Center
Integra
KATZEN International, Inc.
Kendle International, Inc.
Mar-Test, Inc.
Medpace, Inc.
Meridian Bioscience, Inc.
Molecular Diagnostic Laboratories
Molecular Research Center, Inc.
National Research Labs, LLC
P & G Pharmaceuticals, Inc.
Patheon, Inc.
Phase 2 Discovery, Inc.
SpineForm
Sterling Research Group, Ltd.
Triathlon Medical Ventures
UMD, Inc.

We also thank Brandon Holmes as the fifth interviewer who helped tremendously with the set-up and interviewing phases of this project and Annalee Duganier, Senior Planner for the Hamilton County Regional Planning Commission, for contacting all of the biotechnology firms, collecting and compiling the interview results, and offering suggestions and insights on earlier drafts of this report. We appreciate as well the comments and suggestions of Carol Frankenstein and Ruben Papoian on an earlier version of this report.

An earlier version of this report was presented (as a poster) at BioOhio 2006, Columbus, October 23-24, 2006.

Community COMPASS Publications

The following Community COMPASS reports are components of Hamilton County's Comprehensive Master Plan and Strategies. The reports are available at the Hamilton County Regional Planning Commission and can be downloaded at www.communitycompass.org.

1. Project Design -- Scope and Process (Oct. 2001)
2. The Community Values Survey (Jan. 2001)
3. Special Research Reports
   - 3-1. Inventory of Research (2002)
   - 3-2. Conflicting Views on Suburbanization (Sept. 1999)
   - 3-3. Spreading Out: The March to the Suburbs (Oct. 1999; revised 2003)
   - 3-4. Summary Report -- Spreading Out: The March to the Suburbs (Oct. 1999; revised 2003)
   - 3-5. The Use of Public Deliberation Techniques for Building Consensus on Community Plans: Hamilton County Perspectives on Governance (A Guide for Public Deliberation) (Dec. 2002)
   - 3-6. Hamilton County's Comparative and Competitive Advantages: Business and Industry Clusters (Oct. 2003)
   - 3-7. Census 2000 Community Profiles: Political Jurisdictions of Hamilton County
   - 3-8. Community Revitalization Initiative Strategic Plan (Aug. 2003)
   - 3-9. Listening to Biotechnology Leaders: An Interview Study (Nov. 2006)
4. The Report of the Community Forums --Ideas, Treasures, and Challenges (Nov. 2001)
5. The Report of the Goal Writing Workshop (2001)
6. The Countywide Town Meeting Participant Guide (Jan. 2002)
7. Hamilton County Data Book (Feb. 2002)
8. A Vision for Hamilton County's Future --The Report of the Countywide Town Meeting (Jan. 2002)
9. The CAT's Tale: The Report of the Community COMPASS Action Teams (June 2002)
10. Steering Team Recommendations on The Vision for Hamilton County's Future (Jan. 2002)
11. Planning Partnership Recommendations on The Vision for Hamilton County's Future (Jan. 2003)
12. The Vision for Hamilton County's Future (Brochure) (Feb. 2003)
13. Initiatives and Strategies
    - 13-1. Steering Team Recommendations on Community COMPASS Initiatives and Strategies (2002)
    - 13-2. Steering Team Prioritization of Initiatives – Methodology and Recommendations (Aug. 2002)
    - 13-3. Planning Partnership Recommendations on Community COMPASS Initiatives and Strategies (revisions, findings and reservations) (Dec. 2002)
    - 13-4. Community COMPASS Initiatives and Strategies -- Hamilton County Regional Planning Commission Recommendations (Jul. 2003)
14. External Influences: The Impact of National Trends on Hamilton County's Future (Mar. 2003)
15. Population
    - 15-1 Summary Report (Nov. 2004)
    - 15-2 Atlas / comprehensive report (2005)
16. State of the County Reports (Key Findings, Issues, and Community Indicators) (Nov. 2004)
    - 16-1 Civic Engagement and Social Capital
    - 16-2 Community Services
    - 16-3 Culture and Recreation
    - 16-4 Economy and Labor Market
    - 16-5 Education
    - 16-6 Environment
    - 16-7 Environmental and Social Justice
    - 16-8 Governance
    - 16-9 Health and Human Services
    - 16-10 Housing
    - 16-11 Land Use and Development Framework

16-12 Mobility

16-13 Executive Summary

17. 2030 Plan and Implementation Framework (Nov. 2004)

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