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MEMORANDUM

To: Economic and Community Development Committee

Date: June 16, 2009

From: Bob Dean, Principal Regional Planner

Re: RCF Innovation Report

Last fall CMAP contracted RCF Economic and Financial Consulting firm to research several economic development strategies to help CMAP prioritize recommendations in the *GO TO 2040* plan. The strategies include: innovation, infrastructure to support economic development, green economic development, and export promotion/import replacement. Each report provides brief background on how the strategy relates to economic development, outlines the main existing initiatives and resources for supporting the strategy, and identifies specific industries that are critical to the strategy. RCF then makes recommendations to CMAP on how to strengthen the strategy.

RCF's work on the innovation paper is complete and attached for your review. CMAP is interested in your comments and suggestions on which recommendations should be prioritized, as well as additional possible recommendations not included in the paper. The remaining papers will be complete and available for review later this summer.

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Innovation Strategy Report

Final Report

For

**Chicago Metropolitan Agency for Planning
(CMAP)**

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June 2, 2009

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Table of Contents

Summary of Recommendations for Innovation Strategy	1
1. Introduction and Acknowledgements	4
2. Theories of Innovation and Economic Development	7
3. Research and Technology Transfer in Metro Chicago	9
3.A. University Research and Technology Transfer	9
3.B. National Laboratory Technology Transfer	19
3.C. State of Illinois Innovation and Tech Transfer Programs	20
3.D. Other Aspects of the Innovation Infrastructure of the Chicago Area	21
3.D.1 Venture Capital and Investment	22
3.D.2 Technology Parks	24
3.D.3 Non-Governmental Organizations (NGOs)	25
3.D.4 Internet Resources	26
4. Innovative Industries and Industry Clusters	27
5. Challenges and Opportunities in Innovation	32
6. Indicators of Success and Goals for Innovation	35
7. Strategies to Enhance Innovation	37
Appendix A Research on Theory of Innovation and Metropolitan Growth	39
Appendix B State of Illinois Programs Innovation Related	43
Appendix C Non-Governmental Organizations (NGOs)	54
Appendix D Internet Resources	64

Summary of Recommendations for Innovation Strategy

Innovation is a complex process and a fundamental source of economic growth and development. *RCF finds that the Chicago metropolitan area is well supplied with all aspects of the innovative process – from basic science and technology development to innovative local industries. However, the overall performance of the local economy in the current decade has been disappointing.* Total employment in the metropolitan area reached a peak in 2001 and then declined during the recession of 2001-02. Recovery from the recession was relatively slow. The metropolitan area did not regain its peak level of total employment until 2007, and the current recession undoubtedly has caused employment to drop below its 2007 level.¹ Recovery from the current recession in the short run depends upon macroeconomic policy, but the long-term success of the local economy depends upon factors that cause growth and development. Innovation is near the top of the list of those factors.

Can the performance of the innovative sectors of the local economy be improved?

This report attempts to answer this question. While innovative activity of all types is taking place in the metropolitan economy, RCF suggests that the data show improvements can be made. Specific recommendations are as follows:

A. CMAP to Conduct Targeted Research

1) Innovation and Infrastructure

Innovation does not all originate in the R&D, medical, engineering, or science lab. Innovation also takes place in Professional and Management Services, Finance and Insurance, Higher Education, and Arts, Entertainment, and Recreation – to pick some prominent examples in Chicago. RCF recommends that CMAP might conduct further research into innovation in these sectors, including an examination of the extent to which infrastructure is needed to support continued innovation.

2) Sources of Growth

Further research on the sources of growth for metropolitan Chicago is needed. Has growth resulted from growth in large firms, small firms, or new firms? What specific labor skills are associated with recent growth? As noted above, the performance of the local economy in this decade has been disappointing. Better understanding is needed.

B. Facilitate Performance Improvements of Local Technology Transfer Programs

This report includes the finding that some technology transfer programs at some local universities (with the exception of Northwestern University) may be under performing. Baumol, Litan, and Schramm suggest consolidation of tech transfer offices might enhance their productivity.² They also suggest that universities change

¹ See RCF Economic and Financial Consulting, Inc., *Databook Chicago* (Chicago: RCF, 2008) for an examination of the data up through the end of 2007.

² Baumol, Litan, and Schramm, *op. cit.*, pp. 266-67.

their focus from license fees to the number of licensing “deals” completed. CMAP might initiate meetings with university officials to discuss these ideas. Alternatively, such meetings could be convened by the Chicagoland Chamber of Commerce as part of its InnovateNow initiative. Examples of cooperation among university technology transfer offices exist within multi-campus universities (University of Illinois, University of California system), but none have been found at the level of a major metropolitan area.

C. Assist Growth of Start-up Firms

A strong emphasis on start-up firms pervades the public programs and private support efforts. Given that the most productive innovations often require adoption by larger, existing firms, this emphasis may be misplaced. Further research might concentrate on the processes of taking new products and services to the larger market. Mr. Baker of IIT emphasized one aspect of this process when he suggests that CMAP should consider the issue of providing space for firms that are able to “graduate” from the tech parks. Mr. Pruett of the Chicago Technology Park suggested that more public funds are needed for technology park infrastructure and other programs, and that public resources could be concentrated in the most promising areas.

D. Encourage Connections between Advanced Education and Entrepreneurial Programs with Companies involved in Innovation

Innovation depends upon people – scientists, engineers, skilled workers, and above all, entrepreneurs. Several colleges of business administration in the metropolitan area have programs in entrepreneurship (University of Chicago, UIC, DePaul). These programs need to be connected to the innovative industries. CMAP might consider convening a meeting of deans and directors of local entrepreneurship programs to share goals and ideas. Perhaps it would lead to a conference that would be part of the follow-up to the Go To 2040 plan. Alternatively, the Chicagoland Chamber of Commerce might undertake this task as part of its InnovateNow initiative.

E. Provide Information on Innovation Developments

The report notes that useful discoveries are being made around the world. RCF suggests that CMAP might initiate discussions for how to provide local firms with information about useful discoveries that originate outside the metropolitan area. It is suggested that this effort might start with one particularly innovative industry.

F. Develop Goals and Track Metrics of Innovation Performance

CMAP could develop goals and track innovation performance metrics based on general economic indicators, innovation production indicators, and innovation diffusion indicators.

G. CMAP to Assume Leadership Role in Local Innovation Development

Indeed, innovation is so important to the economy of metropolitan Chicago that CMAP might take the lead in organizing a series of meetings and conferences at which the issues are discussed and further connections are made. In essence, **RCF recommends that CMAP begin to take an active role in supporting further investigation into economic growth in the local economy and in stimulating further conversation and connections among the innovators in the metropolitan area.**

1. Introduction and Acknowledgements

There is general agreement that economic growth and development depend critically upon innovation. The study of economic growth, invention, innovation, and entrepreneurship has been and is booming, especially during the past two decades. And firms and governments at all levels have been attempting to apply what has been learned through research and experience. The tasks of this report are to distill what is known about this vast area as it applies to the Chicago metropolitan area, and to make suggestions that may be able to improve its performance on this key dimension.

A good place to start is the recent book by William Baumol, Robert Litan, and Carl Schramm titled *Good Capitalism, Bad Capitalism, and the Economics of Growth and Prosperity*.³ Baumol is a prominent economist who currently holds a chair in entrepreneurship at New York University, and Litan and Schramm are vice president and president, respectively, of the Kauffman Foundation – the leading supporter of research on entrepreneurship. This book provides a good overview of what is known about the sources of economic growth and development in capitalistic economies.

Baumol, Litan, and Schramm concentrate their attention on entrepreneurs, the people who provide a new product or service or develop a new method for delivering existing goods or services at lower cost. They point out that different forms of capitalism have different incentives for entrepreneurs. Four versions of capitalism exist around the world:

- entrepreneurial,
- big-firm,
- state-directed, and
- oligarchic.

These authors argue that the version of capitalism that is most effective at providing incentives for entrepreneurs and generating innovation is a combination of entrepreneurial capitalism and big-firm capitalism. The combination of innovative firms and established firms is needed to generate innovation and to produce new goods and services (or utilize new cost-cutting ideas) at a large enough scale to be of substantial benefit to the whole economy. This is precisely the type of capitalism that exists in the U.S. The book provides numerous insights for improving the performance of the U.S. economy and economies around the world through this lens.

The performance of the U.S. economy depends upon many factors, including:

- ease in forming a business (and abandoning a failed business),
- financial system that functions well,
- human capital,
- flexible labor markets,

³ W. Baumol, R. Litan, and C. Schramm, *Good Capitalism, Bad Capitalism* (New Haven: Yale University Press, 2007).

- reward for successful entrepreneurial activity, and
- incentives for firms, both small and large, to innovate and grow – including openness to trade and other competitive pressures.

Successful entrepreneurship depends upon using new knowledge to generate new products and services and new production methods. Baumol, Litan, and Schramm and other authors, such as Amar Bhide, point out that the production of new knowledge increasingly is a global phenomenon.⁴ The U.S. has been (and still is) the major source of knowledge and technologies that other nations use, but now the flow of useful knowledge and technology also can move in the opposite direction. These authors think that firms in the U.S. need to know about and take advantage of discoveries that are made elsewhere. This is not a zero-sum game. By extension, firms in metropolitan Chicago need to know about and take advantage of discoveries that are made both inside and outside of the metropolitan area.

This report does not investigate the role that human capital development in general plays in metropolitan growth because this is the topic of another CMAP study. However, human capital – in particular, higher education – is the one policy variable that consistently exhibits a strong positive effect in econometric studies of metropolitan growth rates. Rauch found that the wage rates of individuals are influenced by many factors (e.g., one's own education and work experience), including the *average level* of education in the metropolitan area in which the worker resides.⁵ An important study by Glaeser and Saiz of metropolitan population growth from 1970 to 2000 shows that a one percentage point increase in the share of adults who have a college degree increased the population growth over a decade by one-half of one percent.⁶ They tested for reverse causation, and confirmed that skills induce growth; the effect does not operate in the opposite direction. Further, they showed that higher education leads to growth in real wages, which confirms the hypothesis that the initial level of skills leads to productivity growth. A recent study by Blumenthal, Wolman, and Hill investigated the determinants of metropolitan growth in employment and Gross Metropolitan Product (GMP) over the 1990-2000 decade.⁷ An increase in the percentage of adults with a college degree in 1990 is associated with an increase in employment growth of 0.7% to 0.8% and an increase in GMP growth of 1.5%. In short, a metropolitan area that seeks to increase economic growth and development should invest in higher education. This report concentrates on a more specific aspect of skills and growth – the role of innovation.

RCF especially thanks Mr. David Baker, Executive Director of the University Technology Park at IIT, Indrani Mukharji, Executive Director of the Northwestern University Technology Transfer unit, Samuel Pruet, President of the Chicago Technology Park (UIC), Stephen Ban, Director of the Office of Technology Transfer at Argonne

⁴ A. Bhide, *The Venturesome Economy* (Princeton: Princeton University Press, 2008).

⁵ J. Rauch, "Productivity Gains from Geographic Concentration of Human Capital: Evidence from the Cities," *Journal of Urban Economics*, Vol. 34 (1993), pp. 380-400.

⁶ E. Glaeser and A. Saiz, "The Rise of the Skilled City," *Brookings-Wharton Papers on Urban Affairs*, Vol. 5 (2004), pp. 47-94.

⁷ P. Blumenthal, H. Wolman, and E. Hill, "Understanding the Economic Performance of Metropolitan Areas in the United States," *Urban Studies*, Vol. 46 (2009): pp. 605-627.

National Laboratory, Geoffrey Hewings, and Don Jones for their valuable insights and suggestions.

2. Theories of Innovation and Economic Development

The “new” theory of economic growth is now twenty years old. This theory places innovation at the center of economic growth and development, and provides an explanation for innovation.⁸ The older theory of economic growth (based on the work of Robert Solow in the 1950s) recognized the importance of “technological change” as a primary force in economic growth (in addition to capital accumulation), but did not explain how technological change occurs. The purpose of this section is to outline the new theory of economic growth and development as it applies to major urban areas, and to assess the empirical evidence that has been done to test the theory. This augmented theory combines the new theory of economic growth, the new economic geography, and entrepreneurship. A fundamental question is whether the new theory can serve as a guide to an economic development strategy for metropolitan Chicago. The theory can be outlined as follows:

- The stock of knowledge, and the creation of additional knowledge, is the primary basis for improvements in the standard of living. Most knowledge is a “pure” public good, freely and readily available to anyone who is interested. However, both the creation and the transmission of knowledge often require face-to-face contact at professional meetings, seminars, and informal gatherings.
- Knowledge can be turned into economically relevant innovations (or technology, as some call it). Some innovations can be readily copied and adopted by all, while other innovations are closely held by particular firms. To quote Romer, “The distinguishing feature of technology as an input is that it is neither a conventional good nor a public good; it is a nonrival, partially excludable good.”⁹ A “nonrival” good is one that can be used by all simultaneously, such as a mathematical theorem or a computer program that is in the public domain (e.g., linear programming). But technology is partially excludable, which means that it is possible to exclude some (maybe even most) people from having access to it for some period of time. Consider a baseball game. It is viewed by all in attendance (nonrival consumption), but people can be excluded by simply building a fence and charging admission. So it can be with much technology. Partial excludability gives firms incentives to innovate to make profits.
- Jaffe proposed that innovations – measured as patents – are produced by university research and industrial research and development, given the existing stock of knowledge, in a manner in which the ability of each of these two

⁸ R. Barro and X. Sala-i-Martin, *Economic Growth*, 2nd ed. (Cambridge, Mass.: MIT Press, 2004) is a graduate level textbook on the new theory of economic growth (and the old theory as well), and David Warsh, *Knowledge and the Wealth of Nations* (New York: Norton, 2006) is an excellent high-level journalistic account of the development of the new theory.

⁹ Paul Romer, “Endogenous Technical Change,” *Journal of Political Economy* 98 (1990), pp. S72-102. Romer is credited with being the originator of new growth theory, and is the central figure in Warsh’s account.

factors to produce innovations is enhanced by more of the other; e.g.,
Innovations Produced = Knowledge times University Research times Industrial R&D.¹⁰ The creation of innovations also requires highly educated and skilled workers.

- The creation of innovations often requires close collaboration between those who have basic knowledge and those who conduct R&D work. This means that innovations are created in particular places where these elements come together.
- Because innovations are partially excludable, the adoption of innovations also has a geographic component. One's ability to use an innovation can depend upon close proximity. The "diffusion" of innovations over space takes time, and relies partly on personal contact. This process is often called the innovation "spillover" effect. A metropolitan area in which an innovation is created can have a significant "first mover" advantage in some cases. This observation accounts for the fascination with the Silicon Valley phenomenon.
- The adoption of innovations also requires entrepreneurs (and their backers such as venture capitalists – although most entrepreneurs are not backed by those in the venture capital business), the people who take the risk that a particular innovation will pay off. The entrepreneur starts the business that produces the product that creates economic growth and development for the metropolitan area.
- New growth theory places government in a central role of providing resources for the creation of basic knowledge, a public good, and in establishing the rules that give incentives for firms to innovate – patent and intellectual property laws.

In short, according to the theory, metropolitan areas that are successful in economic development are required to have:

- Research universities that create and transmit knowledge,
- R&D activities in both universities and private firms (with highly educated and skilled workers) to create innovations,
- Mechanisms for adoption of innovations, and
- Entrepreneurs (with backers).

This is a series of hypotheses. Have these hypotheses been confirmed? A huge outpouring of applied research has studied these and related issues. New academic journals have been founded, including *Research Policy* and *Economics of Innovation and New Technology*. Some of that research is reviewed briefly in the appendix to this report. It is fair to say that there is evidence in support of the series of hypotheses, but that more research is needed (a favorite conclusion among researchers).

¹⁰ A. Jaffe, "Real Effects of Academic Research," *American Economic Review* 79 (1989), pp. 957-70.

3. Research and Technology Transfer in Metro Chicago

3.A. University Research and Technology Transfer

The major universities in the metropolitan area all conduct basic and applied scientific and technological research, and they all have invested in programs of technology transfer. These university programs are based on the federal law known as the Bayh-Dole Act of 1980. This law (Patent and Trademark Amendments of 1980) enables universities and small businesses to retain title to inventions made under federally-funded research projects. Previously universities had to apply for the right to patent such inventions from the particular federal funding agency, and each agency had its own rules. In response most major universities have offices of technology transfer, and the Association of University Technology Managers (AUTM) is the professional organization for these offices and their employees.

The major provisions of the Act (as amended in 1984 and 1986) are:

- Non-profits such as universities and small businesses may elect to retain title to innovations developed with federal research funds.
- Universities are encouraged to collaborate with commercial firms to use these inventions.
- Universities are expected to file patents on inventions they elect to own.
- Universities are expected to give licensing preference to small businesses.
- The federal government retains a non-exclusive license to use the patent, and retains “march-in” rights if the invention is not being used.

Reports from AUTM document the enormous response to this new federal policy.¹¹ In 1980 fewer than 250 patents were issued to U.S. universities. In 2003 the number was 3,933. AUTM noted that 374 university start-up companies were created in 2003, for a total of 4,081 new companies since 1980. (AUTM does not report how many are still in business.) About 70% of the innovations that are recognized by AUTM have been in biotechnology; other active areas include electronics (including nanotechnology), computer software, and materials science.

The Bayh-Dole Act is not without its critics. Some argue that the emphasis on patents and commercialization has shifted research priorities in universities away from more “basic” research and from areas that do not have much market demand (such as studies of poverty and diseases related to poverty). Emphasis on patents reduces the open communication among researchers and publication of results. And Bayh-Dole has led to a huge outpouring of patents that are not very important. Research by Henderson, Jaffe, and

¹¹ BayhDole25, Inc., “The Bayh-Dole Act at 25”, April 17, 2006, New York. .

Trajtenberg documents the increase in the propensity of universities to patent less important discoveries by studying how often patents are cited by other patents.¹² However, in spite of the fact that nearly half of university patents receive no citations, these authors state that, "... the increase in university patenting probably reflects an increased rate of technology transfer to the private sector, and this probably increased the social rate of return to university research."¹³

The major universities involved in technology transfer in the metropolitan area are Northwestern University, the University of Chicago, the University of Illinois (both UIC and UIUC), Illinois Institute of Technology, Rush University, Loyola University, and Northern Illinois University. This section concentrates on the current technology transfer programs at these universities. Given the large number of technology transfer centers and organizations that support business start-ups, it is difficult to conclude that any more programs are needed. Indeed, it may make sense to consolidate the programs that make use of taxpayer money.

AUTM conducts an annual survey of university technology transfer activity. Table 1 shows the top ten universities (plus the University of Chicago and the University of Illinois), ranked by license income in 2007. The table also shows the number of active licenses as of 2007, the number of start-up firms from 2004 to 2007, and the size of the technology staff as of 2007. (Tech transfer office budgets are not reported to AUTM.)

Table 1. Top Technology Transfer Universities

Rank	University	License Income in 2007 (\$mil.)	Active Licenses	Start-up Firms 2004-07	Tech Transfer Staff
1	NYU	791.2	38	18	4
2	Columbia	135.6	n.a.	n.a.	n.a.
3	U. of Cal. System	97.6	1819	101	77
4	Northwestern	85.3	173	23	11
5	Wake Forest	71.2	n.a.	7	4
6	U. of Minnesota	63.3	756	11	26
7	U. of Washington	63.3	1040	32	16
8	MIT	61.6	840	87	18
9	U. of Rochester	53.3	106	21	7
10	Stanford	50.4	986	30	14
20	U. of Chicago	15.1	192	2	22
31	U. of Illinois	8.1	399	40	23

Source: AUTM annual surveys.

New York University is the top university in the nation in terms of license income with an amazing \$791.2 million in just one year. NYU has relatively few active licenses, a

¹² R. Henderson, A. Jaffe, and M. Trajtenberg, "Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965-1988," *Review of Economics and Statistics* 80 (1998), pp. 119-127.

¹³ *Ibid.*, p. 126.

relatively small number of start-up firms, and a very small tech transfer staff. In some cases, license income is based on only one or a small number of patents. The Executive Director of the Northwestern Technology Transfer office reports that their license income is derived primarily from a single patent for a drug that is marketed by Pfizer. Columbia University is next in line with \$135.6 million of license income, but they do not make a full report to AUTM. The University of California System (Berkeley, Irvine, et al.) are in third place with license income of \$97.6 million. Clearly tech transfer is a major effort in the U. of California System, with 1819 active licenses, 101 start-up companies in four years, and a staff of 77 spread out over the system.

Northwestern University ranks fourth in the nation, with license income of \$85.3 million in 2007 (based primarily on a single patent for a drug called Lyrica, as noted above). This is accomplished with 173 active licenses and a staff of 11 people. Start-up firms number 23 for 2004-2007. Indeed, Northwestern stands out among the universities in the Chicago area. The University of Chicago ranks 20th in the nation, with \$15.1 million license income in 2007. The University of Chicago actually has a few more active licenses (192) than does Northwestern, but it has a staff of only 2 people and only 2 firms were started during the 2004-2007 period. The University of Illinois (UIUC and UIC combined) ranks 31st in the nation with \$8.1 million in license income in 2007. Tech transfer is a major effort at the University of Illinois, with 399 active licenses, 40 start-up firms during 2004-2007, and a staff of 23. Indeed, the University of Illinois has one of the largest tech transfer staffs in the nation, exceeded only by the University of California System, the University of Wisconsin (with a staff of 37 and license income of \$46.7 million in 2007), and the University of Minnesota. The other universities in the Chicago area – IIT, Northern Illinois University, Loyola, and Rush University – did not report their tech transfer activities to AUTM, which suggests that their level of activity as of 2007 may still be rather small. We turn now to a detailed examination of the tech transfer programs at each of these Chicago-area universities.

Northwestern University

The Northwestern University Office of Technology Transfer (OTT) provides a mission statement that is comprehensive, and applies to all of the other similar offices at the other universities.

The Northwestern University OTT mission is to:

- facilitate commercialization of the university's innovative technologies for public use and benefit,
- educate faculty and students regarding intellectual property and its timely protection,
- protect the inventors' and university's rights,
- assist faculty, students, and staff to determine market opportunities,

- market technologies to industry and assist entrepreneurs in creating start-up companies,
- structure and negotiate license deals to generate revenue for the university, and
- reward inventors, departments, schools, and centers by sharing license revenue under university policies.

Table 2. Discoveries Available for Commercialization at Northwestern University

Clean Technologies (20 discoveries) Alternative energy Bioremediation Recycling	Life & Medical Sciences (77 discoveries) Devices, sensors Diagnostics Physical therapy Therapeutics Research tools
Engineering & Software (84 discoveries) Advanced manufacturing Computers and networks Imaging Robotics Sensors Automotive Consumer products Photonics and optics Software Semiconductors and super conductors	Nanotechnologies (34 discoveries) Molecular electronics Nanosensors Nano fabrication Non-linear optics Physical Sciences & Advanced Materials (39 discoveries) Catalysts and polymers Optics and photonics

Northwestern lists 26 start-up companies that are based on discoveries that have come from this university. These companies fall into the categories reported in Table 3 below.

Table 3. Types of Start-up Companies Listed by Northwestern University, by Industry

Technology Area	Firms
Nanotechnology	4
Advanced materials	2
Medical technology	4
Computer and software	3
Pharmaceutical	5
Web services	4
Others	4

Northwestern University has a very effective program in technology transfer. An important question to ask in future investigations is, “How do they do it?” Dr. Indrani Mukharji, the Executive Director of the Technology Transfer program, provided some insightful answers. First, one needs a highly talented staff. Dr. Mukharji states that,

“I prefer to hire analytical individuals with solid technical background as well as with experience in the private sector who will be willing to learn new fields in order to be able to see things from the inventor’s perspective.”

The staff of 11 (including Dr. Mukharji) includes seven who hold a PhD degree. The staff includes the Executive Director, a Director of Business Development, an Associate Director, four licensing associates each assigned to a different area (engineering and software, two in physical sciences, and life sciences), and four others. Dr. Mukharji’s mission was to create a unit that is self-supporting, and he has succeeded.

A second important element involves internal reporting to university officials. Dr. Mukharji finds it most productive to report directly to the President of the University and to an oversight committee of the Board of Trustees. He notes that it is important to communicate effectively and to manage expectations carefully. As he notes, “Only a small handful to the academic ideas succeed in the marketplace.”

University of Chicago

The University of Chicago Office of Technology and Intellectual Property (OTIP) provides assistance to their inventors regarding support organizations, patent information, business funding information, marketing, product and regulatory information, and so on. The Office has a staff of 22, headed by Director Alan Thomas. Eleven of the staff members hold a PhD degree in biological or physical science. The history of the Office began in 1986 with the founding of ARCH Development Corporation, a wholly-owned non-profit affiliate of the University of Chicago. ARCH Development was given the responsibility for intellectual property and technology transfer for both the University and Argonne National Laboratory, which the University operates for the U.S. Department of Energy. In 1994 some managers from ARCH Development left to form ARCH Venture Partners, a venture fund of some prominence. There is no formal affiliation of the Office with ARCH Venture Partners. Also, in 2001, some managers from ARCH Development left to form ARCH Development Partners – another entity with which the University has no official affiliation. The name of the university entity was changed to the Office of Technology and Intellectual Property in 2006. The Office reports directly to the Vice President for Research of the University.

The Office also provides information on the discoveries that are available for commercialization. This is done through the ibridge network, which maintains a web site that has 2,600 individual members, 5,800 innovations, and 68 organizations that are members. Table 4 reports the number of discoveries that were submitted by the University of Chicago OTIP, according to a number of technology categories.

Table 4. Discoveries Submitted by the University of Chicago Office of Technology and Intellectual Property, by Technology

Technology	Discoveries
Agriculture	2
Animal/Veterinary	1
Bioinformatics	18
Chemicals	9
Communication	3
Computer hardware	1
Computer software	1
Dental	1
Drug delivery	5
Drug discovery	13
Drug screening	5
Electronics	2
Gene therapy	3
Genomics/Genetics	6
Imaging	45
Materials	2
Nanotechnology	1
Optics	3
Process/Procedure	18
Proteomics	18

As shown below, each university tends to have its own system for classifying discoveries that are available for commercialization. The ibridge system is only one.

The web site for the OTIP recounts four success stories of successful firms that began with discoveries at the University of Chicago. These include a novel mathematics curriculum (Everyday Learning, now a division of McGraw-Hill), neural networks for detection of breast cancer (R2 Technology), software to anticipate machine failure (SmartSignal Corp.), and manipulation of particles with light beams (Arxyx).

The SmartSignal success story is particularly instructive, and illustrates the relationship between OTTP and Argonne National Laboratory. Scientists at Argonne developed a statistical software package that can detect failure of a machine long before it happens. The technology has wide application to industrial and consumer equipment, but at Argonne it was operating on several different platforms and was written in six different computer languages. In 1997 ARCH Development (the predecessor of OTTP) formed SmartSignal Corp. to license Argonne's copyrighted software in order to convert it into a user-friendly product. SmartSignal is a successful company, with clients that include Delta Airlines (jet engine monitoring), Archer Daniels Midland (monitoring chemical plants),

U.S. Steel (steel plants), and Sun Microsystems (computer hardware and software reliability).

The University of Chicago does not operate a technology park, but rather makes use of the Chicago Technology Park that is located in the Illinois Medical District (see below).

University of Illinois

The University of Illinois now includes economic development among its primary functions, and it operates a major technology transfer program. At the top of this program is the University of Illinois, Office of Corporate Relations that is located in Urbana and headed by the Vice President for Technology and Economic Development. Offices of Technology Management (comparable to the office at Northwestern) exist on both the Urbana-Champaign and Chicago campuses, and each of these campuses has an adjacent technology park (the Research Park at UIUC and the Chicago Technology Park). The University of Illinois is unique among local universities in that it founded a private venture capital company, IllinoisVENTURES, LLC, to support the start-up firms that are based on university research. The latest issue of Illinois Innovations reports that, in the past five years (FY 2003 to FY 2007), the university has received 255 patents, 366 licenses and options, and over \$42 million in royalty income (\$8.4 million per year, which is consistent with the data in Table 1 above).¹⁴ Licenses to start-up companies number 46 over these years.

The Research Park at UIUC has a total of 403,000 square feet and 68 tenants with 1200 employees, including 36 tenants with 249 employees in the Enterprise Works & Technology Commercialization Lab. This lab contains 43,000 square feet and offers start-up companies an affordable high-tech facility with lab and office space and access to investment funding and business development services from IllinoisVENTURES, LLC. IllinoisVENTURES is a seed and early-stage technology investment firm with its main office in Chicago and another office in the Research Park at UIUC.

The Offices of Technology Management are partnering with the Illinois Department of Commerce and Economic Opportunity to assist firms in applying for federal funding under the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. Small grants are awarded and consulting services are provided, provided that the firms agrees to complete an application for federal funding.

The Chicago Technology Park and Research Center occupies 56 acres in the Illinois Medical District on the near west side of Chicago, and provides a 56,000 square foot Research Center. The Chicago Technology Park currently has 34 tenants with 518 employees, including 17 companies with 83 employees in the Research Center. The Chicago Technology Park offers expansion space for start-up firms that are established and growing. Companies that started in the Chicago Technology Park include firms in drug

¹⁴ University of Illinois, "Illinois Innovations," U of I Office of the Vice President for Technology and Economic Development, 2008.

discovery and delivery, medical devices and testing, genomics, nanotechnology, and others that collaborate with medical researchers. Since it was founded in the 1980s the Chicago Technology Park has “graduated” 25 firms into the local economy.

Samuel Pruett, President of the Chicago Technology Park (CTP), responded to a questionnaire. Mr. Pruett has been President for five years, and notes that CTP focuses on life sciences – as it is located in the Illinois Medical District. CTP includes companies that are spin-offs from UIC and the University of Chicago. Mr. Pruett believes that the lack of public funding for infrastructure and facilities has held CTP back from being as effective as it could be. He feels that there is a lack of leadership among elected officials “... in positioning Illinois as a player in the life sciences arena on a national level.” He feels that CTP should have funds available for investment in promising companies, and that the state and city should invest in the necessary infrastructure. He makes some pointed suggestions:

“I believe that to be competitive, Illinois needs an SBIR/STTR (federal programs for small business innovation research and small business technology transfer) matching program. I also believe that we need to focus resources rather than the buckshot approach our state has employed. With so few resources available, it is important to concentrate those available resources where there is the highest potential for growth. Public support for technology business incubation is also lacking.”

Mr. Pruett’s suggestions imply increased public funding concentrated in certain areas, and a program to inform the public about the importance of economic growth and development in general and technology transfer in the life sciences in particular.

Illinois Institute of Technology

The Illinois Institute of Technology, with the support of the State of Illinois, has established the University Technology Park at IIT that is adjacent to the main IIT campus. That facility includes the Jules E. Knapp Entrepreneurship Center, which is designed to support expansion of entrepreneurial activity in the IIT area. The IIT program is relatively new (2005), and appears to be a successful program in knowledge and innovation creation in advanced business services, electronics, and bioengineering.

IIT lists several research centers that provide discoveries that potentially can be turned into innovations. Some of these research centers are collaborative efforts with other local universities (e.g., the University of Chicago) or with Argonne National Laboratory. Collaborative efforts in research are common among university researchers. A question that should be explored is whether collaboration among university technology transfer offices, which does not appear to exist now, would be productive.

These research centers include:

- Biophysics Collaborative Access Team (located at Argonne) provides advanced equipment for the study of biological materials.

- Center for Molecular Study of Condensed Soft Matter studies both synthetic and biological soft matter.
- Pritzker Institute for Biomedical Science and Engineering is an umbrella organization that includes Medical Imaging Research Center, Engineering Center for Diabetes Research and Education, Center for Integrative Neuroscience and Neuroengineering (with the University of Chicago).
- IIT Research Institute provides non-clinical services to the pharmaceutical and biotechnology industries in support of new drug submissions and has program in cancer diagnosis and prevention funded by NIH.
- National Center for Food Safety and Technology, Clinical Nutrition Research Center at IIT, studies impacts of foods with health promoting features.
- Particle Technology and Crystallization Center, in partnership with the pharmaceutical industry, studies how to produce new pharmaceutical compounds more rapidly.
- Power Electronics and Motor Drives Laboratory works on advanced power electronic converters that can be used in electric vehicles.
- Wireless Network and Communications Research Center seeks to improve wireless networks.

The University Technology Park at IIT web site lists 22 affiliated firms, distributed across the industries and technologies identified in Table 5 below.

Table 5. Categories of Firms Affiliated with the IIT Technology Park

Industry	Firms
Business services (software, decision systems, on-line learning)	9
Biotechnology (drug design and discovery, and so on)	7
Electronics (wireless systems, batteries, hybrid vehicles, solar cells, advanced chips)	5
Packaging technologies	1

Rush University

The Intellectual Property Office at Rush University lists 35 technologies that are available for licensing that are in the fields of diagnostic assays (5), drug discoveries (7), immunology (3), medical devices (2), orthopedics (3), research tools (6), transplants (2), tissue and cell biology (2), and other areas growing out of medical research (5).

Loyola School of Medicine

The Stritch School of Medicine of Loyola University, which has active research programs in the health sciences funded by NIH, has a policy regarding intellectual property and technology transfer, but at this time it is just beginning to have an active commercialization effort. As reported in Summer, 2008, the Stritch School of Medicine will hire outside consultants to perform technology assessments, examine market opportunities, design technology protection, and negotiate licenses.

Northern Illinois University

Northern Illinois University has a Technology Transfer Office (TTO) that was “created to encourage and nurture the development, disclosure, protection, and exploitation of university intellectual property.”¹⁵ TTO explicitly states that it has an economic development mission. TTO lists 22 technologies that are available for use by innovators. These include discoveries in electronics, chemicals, biotechnology, and kinesiology.

Northern Illinois University also funds the Northern Illinois Technology Enterprise Center (NITEC), which has the mission of helping researchers, inventors, and entrepreneurs commercialize new technology. NITEC works with other organizations in the area, including College of DuPage, IIT, and other groups.

Target clients for NITEC are entrepreneurs and seed stage companies that own or have licenses to proprietary technology in:

- Information technology and complex software,
- Telecom/photonics,
- Life sciences,
- Biotechnology,
- Medical technology/devices,
- Advanced materials,
- Nanotechnology,
- Manufacturing technology, and
- Lasers.

NITEC will work with students, faculty and staff at Northern Illinois University or other local universities, entrepreneurs or experienced managers in the region who are starting a business in one of these fields, or spin out ventures from existing businesses in the area. In short, NITEC will work with much of the general public.

DePaul University

DePaul University has the Coleman Entrepreneurship Center that is dedicated to connecting entrepreneurs with one another and finding “angels” for start-up firms. The Center does not focus specifically on high-tech businesses.

¹⁵ NIU Technology Transfer Office web site. <http://www.tto.niu.edu/tto/>

3.B. National Laboratory Technology Transfer

Argonne National Laboratory has an Office of Technology Transfer. The Stevenson-Wydler Technology Transfer Act of 1980 made technology transfer a mission of the federal government, and the Act was amended in 1986 to give authority to the Directors of the National Laboratories to enter into cooperative R&D and licensing agreements with industry, universities, and others. Argonne staff members are permitted to be partners with these outside entities. It appears that national laboratory staff members can function in a manner that is similar to university researchers.

Argonne has a lengthy list of available technologies in the following areas:

- Battery technology,
- Biological sciences,
- Chemical sciences,
- Emergency response,
- Engineering,
- Environmental research,
- Fuel cells,
- Imaging technology,
- Material science,
- Nanotechnology,
- Physical sciences,
- Transportation,
- High-impact technologies,
- Homeland security, and
- Software.

The Office of Technology Transfer (OTT) maintains a list of available technologies that are deemed to be of good commercial potential. Some of these are:

- Ceramicrete, a new generation material with superior strength,
- Lithium-ion batteries with longer life and lower cost,
- Near-frictionless carbon films, and
- Low-cost oxygen sensor.

OTT provides the standard set of services – technical services, license agreements, information about funding, and so on.

Stephen Ban, Director of OTT, responded to a questionnaire as follows. He has served as Director for seven years, and notes that Argonne's role in the Dept. of Energy as a multi-purpose laboratory means that a wide variety of potentially commercial products are produced. About 20 Chicago-area entrepreneurs and firms have participated in the tech

transfer program in the past 15 years. Participation has been held back, in Mr. Ban's opinion by

“... a lack of funding for technology maturation to get promising emerging innovative technologies to a point in which investors are willing to partner or invest. This is a major impediment to success in DOE labs – the so called “valley of death.”

In his view the process of basic science to technology deployment and demonstration should be “seamless.” Basic research should “always” focus on key long-term objectives with the goal of producing useful applications to applied R&D and engineering systems. He advises that CMAP planners (and others) should support the need for “maturation/demonstration/deployment activities” in order to take advantage of the potential benefits of innovations in science and technology.

Mr. Ban reports that commercial opportunities that originate at Argonne will be found in energy storage, biofuels, advanced materials, high efficiency processes, nano-engineering processes, and waste recovery/recycling. In essence, Mr. Ban is reporting that major opportunities are being missed, and that CMAP and the State of Illinois should take an active role in the process of moving innovations to commercial products.

Fermilab has an Office of Research and Technology Applications (ORTA) that facilitates patent applications and software copyrights for lab employees. Once the forms are filled out, ORTA decides whether the Fermi Research Alliance, LLC (FRA) has an interest in the invention. FRA will then decide to pursue a patent, but will do so only if it is likely that the costs can be recouped through licensing agreements. FRA will not pursue patents for vanity or “defensive” reasons. A small number of patents are available for licensing. The same policy applies to software copyrights.

3.C. State of Illinois Innovation and Tech Transfer Programs

The Illinois Department of Commerce and Economic Opportunity (DCEO) runs a large number of programs in the following areas:

- Business development,
- Coal,
- Community development,
- Energy and recycling,
- Entrepreneurship and small business,
- Film,
- Homeland security market development
- Technology,
- Tourism, and
- Workforce development.

The programs in Entrepreneurship and Small Business and Technology are relevant for this report. The Entrepreneurship and Small Business programs include:

- Entrepreneurship Centers, a network of 13 centers statewide that is targeted at companies with high growth potential. Services offered include access to capital, product licensing assistance, access to technology, and access to business networks.
- Small Business Development Centers, which serve new and existing small businesses with counseling, management and business plans, marketing, financial services, and training.
- Illinois Technology (ITEC) Enterprise Centers, which serve technology-based start-up companies with financing programs, training, assistance with product development, and marketing assistance.

The Technology programs are operated by the Bureau of Technology and Industrial Competitiveness. The Bureau largely has the function of connecting entrepreneurs with the resources that are available in Illinois for business planning and assistance in product development, marketing, training, government contracts, international trade, and regulatory compliance. These services are offered by the centers listed above. The Bureau also provides information on other resources in Illinois. For example, detailed information is provided on nanotechnology in Illinois.

Nanotechnology is often referred to as molecular manufacturing, which involves the manipulation of matter at the atomic level. Major research programs exist at Northwestern University, the University of Chicago, and the UIUC.

DCEO also provides information services. For example the Business Information Center has a guide to federal, state, and regional loan and grant programs for business and economic development. Programs listed are offered by the U.S. Small Business Administration, DCEO, Illinois Development Finance Authority, Illinois State Treasurer's Economic Program, and local government programs such as tax increment financing districts. These programs are too numerous to list here.

For a detailed breakdown of State of Illinois programs including loan programs, grants, tax assistance and start-up incentives, resources and support, entrepreneurship and small business, technology, nanotechnology, manufacturing and coal programs, see Appendix B.

3.D. Other Aspects of the Innovation Infrastructure of the Chicago Area

The innovation infrastructure of the metropolitan area includes a wide range of organizations and firms engaged in business startups such as: venture capital, technology parks, non-governmental organizations, and internet resources.

3.D.1 Venture Capital and Investment

Venture capital can be an important element in fostering innovation by supporting firms that are on the verge of rapid growth. The most recent edition of a report by Global Insight states that

“Venture capital firms are professional, institutional managers of risk capital that enables and supports the most innovative and promising companies. This money funds new ideas that could not be financed with traditional bank financing, that typically threaten established products and services in a corporation, and that typically require five to eight years to be launched.”¹⁶

Venture capital is equity capital for a company whose stock has little initial value until it matures in five to eight years. Capital typically is allocated in successive “rounds” as the firm develops and matures. Venture capitalists are actively engaged in the firm’s growth and development.

Global Insight reports that firms backed by venture capital from 1970 to 2005 employed 10.4 million workers in the U.S. in 2006 (up from 8.7 million in 2000) and had revenues of \$2.3 trillion in 2006 (up from \$1.5 trillion in 2000). Between 2003 and 2006 firms backed by venture capital grew in employment by 3.6% (compared to national growth of 1.4%), and sales grew by 11.8% (compared to 6.5% for national growth) over these same years. The top five industry sectors for firms backed by venture capital are computers and peripherals, industrial/energy, retailing, software, and consumer products. Venture capital backs firms in two rapidly growing sectors – biotechnology and medical devices and equipment. The top five states (based on employment) with venture capital backed companies headquartered in the state are California, Texas, Pennsylvania, Massachusetts, and Georgia. Illinois ranks 13th in the nation with 215,000 workers in venture capital backed firms headquartered in the state.¹⁷

Venture capital fund investments are highly concentrated geographically. The top five states and the amounts invested in 2007 are California (with \$14.1 billion, 1313 companies), Massachusetts (\$3.5 billion, 356 companies), Texas (\$1.4 billion, 140 companies), Washington (\$1.3 billion, 139 companies), and New York (\$1.2 billion, 140 companies). These five states account for 72% of total venture capital funding in 2007, and California alone accounts for 47% of the total invested. Illinois ranks 12th in the nation, with \$520 million in venture capital investments in 62 companies in 2007. The major source of venture capital funds for California is California itself (46% of the funds invested in 2007). However, 54% of the funds invested in California came from other locations – other states and foreign sources. California is the leading source of venture capital funds invested in Illinois (\$123 million in 2007), followed by Illinois itself (\$115 million in 2007). However, California received \$275 million in venture capital investments from Illinois in 2007. A total of \$713 million in venture capital investments

¹⁶ Global Insight, “Venture Impact: The Economic Importance of Venture Capital Backed Companies to the U.S. Economy,” National Venture Capital Association, 2007.

¹⁷ Ibid.

was raised in Illinois in 2007, but Illinois firms received only \$520 million in venture capital in that year – most of it from sources outside Illinois.¹⁸

However, the number of venture capital firms in the Chicago area has increased in recent years. The web site Internet-Chicago.com currently lists 82 venture capital firms that have offices in the Chicago area (and one California firm that has just become active in the region). The web site also lists the firms in the Chicago area that have been funded by these venture capitalists.

The most active venture capital firms, with start-ups' industries, are:

KB Partners, LLC (11 start-ups funded)	
▪ Manufacturing (advanced)	4
▪ Software/internet tools	4
▪ Business services	1
▪ Internet retailing	2
William Blair Capital Partners (9 start-ups funded)	
▪ Manufacturing (advanced)	3
▪ Software	2
▪ Business services	2
▪ Internet service	1
▪ Retailing	1
Alpha Capital Partners (7 start-ups funded)	
▪ Retailing	2
▪ Software	2
▪ Telecom	2
▪ Manufacturing (advanced)	1
ARCH Venture Partners (7 start-ups funded)	
▪ Software	4
▪ Education/training products	2
▪ Genetic data bank	1
Madison Dearborn Partners (7 start-ups funded)	
▪ Telecom	2
▪ Manufacturing (advanced)	2
▪ Medical	2
▪ Options/stocks clearing	1

All of these firms have supported at least one firm in advanced manufacturing and, except for Madison Dearborn Partners, software development. The Internet-Chicago.com web site connects one to the web sites for the venture capital firms and to the firms that have been funded.

¹⁸ Data from National Venture Capital Association web site.

A great deal of academic research has examined the impacts of venture capital. One question is whether venture capital simply follows economic opportunity (i.e., follows the market) or is an independent stimulus for an industry or a local economy. Researchers have addressed this question and found that venture capital does act as an independent stimulus. Kortum and Lerner found that increases in venture capital in an industry are associated with greater numbers of patents in that industry.¹⁹ A recent paper by Samila and Sorenson finds that an increase in the supply of venture capital during 1993-2002 positively affects the number of firm births, employment, and aggregate income in a metropolitan area. It appears that "...would-be entrepreneurs that anticipate a future need for financing are more likely to start firms when the supply of capital expands."²⁰ It also appears that venture-capital funded firms may train their employees with knowledge that can be used to start more new firms. Other researchers do not agree with these conclusions. Hirukawa and Ueda provide a brief summary of research in the field and conclude that, "However, taken together, the evidence supporting the positive impact of venture capital on innovation is weak at best."²¹ They point out that the first study of this kind by Zucker, et al. found that, controlling for the presence of star scientists, venture capital had a negative impact on the rate of new firm formation in biotechnology.²² Other research, including unpublished work by Hirukawa and Ueda, finds that venture capital follows, rather than leads, innovation. Indeed, Stuck and Weingarten contend that venture capitalists inhibit innovation because of their business (as opposed to scientific) orientation.²³ This very old academic debate about the causality between finance and economic performance will continue, but the need for capital by growing firms exists and needs to be filled in some manner. And what is the best role in this matter for public policy at the state and local level? At this time there is no clear-cut answer.

3.D.2 Technology Parks

Technology parks in Illinois are listed on the Illinois Technology Parks web site. Eight tech parks are listed, four of which are located in the Chicago area. These four are:

- Illinois Science + Technology Park, located in Skokie. This tech park has a focus on pharmaceuticals, biotechnology, and medical diagnostics and devices. When completed, the park will consist of 2 million square feet of research and office space. Facilities are ready to move into now, and allow room for expansion.

¹⁹ S. Kortum and J. Lerner, "Assessing the Contribution of Venture Capital to Innovation," *RAND Journal of Economics* 31 (2000), pp. 674-92.

²⁰ S. Samila and Olav Sorenson, "Venture Capital, Entrepreneurship, and Regional Economic Growth," Social Science Research Network, 2008.

²¹ M. Hirukawa and M. Ueda, "The Tenuous Relationship of Venture Capital and Innovation," VoxEU.org web site.

²² L. Zucker, M. Darby, and M. Brewer, "Intellectual Capital and the Birth of U.S. Biotechnology Enterprises," *American Economic Review* 88 (1998), pp. 290-306.

²³ B. Stuck and M. Weingarten, "How Venture Capital Thwarts Innovation," *IEEE Spectrum* (April 200), pp. 50-55.

- DuPage National Technology Park, located in West Chicago. This park features a geographically redundant fiber communications network scalable to 100 GB per second speed. The park contains 700 acres, and space is available for corporate headquarters, lab space, data centers, offices, R&D facilities, manufacturing, and retail/wholesale/distribution.
- Chicago Technology Park (located at UIC, as noted above).
- University Technology Park at IIT (located at IIT, as noted above).

The other four tech parks in Illinois are located at UIUC (as discussed above), Southern Illinois University (Carbondale and Edwardsville), and Peoria (Bradley University).

3.D.3 Non-Governmental Organizations (NGOs)

Several other non-governmental organizations exist to help the creation and development of Illinois businesses.

These include:

- iBIO: The Illinois Biotechnology Industry Association
- Chicagoland Chamber of Commerce, which has recently initiated a program called InnovateNow. The first Innovation Summit takes place on May 21, 2009. The portfolio of InnovateNow could be expanded to include technology transfer and product and process innovation. Chicagoland Chamber is an influential business organization that is actively interested in economic growth and development of the entire metropolitan area, so its assistance should be enlisted.
- Illinois Information Technology Association, a group that serves member businesses that create, deploy, and utilize information technology as a core part of the business.
- Illinois Technology Development Alliance, a non-profit professional services firm that assists high-tech businesses.
- Chicagoland Entrepreneurial Center, which helps entrepreneurs and high-growth businesses.
- Illinois Innovation Accelerator Fund, a for-profit early stage investment fund to help companies seize high-growth opportunities.
- Ceres Venture Fund, a venture capital fund seeking to fund start-up firms in the Midwest.

- Illinois Venture Capital Association, a non-profit trade organization that assists the private equity community.
- Heartland Angels, a private equity network that seeks to bring together investors with start-up companies.

A detailed description of each of the above NGOs is provided in Appendix C of this report.

3.D.4 Internet Resources

Several web-based information services exist to provide news about industries, information about the region, and networking opportunities:

- BioSpace.com, DeviceSpace.com, ClinicaSpace.com
- MidwestBusiness.com
- TechWeb.com
- GreenBiz.com
- ScienceResourceWorld.com

Traditionally information has been shared and transmitted by face-to-face contact in seminars, professional meetings, and personal contact. Clearly the internet is now providing another means for sharing information that provides wider and more rapid dissemination.

A detailed description of each of the above internet resources is provided in Appendix D of this report.

4. Innovative Industries and Industry Clusters

As discussed in the report on export promotion and import substitution, metropolitan Chicago has some highly successful manufacturing and service export industries, which are shown in Table 6. Other service industries with some export content are also listed. The table shows employment in the industry in 1997, 2002, and 2007, industry type (discussed below), and some detail about the industry that may not be obvious from the industry title.

Table 6. Export Industries in Metropolitan Chicago (from CREIM)

Industry	Employment in 1997	Employment in 2002	Employment in 2007	Industry Type*	Details
<i>Manufacturing</i>					
Food & Kindred Products	62,152	47,709	41,930	Loc	
Printing & Publishing	79,290	60,076	50,909	Innov.	Printing, Publ., Internet
Chemicals & Allied Products	51,039	39,197	38,813	Innov	Pharma., Drugs
Industrial Machinery and Equipment	80,941	60,678	55,827	Innov	
Computer & Other Electrical Products	122,619	89,889	77,066	Innov	Phones
Transportation Equipment	22,859	17,342	16,074	Loc	Auto & Parts
<i>Exported Services</i>					
Wholesale Trade	279,383	245,987	244,331	Loc	
Air Transportation	69,959	60,496	63,998	Loc	
Information	51,665	39,905	38,156	Innov	Broadcast, Telecom
Finance & Insurance	384,858	422,806	466,674	Innov	
Real Estate	77,750	86,568	92,757		
Professional & Mgmt. Services	545,816	676,318	724,250	Innov	Legal, Account., Architect., Computer, Mgmt. Consult., Advert., Research

Industry	Employment in 1997	Employment in 2002	Employment in 2007	Industry Type*	Details
<i>Other Services</i>					
Education	94,096	117,371	125,179	Innov	Schools, Colleges
Health Care	313,146	369,850	398,474	Innov	
Arts, Ent., Rec.	42,019	55,151	61,006	Innov	

*See text below for discussion.

Each successful local industry is innovative in its own way, but RCF hypothesizes that some of Chicago’s export industries are based more on location and infrastructure than on innovation. These industries are denoted Loc above. Other industries are based largely on innovation, and they are denoted Innov. Innovative industries can cluster in many locations. Clearly Chicago’s innovative industries include a wider range than the “high-technology” activities that are discussed in Section A. An innovative local economy can and does include innovative publishers, providers of professional and financial services, and other industries that do not necessarily rely on inventions and patents. Some of the industries listed in Table 6 clearly are linked to research and technology transfer activities discussed in Section 3; these include Printing and Publishing (which includes internet publishing), Chemicals and Allied Products (which includes pharmaceuticals), Industrial Machinery and Equipment, Computer and Other Electrical Products, Information (including telecommunications), Professional and Management Services (which includes custom computer programming and systems design as well as scientific research services), and Health Care. Each of these industries is supported by a variety of entities listed in Section 3, but it would appear that there are no focused efforts of support.

Four of the six manufacturing export industries can be regarded as based largely on innovation (rather than location and infrastructure). However, all six manufacturing industries have one thing in common. All experienced a sharp drop in employment from 1997 to 2002, and then continued to decline in employment to 2007. Employment in one of the four innovative industries – Chemicals and Allied Products – held up pretty well (decline of only 4.4% from 2002 to 2007), but the other three have experienced sizable employment declines in these recent years. Given that productivity can increase, output and export earnings can increase while employment remains constant (or declines). Increases in export earnings are a source of employment increase for the metropolitan area through the local multiplier effect, of course, but these manufacturing industries should not be viewed as a major direct source of employment increases.

The employment picture for innovative exported services stands in sharp contrast to that for exported manufactures. While employment in Information dropped sharply between 1997 and 2002 (and recovered slightly from 2002 to 2007) because of the dot-com bust, employment in Finance and Insurance and Professional and Management Services grew strongly throughout the ten-year period. Indeed, these sectors have been the source of the bulk of employment growth in the metropolitan area in this decade.²⁴

²⁴ RCF Economic and Financial Consulting, Inc., *Databook Chicago* (Chicago: RCF, 2008).

Table 7 also includes three service industries that combine some forms of innovation with some export content – Education (including Higher Education); Health Care; and Arts, Entertainment, and Recreation. Employment in these industries increased throughout the 1997-2007 period.

A report prepared by CMAP staff has identified industry clusters with favorable characteristics of local concentration (as measured by location quotients) and/or recent growth.²⁵ This report identifies the following broad sectors as having high location quotients and/or employment growth, as shown in Table 7 below.

Table 7. Local Industries with Characteristics Favorable to Continued Growth

Industry	Characteristics	
	High Location Quotient	Employment Growth
Professional Services	X	X
Finance and Insurance	X	X
Wholesale Trade	X	
Transportation and Warehousing	X	
Health Care		X
Education		X
Leisure and Accommodation		X

The CMAP report also identified specific industries that have high location quotients and employment growth (important growth industries) and specific industries with relatively rapid growth but low location quotients (emerging industries). Some of these industries produce primarily for local consumption; the export industries in these categories (omitting some very small industries) are:

- Important Growth Industries
 - Merchant Wholesalers (drugs and groceries)
 - Freight Transportation Arrangement
 - Other Financial Investment Activities
 - Management of Companies and Enterprises
 - Business and Professional Organizations
 - Food Manufacturing (other)
 - Support Activities for Rail Transportation
 - Information Services (other)
 - Activities Related to Credit Intermediation
 - Performing Arts Companies
 - Other Amusement and Recreation Services
 - Securities and Commodity Contracts Intermediation and Brokerage
 - Securities and Commodity Exchanges

²⁵ B. Rademacher, “Cluster Analysis: Regional Economic Base Analysis,” Chicago Metropolitan Agency for Planning, Sept. 2008.

- Emerging Industries
 - Medical Equipment and Supplies Manufacturing
 - Merchant Wholesalers (lumber and petroleum)
 - Freight Trucking
 - Traveler Accommodation

The list of Important Growth Industries includes industries in Wholesale Trade and Transportation, Financial Services, Business and Professional Services, and Tourism (Performing Arts and Other Amusement and Recreation Services). The Emerging Industries include an industry in Wholesale Trade, Transportation, Tourism, and one in manufacturing – Medical Equipment. These industries map reasonably closely to the export industries listed above (except for Tourism).

The biotech industry emerged in the 1970s and 1980s and a new industry that is based on using “...biological processes rather than traditional chemical methods to develop drugs, vaccines, and diagnostic tests.”²⁶ The first biotech drug – human insulin produced in bacteria that are genetically modified – was introduced in 1982. Since then, over 400 drugs and vaccines have been developed by the biotech industry for numerous diseases including cancer, Alzheimer’s disease, heart disease, diabetes, multiple sclerosis, Parkinson’s disease, AIDS, and other diseases. The biotech industry has also invented hundreds of new diagnostic tests – many of which involve identification of genetic features in human DNA. Barfield and Calfee review the numerous studies of the large benefits of the new drugs and diagnostic tests, and note that the industry is “... so new and its science and technology base expanding so rapidly, one can fairly say that in terms of health benefits, the field has barely emerged from its infancy.”²⁷ Some of the basic characteristics of the industry include:

- The industry depends upon advances in basic and applied research in universities and firms, which will require large expenditures and continued support from the federal government;
- Product development times are lengthy;
- Bringing a new drug to market is both costly and fraught with uncertainty, and;
- The definition of property rights is critical to providing incentives.

World Business Chicago points out that the Chicago area is a leading center of life science and biotechnology.²⁸ The metropolitan area has a concentration of medical research at the Northwestern University, the University of Chicago, UIC, Rush University, and Loyola University (Stritch School of Medicine). The drug and pharmaceutical

²⁶ C. Barfield and J. Calfee, *Biotechnology and the Patent System* (Washington, D.C.: AEI Press, 2007), p. 3.

²⁷ Barfield and Calfee, *op. cit.*, p. 6.

²⁸ World Business Chicago, “Biodiversity,” WBC web site, 2008, <http://www.worldbusinesschicago.com/>.

industry consists of 67 firms with employment of 17,700 (6.1% of the national total). The roster of firms includes:

- Abbott Laboratories (HQ),
- Dade Behring (HQ),
- Pfizer,
- Takeda Pharmaceuticals of North America (US HQ),
- Wyeth Pharmaceutical,
- Amgen
- Briston-Myers Squibb,
- Eli Lilly,
- Hospira (HQ),
- Novartis,
- Sanofi-Adventis (HQ),
- Watson Pharmaceuticals, and
- Centocor.

World Business Chicago lists 11 newly formed firms in the industry such as Acura Pharmaceuticals, Advanced Life Sciences, Abraxis Life Sciences, Morton Grove Pharmaceuticals, and others. The Chicago area is also well represented in the Medical Devices and Equipment industry. World Business Chicago lists 33 local firms, including venerable firms such as Baxter (HP) and Beltone (HQ).

5. Challenges and Opportunities in Innovation

This section summarizes what is known about both the creation and diffusion of innovation, and identifies some opportunities for improvement in the Chicago metropolitan area. As noted above, innovations are of various types. As Bhide puts it, there are layers of innovation.²⁹ Innovation can consist of the creation of new basic knowledge, the creation of practical uses for basic knowledge, and the use of existing know-how in new combinations. Further, innovation can consist either of new products and services or better methods for producing existing products and services. As Baumol, Litan, and Schramm have emphasized, the version of a capitalistic economy that is most innovative overall is one that combines entrepreneurial and large-firm capitalism.³⁰

Recent research by the Bureau of Labor Statistics makes use of the data from the Business Employment Dynamics program.³¹ This research examined the net change in employment from 1992 to 2005 by size of *firm*, which is the correct unit of analysis for the present purpose (as opposed to data on establishments). The results for net change in employment by size of firm are shown in Table 8. This table shows clearly that, contrary to some popular opinion, the bulk of employment growth did not occur in small firms. Firms with employment under 10 (under 50) contributed 16.5% (37.0%) of net employment growth, while large firms of 250 or more employees contributed 41.9% of the net employment growth. As Baumol, Litan, and Schramm suggest, economic success requires the efforts of firms both large and small.³²

Table 8. Net Change in Employment by Firm Size: 1992 – 2005

Size of Firm by Employment	Net Change in Employment (1000s)	Percentage of Net Change in Employment
1-9	3,393	16.5%
10-49	4,234	20.5%
50-249	4,335	21.0%
250 and higher	8,635	41.9%

Source: Bureau of Labor Statistics, Business Employment Dynamics data.

Innovations of all types are being produced in many places around the world, so the successful economy adopts and adapts innovations no matter where they were created. Lastly, as the research discussed above shows, the world is “spikey,” not “flat.”³³ Some urban areas are centers of innovation and generators of economic growth and development.

²⁹ Bhide, 2008, op. cit.

³⁰ Baumol, Litan, and Schramm, 2007, op. cit.

³¹ Bureau of Labor Statistics, “New Quarterly Data from BLS on Business Employment Dynamics by Size of Firm,” BLS, December, 2005.

³² In a well-known short article on regression toward the mean, Milton Friedman stated that, “For example, ‘everyone knows’ that job creation comes mainly from small firms.” See M. Friedman, “Do Old Fallacies Ever Die?” *Journal of Economic Literature* 30 (1992), pp. 2129-32. Perhaps BLS has put this old fallacy to rest (but only perhaps).

³³ Baumol, Litan, and Schramm, *ibid.*, p. 255, mention Austin, Boston, Raleigh, Seattle, and the San Francisco Bay area as examples of geographic agglomerations in the U.S. Richard Florida, “The World is

Metropolitan Chicago has already established itself as a center of innovation in some areas, including:

- Life Sciences, Medical Sciences, and Pharmaceuticals,
- Fabricated Metals and Industrial Machinery and Equipment,
- Financial Services (risk management; futures and options, insurance),
- Software Development, and
- Electronics.

All of the types of innovations mentioned in the previous paragraph exist in these areas in metropolitan Chicago. The Chicago area conducts basic and applied research, has start-up firms and licensing agreements, and is home to large firms in all five of these areas. In addition, as the report on Infrastructure shows, the metropolitan area is the world's leader in internet backbone for research (but not for general use). The future success of the metropolitan area will depend in sizable measure on the ability of each of these agglomerations to continue to thrive and take advantage of opportunities that will arise.

One challenge is to improve performance in these five critical sectors. Those who perform basic research tend to be well-informed about new basic knowledge that is created elsewhere, but are entrepreneurs aware of pertinent developments from around the world? Baumol, Litan, and Schramm suggest the creation of a federal office of technology monitoring, with much of the work out-sourced to universities.³⁴ They point out that there is no "office of technology monitoring," and suggest that it could be housed in the Department of Commerce, or even be an arm of the Patent and Trademark Office. If such a proposal is adopted, the major universities in the metropolitan area should participate in this work. However, an entity could be created in the metropolitan area that would focus only on innovations in certain critical areas. Also, Baumol, Litan, and Schramm (and others) are critical of most university tech transfer operations. Research conducted by the Kauffman Foundation finds that these offices often are too bureaucratic, lack high-level talent, and are too small to be effective.³⁵ This situation leads some university researchers to circumvent the university tech transfer office and, in some cases, found start-up firms. Also, while information on the effectiveness of university tech transfer programs is available, more information about the tech transfer program at Argonne National Laboratory is needed. One idea voiced by Baumol, Litan, and Schramm is to consolidate university tech transfer programs in a single entity (or smaller number of entities) that can operate more effectively at a larger scale and with more highly professional staff.³⁶

Another challenge is to assess the effectiveness in fostering innovation of the numerous business assistance programs that are provided by the State of Illinois and by

Spiky," *Atlantic Monthly*, October, 2005, gets credit for "spiky" characterization in response to Thomas Friedman, *The World is Flat* (New York: Farrar, Strauss & Giroux, 2005).

³⁴ Baumol, Litan, and Schramm, 2007, op. cit., pp. 258-9.

³⁵ D. Audretsch, et al., "Scientist Entrepreneurship: The Sleeping Giant of University Commercialization," Kauffman Foundation, 2006.

³⁶ Baumol, Litan, and Schramm, op. cit., 2007, p. 266.

numerous other organizations. These programs have several objectives, including helping people start small business of any type, helping businesses upgrade their computer technology and other facilities, and so on. Of particular importance is the network of Entrepreneurship Centers operated by the State of Illinois.

The network of four technology parks in the metropolitan area was discussed in a previous section. This network consists of:

- University Technology Park (at IIT),
- Chicago Technology Park (at UIC),
- Illinois Science + Technology Park (in Skokie), and
- DuPage National Technology Park (in DuPage County).

David Baker, the Executive Director of the University Technology Park, responded to a set of questions for this report as follows. He believes that the main areas for commercial success for this facility are in hybrid vehicle technologies, battery related research, and software development. A key factor in the success of this relatively new venture (begun in 2005) is the participation of a strong private sector partner, Wexford Science and Technology LLC in addition to the support of federal, state, and city government – and IIT. Mr. Baker sees some challenges that may involve CMAP. First, he would like to see a mechanism that would assist firms with their need for space as they grow and ultimately leave the tech park. He also suggests that CMAP planners should become familiar with the special needs of technology companies other than software companies. The building requirements of biotech and energy firms are quite different from the needs of software companies, and include wet lab space and room for production activities and physical inventory. Finally, he suggests that CMAP should find a means for supporting the network of technology parks listed above.

The comments in this section so far have concentrated on supporting the areas in which the metropolitan area possesses an innovative agglomeration. The more difficult and speculative question is the identification of emerging areas of innovative agglomeration. This is a most difficult challenge. Indeed, it may be that local planning officials should not be engaged in picking emerging areas of innovation. Rather, targeted support should not be designed until an area of innovation clearly has begun to emerge. One indicator of this might be a cluster of start-up firms that come out of the university technology transfer programs. Another method for identifying emerging areas is to interview directors of technology transfer programs and other experts who work in the field (otherwise known as the “Delphi Method”).

Nevertheless, the survey of discoveries available for licensing suggests that the Chicago area may well see these areas emerge as innovative agglomerations:

- Nanotechnology,
- Advanced materials,
- Electric and hybrid vehicles,
- Bioinformatics, and
- Medical imaging.

6. Indicators of Success and Goals for Innovation

Successful development in innovation can be measured by general economic indicators, direct indicators of innovation production itself, and by indicators of innovation diffusion. Overall, increases in these measures of success are the main goals for innovation in the Chicago region, and thus a major driver of economic growth. Overall growth in employment, output, and exports in innovative export industries would be indicative of successful innovation development and practice in the region.

Performance (value added, total value of output, employment) in the following industries would be a particularly useful method of tracking overall innovation:

- Fabricated Metals
- Chemicals and Allied Products (i.e., pharmaceuticals and drugs)
- Industrial Machinery and Equipment
- Computer and Other Electronic Products
- Information
- Finance and Insurance
- Professional and Management Services
- Other Industries (Higher Education, Health Care, Arts, Entertainment and Recreation)

Another general economic indicator to track as a measure of innovation is the occupancy rates in one of the hubs of innovation activities: offices in the technology parks.

More directly, innovation can be measured by indicators of innovation production such as:

- University research expenditures
- Disclosures of discoveries at universities
- Patent applications
- Patents issued
- Discoveries available for licensing

The benefits of innovation as a driver of economic growth can also be measured by the diffusion of innovation activities. Such activities include:

- Licenses and options executed at universities and Argonne
- Start-up firms based on university discoveries
- Start-up firms in other innovative industries
- Movement of start-up firms out of tech parks to other locations
- Acquisitions of start-up firms by larger firms

Data on venture capital activity at the state level are readily available from the National Venture Capital Association. They provide data on venture capital fund commitments, investments, and firms funds. A matrix of origins and destinations of

venture capital investment funds is also provided. Global Insight has access to a database of over 23,500 venture capital backed companies.

7. Strategies to Enhance Innovation

As this report demonstrates, the Chicago metropolitan area contains a sizable group of innovative industries with both small and large firms, great research universities with the aim to transfer discoveries to the marketplace, government programs that support new firm formation, venture capital firms, and other organizations that support innovation. There is much to be happy about when one examines the metropolitan area. However, total employment growth in the Chicago area has lagged in this decade; employment did not recover to its 2001 level until 2007.³⁷ The question at hand is, “Can the performance of Chicago’s innovative sectors be improved?” What strategies can be followed to accomplish this goal?

Strategies to enhance innovation fall into two general categories: provide general support across the board (much as it is done now), or provide more focused programs that concentrate on particular sectors that are targets of opportunity. The general support strategy runs the risk of dispersing limited public resources over too many fields, rendering the effort ineffective. However, the selection of target sectors for support runs the risk of selecting the wrong targets. A middle ground is to select a reasonably modest portfolio of sectors that are not correlated with each other (as in, do not put all of your eggs in one basket). For example, such a portfolio might consist of

- A biotechnology area,
- A nanotechnology area (and emerging opportunity),
- An advanced manufacturing industry, and
- An export service sector that does not necessarily rely on high technology.

This report concludes with some strategic suggestions:

1. Recognize that innovation does not all originate in the R&D, medical, engineering, or science lab. Innovation also takes place in Professional and Management Services, Finance and Insurance, Higher Education, and Arts, Entertainment, and Recreation – to pick some prominent examples in Chicago. RCF recommends that CMAP might conduct further research into innovation in these sectors, including an examination of the extent to which infrastructure is needed to support continued innovation.
2. The report notes that useful discoveries are being made around the world. RCF suggests that CMAP might initiate discussions for how to provide local firms with information about useful discoveries that originate outside the metropolitan area. It is suggested that this effort might start with one particularly innovative industry.
3. This report includes some criticism of the technology transfer programs at local universities (with the exception of Northwestern University). Baumol, Litan, and

³⁷ RCF Economic and Financial Consulting, Inc., op. cit.

Schramm suggest consolidation of tech transfer offices might enhance their productivity.³⁸ They also suggest that universities change their focus from license fees to the number of licensing “deals” completed. CMAP might initiate meetings with university officials to discuss these ideas. Alternatively, the Chicagoland Chamber of Commerce might undertake this task as part of its InnovateNow initiative.

4. A strong emphasis on start-up firms pervades the public programs and private support efforts. Given that the most productive innovations often require adoption by larger, existing firms, this emphasis may be misplaced. Further research might concentrate on the processes of taking new products and services to the larger market. Mr. Baker of IIT emphasized one aspect of this process when he suggests that CMAP should consider the issue of providing space for firms that are able to “graduate” from the tech parks. Mr. Pruett of the Chicago Technology Park suggests that more focused public support is needed, and that the four technology parks would be a good choice for that enhanced support.
5. Innovation depends upon people – scientists, engineers, skilled workers, and above all, entrepreneurs. Several colleges of business administration in the metropolitan area have programs in entrepreneurship (University of Chicago, UIC, DePaul). These programs need to be connected to the innovative industries. CMAP might consider convening a meeting of deans and directors of local entrepreneurship programs to share goals and ideas. Perhaps it would lead to a conference that would be part of the follow-up to the Go To 2040 plan. Alternatively, the Chicagoland Chamber of Commerce might take up this task.
6. Further research on the sources of growth for metropolitan Chicago is needed. Has growth resulted from growth in large firms, small firms, or new firms? What specific labor skills are associated with recent growth? As noted above, the performance of the local economy in this decade has been disappointing. Better understanding is needed.
7. Indeed, innovation is so important to the economy of metropolitan Chicago that CMAP might take the lead in organizing a series of meetings and conferences at which the issues are discussed and further connections are made. This work might be done in collaboration with the Chicagoland Chamber of Commerce, as noted above.

In essence, RCF recommends that CMAP begin to take an active role in supporting further investigation into economic growth in the local economy and in stimulating further conversation and connections among the innovators in the metropolitan area.

³⁸ Baumol, Litan, and Schramm, op. cit., pp. 266-67.

Appendix A

Research on Theory of Innovation and Metropolitan Growth

The theory of metropolitan economic growth and development was outlined above. This appendix summarizes research on the series of hypotheses involved.

Zoltan Acs probably is one of the most active researchers in the field, and he has conducted many empirical tests of these hypotheses. The results of this research program are reported in two recent books, aptly titled *Innovation and the Growth of Cities* and *Entrepreneurship, Geography, and American Economic Growth* and in various articles.³⁹ One important study examined the factors that are related to the number of innovations that were introduced by firms located in 125 large metropolitan areas in 1982.⁴⁰ (Previous research had examined data at the state level.) These data are a compilation of “high-tech” innovations that were introduced to the U.S. market based on extensive reviews of new product announcements in technical and trade sources conducted by the U.S. Small Business Administration. The address of the adopting establishment was identified. The results show that innovations were positively related to:

- University science and engineering expenditures in the metro area and within 50 miles of the metro area,
- Concentration of high-tech employment (measured as a location quotient),
- Employment in business services, and
- The rank of the universities’ high-tech departments.

Innovations were negatively related to the percentage of large firms (employment exceeding 50). Private R&D expenditures were found to be positively related to university science and engineering expenditures, high-tech employment, and the presence of Fortune 500 companies in the metro area. University science and engineering expenditures were positively related to enrollment and the rank in high-tech departments. One important finding is that innovations were related to expenditures on university science and engineering directly and indirectly through the impact on private R&D expenditures. Innovations also depend upon high-tech employment and upon a strong local business services sector.

A report by Fred Block and Mathew Keller that was written for the Information Technology and Innovation Foundation shows that important commercial innovations increasingly originate from work done in universities or national laboratories and

³⁹ Z. Acs, *Innovation and the Growth of Cities* (Northampton, Mass.: Edward Elgar, 2002) and Z. Acs and C. Armington, *Entrepreneurship, Geography, and American Economic Growth* (New York: Cambridge University Press, 2006).

⁴⁰ L. Anselin, A. Varga, and Z. Acs, “Local Geographic Spillovers Between University Research and High Technology Innovations,” *Journal of Urban Economics* 42 (1997), pp. 422-48 and Chapters 3 and 4 in Acs, op. cit., 2002.

decreasingly come from the R&D facilities of corporations.⁴¹ This study is based on the top 100 innovations in years from 1971 to 2006 in the *R&D Magazine* annual competition. They attribute this change to the increasing complexity of emerging technologies and the shift of federal policy to support commercialization of discoveries made in universities and national laboratories. These factors are discussed below.

Other research by Jaffe and his associates has used patent data to show the existence of “spillovers” from university research to commercial innovation, and that spillovers are geographically localized, although spillovers from patents based on university research are less likely to be localized than are patents based on private R&D.⁴²

Another study examined the effect of university science and engineering expenditures on employment in six high-tech industries for 36 metro areas in 1988-91.⁴³ The six industries (with the relevant university units) are shown in Table A1.

Table A1. Academic Disciplines Involved in Innovation, by Industry

Industry	Academic Disciplines
Biotechnology and biomedical	Life sciences
Information technology and services	Mathematics
High-technology machinery and instruments	Environmental sciences and engineering
Defense and aerospace	Engineering and physical sciences
Energy and chemicals	Physical sciences
High-technology research	All hard sciences

The report on Export Promotion and Import Replacement identifies the first, second, third, and fifth industries on this list as major export industries for metropolitan Chicago. High-tech employment was positively related to the size of the metro area, university science and engineering expenditures (lagged), employment in industrial R&D labs in 1985, and the number of innovations that were made in 1982. Results for the six individual industries show that the number of innovations adopted in 1982 was positively related to employment in 1988-91 for Information and Technology Services, High-Technology Research, Biotechnology and Biomedical, and High-Technology Machinery and Instruments.

Acs and his colleagues followed up this line of research with a study of entrepreneurship, measured as the new firm formation rate in labor market areas for 1995-6.⁴⁴ The basic message from this study is that firm formation is positively related to

⁴¹ F. Block and M. Keller, “Where Do Innovations Come From? Transformations in the U.S. National Innovation System, 1970-2006,” The Information Technology and Innovation Foundation, Washington, DC, July, 2008.

⁴² A. Jaffe, “Real Effects of Academic Research,” *American Economic Review* 79 (1989), pp. 957-970, A. Jaffe, M. Trajtenberg, and R. Henderson, “Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations,” *Quarterly Journal of Economics* 108 (1993), pp.577-598 and “The Bayh-Dole Act and Trends in University Patenting, 1965-1988,” Stanford Center for Economic Policy Research, 1996.

⁴³ Chapters 8 and 9 in Acs, op. cit., 2002.

⁴⁴ Acs and Armington, op. cit., 2006.

establishments per 1000 population. This variable is thought to measure the amount of technological spillovers that might occur. Firm formation is negatively related to average establishment size, which is a (negative) measure of the entrepreneurial environment. These are not direct measures of the factors that are thought to encourage entrepreneurship, so the value of this study is not obvious. Results for firm formation in all sectors show that establishments per 1000 population, percentage college graduates in the local population, percentage high school dropouts, population growth, and income growth had positive effects. Establishment size had a negative relationship with firm formation. Results were obtained for industry groups; manufacturing and business services are important as export industries. Firm formation in manufacturing was positively associated with manufacturing establishments per 1000 population (a measure of sector specialization and potential spillover effects), the share of proprietors in local employment, population growth, the unemployment rate, and the percentage of high school dropouts – and negatively related to establishment size. Firm formation in business services was also positively related to establishments in business services per 1000 population, high school dropouts, population growth, and income growth. Results for service firms oriented to the national market show that establishments per 1000 population (sector specialization and possible spillovers) and population growth were positively associated with new firm formation – and average size of establishments had a negative effect. These results are suggestive, but they also illustrate the difficulties inherent in testing this part of the theory.

The study by Acs and Armington also investigated employment growth rates during the 1990s in labor market areas.⁴⁵ Total employment growth was positively related to the contemporaneous new firm formation rate (divided by the size of the local labor force), share of adults with high school diplomas, and establishment size. Establishments per 1000 population and establishments per square mile (business density) had negative effects, and share of adults with college degrees had no effect. The new firm formation rate was found to effect employment positively in business services, but not in manufacturing. The authors interpret the result for the new firm formation rate as supporting the theory, but it would seem that the causation can work in the other direction; employment growth leads to new firm formation. One cannot conclude that new firm formation, considered as a measure of entrepreneurship, is an independent factor that causes greater employment growth.

The other form of empirical evidence that tends to support the new growth theory (with its geographic and entrepreneurship features) is the history of urban agglomerations that have produced major innovations and economic growth such as Silicon Valley. Other examples in the U.S. include Detroit and the auto industry in the early 20th century, Route 128 in the Boston area, and the Chapel Hill area in North Carolina. Silicon Valley had (and has) all of the elements listed above; a major university (Stanford) with an industrial park, firms that spend on R&D, a highly competitive environment, entrepreneurs, and venture capitalists. A huge literature has been generated that describes these and other examples around the world.

⁴⁵ Ibid.

The econometric evidence in support of the new growth theory outlined above is not completely clear and convincing. And the numerous case studies are just that – case studies that do not indicate where and how often the experience of endogenous growth and development in a metropolitan area can be replicated. Nevertheless, policy makers have proceeded on the presumption that the experience can be replicated. The federal government enacted the Bayh-Dole Act in 1980 that encourages university researchers to turn their discoveries into commercial products (see below). Chicago is one place where serious efforts have been and are being made to make the metropolitan area into a central place for innovation.

Appendix B

State of Illinois Programs Innovation Related

The Illinois Department of Commerce and Economic Opportunity (DCEO) is the lead state agency responsible for improving Illinois' competitiveness in the global economy. DCEO administers a wide range of economic and workforce development programs, services and initiatives designed to create and retain high quality jobs and build strong communities. DCEO leads the Illinois economic development process in partnership with businesses, local governments, workers and families. Information for this appendix was obtained from the DECO website (<http://www.commerce.state.il.us/dceo/>).

Business Development

DCEO's Bureau of Business Development administers a wide array of programs and services including: expansion incentives, technology support services, access to capital, global marketing expertise, and job training and education for workers. DCEO is committed to forging partnerships with the private sector in an effort to build upon Illinois' reputation as a world class center for business and industry.

Loan Programs

Community Service Block Grant (CSBG) Loan Program

The CSBG Loan Program is administered jointly by the Illinois Department of Commerce and Economic Opportunity (DCEO), statewide Community Action Agencies (CAAs) and Illinois Ventures for Community Action (IVCA). The Program provides long-term, fixed-rate financing to new or expanding small businesses in exchange for job creation and employment for low-income individuals. CSBG funds usually make up between 20-49% of the entire loan project and have a low interest rate of 5% to 7.5%.

Illinois Capital Access Program (CAP)

The Illinois Capital Access Program (CAP) is designed to encourage financial institutions to make loans to small and new businesses that do not qualify under conventional lending policies. CAP is a form of loan portfolio insurance, which provides additional reserve coverage to the lender on loan defaults. By participating in CAP, lenders have available to them a proven financing mechanism to meet the needs of financial institutions and Illinois small businesses.

Illinois State Treasurers Office

The Illinois State Treasurer's Office offers programs that are designed to assist the Illinois business community by providing access to capital and financing at affordable rates in order to promote economic development activities that create and retain jobs within the state.

Enterprise Zone Participation Loan Program (EZ/PLP)

The EZ/PLP is a variation of the conventional PLP Program, in that DCEO subordinates the loans through participating lending institutions, but the EZ/PLP may be able to provide small businesses located in an enterprise zone a more attractive loan rate than a conventional PLP.

The Illinois Finance Authority (IFA)

The Illinois Finance Authority (IFA) is a self-financed, state authority principally engaged in issuing taxable and tax-exempt bonds, making loans, and investing capital for businesses, non-profit corporations, agriculture and local government units statewide. IFA finances about \$3 billion each year, helping generate economic growth and job creation.

Manufacturing Modernization Loan Program

The Manufacturing Modernization Loan Program is designed to provide manufacturers with access to adequate and affordable financing for upgrading and modernizing their manufacturing equipment and operations.

Minority, Women, and Disabled Participation Loan Program (MWD/PLP)

The MWD/PLP program is a variation of the conventional PLP, in that DCEO subordinates the loans through participating lending institutions, but the MWD/PLP program can provide Illinois small businesses that are 51 percent owned and managed by persons who are minorities, women, or disabled, with loans up to loans up to \$50,000 or 50 % of the total project.

Participation Loan Program (PLP)

The PLP program is designed to work through banks and other conventional lending institutions, to provide subordinated financial assistance to Illinois small businesses that employ Illinois workers. A business with 500 or fewer employees may apply for a PLP loan of not less than \$10,000 nor more than \$750,000. Loans shall not exceed 25% of the total project and may not be used for debt refinancing or contingency funding.

Revolving Line of Credit Program (RLOC)

The RLOC program can provide qualifying businesses with a subordinated line of credit through banks and other convention lending institutions at affordable interest rates.

Grants

Illinois Department of Agriculture AgriFIRST Grant Program

The AgriFIRST program is designed to provide grants to persons and agribusinesses in Illinois for the purpose of developing projects that enhance the value of agricultural products or expand agribusiness in Illinois.

Business Development Public Infrastructure Program (BDPIP)

The BDPIP program is designed to provide grants to units of local government for public improvements on behalf of businesses undertaking a major expansion or relocation project that will result in substantial private investment and the creation and/or retention of a large amount of Illinois jobs. The infrastructure improvements must be made for public benefit and on public property and must directly result in the creation or retention of private sector jobs. The local government must demonstrate clear need for financial assistance to undertake the improvements. Grant eligibility and amounts are determined by the amount of investment and job creation or retention involved.

Illinois Department of Transportation (IDOT)

IDOT has several programs that provide state assistance in improving highway and rail access improvements to new or expanding industrial, distribution or tourism developments. The focus of these programs is the retention and creation of Illinois jobs. Funding may be available for transportation improvement projects related to facilities that provide direct access to economic development projects. Projects providing access to retail establishments, office parks, government facilities or school/universities are not eligible. To view IDOT programs please click on the links below.

Employer Training Investment Program (ETIP)

The Employer Training Investment Program (ETIP) helps keep Illinois workers' skills in pace with new technologies and business practices, which, in turn, helps businesses increase productivity, reduce costs, improve quality and boost competitiveness. ETIP grants can reimburse new or expanding companies for up to 50 percent of the cost of training their employees. Trainees must be employed by the company prior to implementation of the training program. Instructors may be plant workers, public educators, private consultants, or others possessing the required expertise. Grants may be awarded to individual businesses, original equipment manufacturers sponsoring multi-company training for employees of their Illinois supplier companies, and to intermediary organizations operating multi-company training projects.

Large Business Development Program (LBDP)

The LBDP program is designed to provide grants to businesses undertaking a major expansion or relocation project that will result in substantial private investment and the creation and/or retention of a large number of Illinois jobs. Funds available through the program may be used by large businesses for bondable business activities, including financing the purchase of land or buildings, building construction or renovation, and certain types of machinery and equipment. Grant eligibility and amounts are determined by the amount of investment and job creation or retention involved.

Tax Assistance and Start-Up Incentives

By providing entrepreneurs with a wealth of incentives to open their businesses here, Illinois enjoys a diverse and potent economy. With small business tax incentives such as Enterprise Zones and other programs, Illinois is devoted to giving its businesses the advantage in today's competitive marketplace.

Illinois Entrepreneurship Network Business Information Center

Provides individuals and businesses with access to information and referral assistance to guide them through the permitting, licensing and regulatory processes. First-Stop also can link them to other available resources that can help them comply with government regulations and enhance their competitiveness.

Illinois Business and Industry Data Center

The Illinois Business and Industry Data Center (BIDC) is a network of 28 local and regional affiliates, many from colleges and universities, regional planning commissions, public libraries and small business development centers, that works to help entrepreneurs and small businesses easily access statistical data. Local affiliates deal directly with small businesses and other end users of data, while regional affiliates collect and disseminate information to both end users and local affiliates. Regional affiliates also prepare quarterly regional analyses for statewide distribution.

Illinois Enterprise Zone Program

The purpose of the Illinois Enterprise Zone Program is to stimulate economic growth and neighborhood revitalization at the local level. This is accomplished through state and local tax incentives, regulatory relief, and improved governmental services.

Illinois Technology Enterprise Centers Program (ITECs)

Illinois Technology Enterprise Centers serve technology-based entrepreneurs, innovators and small businesses by assisting them with critical business startup and marketing needs. The regional centers, supported by DCEO, help entrepreneurs locate pre-seed and early stage financing; help innovators in high growth and high technology sectors further their technical and/or managerial skills, and assist with new product development and marketing, thus nurturing new venture development in Illinois.

Economic Development For a Growing Economy Tax Credit Program (EDGE)

The EDGE program is designed to offer a special tax incentive to encourage companies to locate or expand operations in Illinois when there is active consideration of a competing location in another State. The program can provide tax credits to qualifying companies, equal to the amount of state income taxes withheld from the salaries of employees in the newly created jobs. The non-refundable credits can be used against corporate income taxes to be paid over a

period not to exceed 10 years. To qualify a company must provide documentation that attests to the fact of competition among a competing state, and agree to make an investment of at least \$5 million in capital improvements and create a minimum of 25 new full time jobs in Illinois. For a company with 100 or fewer employees, the company must agree to make a capital investment of \$1million and create at least 5 new full time jobs in Illinois.

High Impact Business (HIB)

The HIB program is designed to encourage large-scale economic development activities, by providing tax incentives (similar to those offered within an enterprise zone) to companies that propose to make a substantial capital investment in operations and will create or retain above average number of jobs. Businesses may qualify for: investment tax credits, a state sales tax exemption on building materials, an exemption from state sales tax on utilities, a state sales tax exemption on purchases of personal property used or consumed in the manufacturing process or in the operation of a pollution control facility. The project must involve a minimum of \$12 million investment causing the creation of 500 full-time jobs or an investment of \$30 million causing the retention of 1500 full-time jobs. The investment must take place at a designated location in Illinois outside of an Enterprise Zone. The program has been expanded to include qualified new electric generating facility, production operations at a new coal mine or, a new or upgraded transmission facility that supports the creation of 150 Illinois coal-mining jobs, or a newly constructed gasification facility as a “Coal/Energy High Impact Businesses.”

New Markets Development Program

The Illinois New Markets Development Program provides supplemental funding for investment entities that have been approved for the Federal New Markets Tax Credit (NMTC) program. This program will support small and developing businesses by making capital funds more easily available and will make Illinois more attractive to possible investors. The NMTC program provides state and federal tax credits to investors that make investments into approved funds, which will make investments in eligible projects located in low income census tracks throughout Illinois. The program provides non-refundable tax credits to investors in qualifying Community Development Entities (CDE's) worth 39% of the equity investment made into the CDE over a 7-year credit allowance period.

Resources and Support

Sites and Buildings/Location One

The Illinois Department of Commerce and Economic Opportunity provides the LocationOne Information System for conducting searches for available commercial and industrial sites and building locations throughout Illinois. Maintained in partnership with communities across the state, LocationOne is designed to address the specific site selection data requirements of businesses and their consultants.

Entrepreneurship and Small Business

Illinois Entrepreneurship Network

The Illinois Entrepreneurship Network (IEN) has a wealth of information to help businesses meet regulations and grow. Some examples include providing information on start-up resources, sources of financing, business publications, proposal writing handbook, small business assistance, incentive programs, workforce development, the Illinois Department of Revenue, Secretary of State Department of Business Services, Department of Employment Security, Division of Professional Regulation, City of Chicago small business assistance center, Illinois small business development center, and the DCEO Energy and Recycling Bureau. For detailed information, visit <http://www.commerce.state.il.us/dceo/Bureaus/Entrepreneurship+and+Small+Business>

Program	Targeted to	Services
<u>Entrepreneurship Centers (EC)</u>	Companies with high growth potential	Access to capital; product licensing; access to technology; access to networks
<u>Small Business Development Centers (SBDC)</u>	New and existing small businesses	One-on-one counseling; assistance with management, business plans and marketing; financial services; training
Illinois Technology (ITEC) Enterprise Centers	Technology-based startup companies	Financing programs; training in technical and managerial skills; assistance with new product development and marketing
<u>Procurement Technical Assistance Centers (PTAC)</u>	Companies interested in selling products to government agencies	One-on-one counseling; technical information; marketing assistance; training
<u>International Trade Centers (ITC)/NAFTA Opportunity Centers (NOC)</u>	New-to-export companies interested in pursuing international trade opportunities	Information; counseling; training
<u>Manufacturing Extension Centers (MEC)</u>	Manufacturing companies	Assessment to improve performance; benchmarking; project manager to ensure satisfaction
<u>Small Business Environmental Assistance Program (SBEAP)</u>	Businesses required to comply with state and federal air pollution regulations	Confidential helpline: 800-252-3998 Workshops, on-site visits, Clean Air Clips, consultant directory, Environmental Resources

Technology

The DCEO Bureau of Technology and Industrial Competitiveness helps Illinois businesses, entrepreneurs and citizens to succeed in a changing economy by: developing the skills of their workers; promoting safe and healthy workplaces; assisting in the commercialization of new technologies; and providing access to modernizing technologies and practices. <http://www.ildceo.net/dceo/Bureaus/Technology>.

Illinois Technology Resources

Incubators/Research Parks

Incubators and research parks are located throughout Illinois in an effort to provide facilities for research and development. These technology parks provide employment for thousands of professionals while generating millions of dollars in research funding. To learn more about Illinois Research and Technology Parks, please visit <http://www.iltechparks.com>.

Illinois University Research Centers

Illinois University-based research centers conduct research across a broad range of fields and are on the forefront of the technological frontier. The research universities in Illinois have technology transfer offices with core functions which involve licensing university-developed technologies to existing or new start-up firms.

Technology Grants & Programs

Innovation Challenge Program

The purpose of the Innovation Challenge Program is to increase the number of Illinois companies that apply for federal research grants. The federal Small Business Innovation Research (SBIR) program and its parallel Small Business Technology Transfer (STTR) program provide over \$2 billion a year to small companies developing leading-edge technologies of interest to 11 federal departments and agencies. The Illinois Innovation Challenge Program provides grant writing assistance to eligible Illinois technology-based entrepreneurs, innovators and new venture startups to access federal SBIR and STTR funding opportunities.

Employer Training Investment Program

The Employer Training Investment Program (ETIP) supports Illinois workers' efforts to upgrade their skills in order to remain current in new technologies and business practices, enabling companies to remain competitive, expand into new markets and introduce more efficient technologies into their operations. ETIP grants may reimburse Illinois companies for up to 50 percent of the cost of training their employees. Grants may be awarded to individual businesses, intermediary organizations operating multi-company training projects and original equipment manufacturers sponsoring multi-company training projects for employees of their Illinois supplier companies.

Employer Training Investment Program - Incentive Component

The ETIP Incentive Program is designed for Illinois businesses applying for training funds as part of an ILDCEO Business Development Project to which the company is operating or locating in Illinois in conjunction with planned permanent expansion, location or retention activities.

High Technology School-To-Work

The goal of the High Technology School to Work Program is to improve education and to prepare Illinois' students to transition from school to high skilled, high paying jobs in the areas of science, mathematics, and advanced technology. Increasing the number of trained students entering technology occupations will help meet the workforce demand of Illinois' high technology businesses.

Advanced Technology Program (ATP)

The ATP views R&D projects from a broader perspective - its bottom line is how the project can benefit the nation. In sharing the relatively high development risks of technologies that potentially make feasible a broad range of new commercial opportunities, the ATP fosters projects with a high payoff for the nation as a whole - in addition to a direct return to the innovators.

Small Business Innovation Research (SBIR) Program

SBIR is a highly competitive program that encourages small business to explore their technological potential and provides the incentive to profit from its commercialization. By including qualified small businesses in the nation's R&D arena, high-tech innovation is stimulated and the United States gains entrepreneurial spirit as it meets its specific research and development needs.

Small Business Technology Transfer (STTR) Program

STTR is an important new small business program that expands funding opportunities in the federal innovation research and development arena. Central to the program is expansion of the public/private sector partnership to include the joint venture opportunities for small business and the nation's premier nonprofit research institutions. STTR's most important role is to foster the innovation necessary to meet the nation's scientific and technological challenges in the 21st century.

Nanotechnology

With the design and manufacture of extremely small mechanical devices and electronics as well as the potential of incredible data storage capabilities, this technology has great promise for Illinois and the world.

The Beckman Institute for Advanced Science and Technology - Univ. of Illinois

The Beckman Institute for Advanced Science and Technology at the University of Illinois at Urbana-Champaign is an inter- and multidisciplinary research institute devoted to basic research in the physical sciences, computation, engineering, biology, behavior, and cognition.

Micro and Nanotechnology Laboratory - Univ. of Illinois

Micro and Nanotechnology Laboratory is an environment to facilitate advanced research in photonics, microelectronics, biotechnology and nanotechnology for the benefit of the University community, the State of Illinois, and society as a whole.

Institute for Nanotechnology - Northwestern University

At the forefront of this new scientific frontier, the Institute for Nanotechnology was established as an umbrella organization for the multimillion dollar nanotechnology research efforts at Northwestern University. The role of the Institute is to support meaningful efforts in nanotechnology, house state-of-the-art nanomaterials characterization facilities, and nucleate individual and group efforts aimed at addressing and solving key problems in nanotechnology.

The James Franck Institute - Univ. of Chicago

The James Franck Institute is an interdisciplinary association of scientists with primary interests in the study of physical chemistry and condensed matter physics. It was established after World War II as the Institute for the Study of Metals, with the present name being adopted in 1967 to reflect a broader emphasis on the chemistry and physics of materials: solids, liquids, and gases. Theoretical and experimental research in the Institute concerns nonequilibrium phenomena, phase transitions, superconductivity, chemical kinetics, molecular beams, laser spectroscopy, surface phenomena, semiconductors, polymer physics and chemistry, and dynamical systems. The Institute provides an environment in which scientists of varied disciplines interact and aid each other's research; it extends to predoctoral and postdoctoral research students the opportunity to study and do research in an interdisciplinary setting. Most of the faculty in the Institute are also associated with the Materials Research Science and Engineering Center, supported by the National Science Foundation.

Nano-CEMMS (Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems) is an NSF-sponsored center for nanoscale science and engineering.

The Nano-CEMMS center receives major funding from the National Science Foundation and works in association with the University of Illinois Center for Nanoscale Science and Technology (CNST). Researchers at the University of Illinois, where Nano-CEMMS is housed, the California Institute of Technology and North Carolina Agricultural and Technological State University tackle the challenge of developing a nanomanufacturing system that will build ultrahigh-density, complex nanostructures.

The activities of the Nano-CEMMS Center span across three campuses. Scholars from mechanical, industrial, chemical, biomolecular, electrical, computer and materials science engineering are collaborating with colleagues in applied physics, chemistry, and molecular and cell biology to create a viable manufacturing technology and science base for nanomanufacturing.

The Center provides a unique opportunity for undergraduate, graduate and post-doctoral students to become involved in groundbreaking research. Students involved

with Nano-CEMMS are also participating in the Center's educational outreach activities, designed to engage K - 12 and community college teachers and students in the emerging fields of nanoengineering and nanoscience.

Also critical to the success of the Center's work is the participation of our industrial partners. They help to identify the specific gaps in technology that need to be resolved before an effective prototype nanoscale manufacturing system can be created.

Manufacturing

The Manufacturing Extension Partnership of Illinois (MEPI)

The Manufacturing Extension Partnership of Illinois' mission is to continually improve the competitiveness of small and mid-sized Illinois manufacturers. The centers and affiliated support organizations help manufacturers with productivity, technology modernization, and enhanced business practices. The MEPI is a program of the Department Commerce and Economic Opportunity, and is part of a broader economic development program of assistance for small businesses administered by DCEO. It is also affiliated with a national network of manufacturing extension centers. Manufacturing Extension Centers offer the following services:

Assessment - an on-site team provides an objective analysis, identifying your company's strengths, weaknesses, opportunities and threats. We suggest steps you can take immediately to improve performance.

Benchmarking - an inexpensive way to compare your performance to that of similar businesses. We deliver a customized report showing where you stand on more than 50 performance indicators.

Projects - based on your needs and priorities, projects are clearly defined up-front. A project manager qualifies the service providers and manages the project hands-on to ensure your satisfaction. Projects can address various manufacturing needs including, but not limited to manufacturing modernization, quality assurance, best manufacturing practices, product development, and market development.

There are two primary Manufacturing Extension Centers in Illinois that coordinate the state's regional Manufacturing Extension Centers and local offices:

The Chicago Manufacturing Center (CMC)
Serves the Metropolitan Chicago area

The Illinois Manufacturing Extension Center (IMEC)
Serves the rest of Illinois

Coal

DCEO's Office of Coal Development is dedicated to the development and use of Illinois' extensive coal resources as a fuel source for the 21st century.

Illinois Coal Competitiveness Program grants provide partial funding to improve coal extraction, preparation and transportation systems within Illinois. The program leverages private investment for improvements to new or existing coal-fired facilities, mining equipment and operations, coal preparation and handling systems, coal transportation corridors and transfer facilities and infrastructure needed to access new markets.

Illinois Coal Demonstration Program grants provide partial funding to bring state-of-the-art, advanced coal-use technologies to commercial readiness. The program is committed to bringing state-of-the-art, advanced coal-use technologies to commercial readiness. Recent projects include partial funding for the construction of a flue gas desulfurization system at Springfield City Water, Light and Power and repowering Southern Illinois Power Cooperative with a new circulating fluidized bed boiler.

Illinois Coal Research Program grants provide partial funding to research clean coal technology, coal chemistry, mining productivity and coal combustion byproduct utilization. DCEO oversees the largest state-sponsored coal research program in the United States. This program is administered by DCEO and is under the technical oversight of the Illinois Clean Coal Institute (ICCI).

Illinois Coal Development Program grants provide partial funding to advance promising clean coal technologies beyond the research stage towards commercialization. The Coal Development Program seeks to advance promising clean coal technologies beyond the research stage towards commercialization. The program provides a 50/50 match with private industry dollars to support market-driven needs of the industry. Development processes include technology maturation, technology transfer and related studies. The Coal Development Program is administered by DCEO with technical oversight by the Illinois Clean Coal Institute (ICCI).

Appendix C

Non-Governmental Organizations (NGOs)

iBIO: Illinois Biotechnology Industry Association (www.ibio.org)

The Illinois Biotechnology Industry Association's mission is to make Illinois and the surrounding Midwest one of the world's top life sciences centers: a great place to do business, and a great place to grow new technology ventures. iBIO advocates for sound public policy, delivers education and training programs, and improves our ability to create, attract, and retain businesses. iBIO is a life sciences industry association composed of:

- International agricultural and human health companies who improve the quality of life worldwide.
- Established small and medium-sized companies who are fueling industry growth.
- Entrepreneurial leaders of start-ups and spinoffs producing breakthrough products and services.
- Scientists and technology transfer specialists from top-tier academic and research institutions.
- Venture capitalists, investment bankers, and angel investors who are investing in innovation.
- Seasoned government people committed to economic development of the region.
- Service providers from major law, accounting, financial, and search firms who create a solid business backbone for industry.
- Business professionals from a wide variety of professions and callings who want to make something special happen in Illinois and the Midwest.

PROPEL is a series of programs created in 2007 aimed at increasing the number of life sciences start-ups in Illinois and boosting the success rates of existing companies. Initial funding for PROPEL came from the generous donations by Abbott, Astellas Pharma US, Baxter International Inc., and Takeda Pharmaceuticals North America. PROPEL and the iBIO Entrepreneurship Center help guide the development of formation-stage and early-stage life sciences companies by providing entrepreneurs with access to specialized resources and expertise. Industry, academia, service professionals, entrepreneurs, and government agencies connect to create and support a vibrant entrepreneurial community in Illinois and throughout the Midwest through PROPEL programs, including:

- The iBIO Entrepreneurship Center

- Coaching
- Business Plan Presentation Panels
- Professional Services
- Workshops, Seminars and Educational Programs
- CEO Roundtables and Networking
- Technical Assistance
- Matching Grants and Innovation Challenge Grants

PROPEL is modeled on the best practices of several other programs around the United States including the San Diego CONNECT[®] Springboard program, which has been shown to dramatically improve start-up company success. Past and current PROPEL participants include:

- Formation stage and early stage companies
- Industry segments within drugs, medical devices, diagnostics, therapeutics, consumable medical supplies, other healthcare-related products, biochemicals, and agricultural-biotech products and processes.

iBIO's Entrepreneurship Center provides formation-stage and early-stage life sciences companies with technical assistance and access to matching grants and innovation challenge grants funded by the Illinois Department of Commerce and Economic Opportunity (DCEO). Launched in early 2008, the iBIO Entrepreneurship Center represents the State of Illinois' second industry-focused entrepreneurship program. Technical Assistance and access to technical experts are provided who provide critical connections within the life sciences community, answer specific issues or questions, or help tackle a specific challenge facing many start-ups. Technical assistance includes business plan reviews, market segmentation strategies, intellectual property filing, licensing strategies, and funding.

Chicagoland Chamber of Commerce: InnovateNow (www.innovatenow.us)

InnovateNow is a joint initiative of the Chicagoland Chamber of Commerce, World Business Chicago and the Illinois Department of Commerce and Economic Opportunity to drive economic growth by promoting business innovation in key sectors of the economy. Business innovation is the development and implementation of new ideas and new ways of doing things (business models, products and services, markets, processes) to create customer value and drive business growth. The goal is to make the Chicagoland region, and eventually the entire state of Illinois, a globally recognized center of innovation. InnovateNow is being guided by a public-private leadership team of business, labor, education, government and civic leaders. InnovateNow was launched on October 24, 2006 at the Chicagoland Innovation Summit with an initial \$1 million in state funding and additional corporate funding. The summit was held in

cooperation with the Council on Competitiveness and featured national experts and over 500 business, education, and government leaders.

Illinois already has undertaken major initiatives to promote innovation by supporting business entrepreneurship through the Illinois Entrepreneurship Network and by targeting major investments in key sectors such as homeland security, energy, and biosciences. InnovateNow will build on these efforts to:

- **Expand the Innovation Capacity of Illinois Businesses:** Assist Illinois businesses in improving their capacity to develop new business models, products/services, and markets, especially small and mid-sized businesses in key sectors such as manufacturing that are facing global competition.
- **Strengthen Public-Private Innovation Networks:** Promote stronger linkages and partnerships between Illinois businesses and universities, colleges, and federal laboratories to drive and support innovation in Illinois.
- **Expand the Innovation Talent Pool:** Develop a new breed of innovation talent in Illinois that can start new businesses and drive innovation in existing businesses in Illinois. Innovate Now will promote the development of innovation talent at all education levels (P-20 pipeline) with stronger foundations in business as well as science, technology, engineering mathematics (STEM) and related creative and design fields.

The Chicagoland Chamber of Commerce Foundation's InnovateNow initiative in partnership with the Illinois Institute of Technology's Institute of Design present the 2009 Innovation Summit on May 21 at the Spertus Institute in downtown Chicago. The Summit will bring together influential innovation experts, business executives, academics and government leaders to discuss innovation and accelerate Chicagoland's development as a globally recognized center for innovation. The first Innovation Summit takes place on May 21, 2009, and has a focus on innovative architectural designs. The portfolio of InnovateNow could be expanded to include technology transfer and product and process innovation.

Illinois Information Technology Association (www.illinoistech.org)

The Illinois Technology Association (ITA) is committed to developing an environment in which information technology (IT) companies can flourish in an increasingly competitive marketplace. The ITA is a regional industry trade association headquartered in Chicago and serving all of Illinois. The ITA provides members with access to connections, information and promotional opportunities to improve business locally, regionally and national. The ITA connects technology organizations that focus on travel, data management, telecommunications, navigation, sales enablement, and much more.

With roots dating back more than twenty-five years, the ITA formally launched in January 2005, changing from the Chicago Software Association. From its inception in 1982 and through the evolution of the organization in more than two decades, this association has been the nexus of powerful networking opportunities, information sharing, educational programming and advocacy for the software and information technology community in our region.

ITA Roundtables are peer-to-peer events allowing executives with similar functional areas an opportunity to share ideas, best practices and fellowship. Roundtables are formed by ITA members. Participating individuals gain direct access to practical, technical and business-related information in specific subject areas through regular meetings. Roundtables are open to all individuals from ITA member companies. Non-members are welcome and encouraged to participate in roundtables for a short period to get a feel for the association and its activities. Pre-registration is required to attend all roundtables.

- Business Intelligence Roundtable
- Chief Executive Officer (CEO)
- Chief Financial Officer (CFO)
- Compliance
- Customer Support
- Emerging Technology
- Human Resources
- Information Security
- Marketing
- Outsourcing
- Sales
- Security
- Software as a Service (SaaS)

Illinois Technology Development Alliance (www.idta.biz)

The Illinois Technology Development Alliance delivers commercialization services to entrepreneurs who have innovative ideas, inventions, and intellectual property that can be developed into scalable, technology businesses.

The mission of the Illinois Technology Development Alliance, a private, not-for-profit group, is to improve the Midwest economy through job and wealth creation by helping early stage technology businesses develop and commercialize their technologies, define and grow their businesses, and raise growth capital from public and private sources. The organization's creative approach helps provide the right kind of support and capital at the appropriate time.

ITDA will create the next generation of better, faster, smarter technology entrepreneurs by connecting, organizing, and educating entrepreneurs while catalyzing

seed and early stage investment within the community. One-one-one coaching and consulting services are provided to members only and at no charge, up to 30 hours per membership year (10 hours for Student Members).

Professional services include:

Strategic Planning and Coaching

- Business concept/definition review
- Strategic business plan review
- Training on presenting a business plan
- Developing an investor pitch
- Technology assessment
- Market and competition review
- Financial analysis of business model
- Management team/skills identification
- Capital and investment planning
- Targeted networking/partnership building
- Risk mitigation

Development and Sales

- Go-to-market strategy development
- Corporate positioning and messaging
- Channel and Market analysis
- Introductions to prospective customers
- Introductions to potential federal agency customers

The ITDA's events, education, and outreach programs connect entrepreneurs with the information and resources they need as well as provide a focal point for investors and other private and public sector organizations with an interest in growing the high technology economy of our state and region. ITDA offers a variety of diverse programs and events from education to social networking.

- **Monday Morning Meeting:** This is a quarterly networking and educational event that prepares early-stage entrepreneurs to raise capital efficiently. The moderated event features three companies presenting their investor pitches to an audience of investors, industry leaders, service providers, and serial entrepreneurs.
- **Expert Perspectives 360°:** Discussion seminars bring together four-person panels of experienced entrepreneurs and domain expert to explore specific topics that are important to entrepreneurial success.
- **Community Connections:** Networking events create a forum of relationship-building and idea exchange. The ITDA invites members and non-members to Community Connections, an informal gathering to encourage wider active participation in our region's high technology community.

- 45 Minutes With: A one-on-one consultation that matches recognized subject matter experts with entrepreneurs in individual one-on-one mentoring sessions.
- FastTrac® TechVenture™: A comprehensive business planning program that addresses the needs of start-up entrepreneurs who are refining their business ideas, writing their business plans and seeking to grow sustainable high-impact companies. The program combines instruction from experienced business professionals, one-on-one business mentoring, peer learning, and ample tools to help entrepreneurs produce all the elements of an effective business. After completing the class, entrepreneurs walk away with a detailed business plan and executive summary presentation, and a strong understanding of how to finance a company.
- Federal Funding Seminar: The ITDA hosts the Annual Federal Funding Seminar to provide in depth information about NASA and other federal agency programs including the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs.

Chicagoland Entrepreneurial Center (www.chicagolandec.org)

The Chicagoland Entrepreneurial Center (CEC) is a nonprofit affiliate of the Chicagoland Chamber of Commerce that seeks to make a perceptible and lasting economic impact on the Chicago region by helping entrepreneurs and high-growth businesses build viable, sustainable, and profitable enterprises. The CEC works with entrepreneurs to create and sustain opportunities for business success, job growth, and profitability.

To succeed in today's increasingly fast moving, complex and competitive economy, entrepreneurs must have innovative ideas, strategic and sound business plans, solid financial backing and the support of the business community. The CEC, through its staff, board of directors and partners, possesses the knowledge necessary to assist entrepreneurs in every aspect of their businesses.

The CEC works with high-growth entrepreneurs in the following industry segments: technology, retail and consumer products, fashion and apparel, food and food services, clean technology, professional services and healthcare IT. The CEC helps entrepreneurs located throughout the six counties of Northeastern Illinois. Primary services are for entrepreneurs in the early-growth stage, but also work with select start-ups and other businesses that are existing CEC clients.

The CEC helps entrepreneurs help themselves. Entrepreneurs are offered advisory services and face-to-face introductions to help with their financing and sales needs. Guidance is provided through the extensive network of experienced entrepreneurs and business leaders, and events are hosted at which entrepreneurs can learn strategies necessary to succeed in a competitive marketplace.

The CEC was created in 1999 in response to studies commissioned by the Commercial Club of Chicago and the Mayor's Council of Technology Advisors and prepared by McKinsey & Co. and the Metropolis Project. The studies documented that while Chicagoland was in an excellent position to benefit from the then-strong economy, 90 percent of Chicagoland businesses were small to mid-size firms seeking support and mentoring to facilitate their growth and development. The studies determined that there were many supportive agencies for entrepreneurs, but most had a narrow focus that didn't allow for the type of comprehensive guidance high-growth businesses often require. It was clear that a single point of access for the region's entrepreneurs was needed to ensure consistency of information and quality, offer a wide variety of practical and educational forums, and be useful to both those just starting out as well as to those in the crucial growth phases that follow.

While the CEC is funded through private entities and corporations and state and city grants, it is also supported by numerous budding and successful entrepreneurs, established businesses and academia that recognize the importance of entrepreneurs and the impact the CEC has on the local economy.

Illinois Innovation Accelerator Fund (www.i2afund.com)

The Illinois Innovation Accelerator Fund (i²A) is an innovative \$10 million for-profit early-stage investment fund created in direct response to the decrease in seed-stage investing that's occurred since the turn of the new millennium. The fund's goal is to provide the first external professional capital raised by companies, allowing them to grow and allowing the fund members to capitalize on high-growth opportunities.

i²A's formation was driven by J.B. Pritzker, Founder and Partner of New World Ventures, himself an enthusiastic early-stage investor, the Illinois Department of Commerce and Economic Opportunity, and the Chicagoland Entrepreneurial Center (CEC), a nonprofit affiliate of the Chicagoland Chamber of Commerce, to address this growing but detrimental seed-stage "capital gap." Structured as an LLC with both individual and institutional investors as members, i²A is administered by the CEC.

i²A invests in well-managed seed-stage companies in Illinois or companies willing to relocate to Illinois that have demonstrated a value proposition in a given market for their products or services. The fund looks to make investments ranging from \$250,000 to \$1 million in each company. i²A focuses primarily on companies that are in the following industry sectors:

- Technology-enabled products and services
- New media and education products and services
- Consumer and retail products

i²A also will consider opportunistic investments in other sectors such as clean technology, life sciences and nanotechnology. i²A is a member-managed fund comprised of many of the area's leading entrepreneurial families, institutions and

members of the investment community. These members have decades of early stage investment experience and will provide the fund's portfolio companies with guidance and valuable connections to target customers, partners, and key members of the management team.

Ceres Venture Fund (www.ceresventurefund.com)

Ceres Venture Fund, L.P. is a Chicago-based venture capital fund dedicated to funding high growth companies located in the Midwest in their early stages of growth. As growth-oriented investors, the fund seeks to partner with entrepreneurs of proven ability and provide them with the resources needed to achieve extraordinary success.

In particular, Ceres believes that early stage businesses in the Midwest are experiencing rapid growth and represent an attractive and under-served pool of investment opportunities. Ceres has particular industry depth in health care, information technology, and business services. Ceres accesses investment opportunities through multiple channels including extensive professional networks in the corporate and investment communities.

Illinois Venture Capital Association (www.Illinoisvc.org)

The Illinois Venture Capital Association advocates for a strong venture capital and private equity in Illinois by:

- Promoting pro-growth public policy initiatives
- Providing educational programming in private equity
- Facilitating member networking
- Endorsing communication and shared programs with organizations of mutual interest

In addition, the IVCA works with entrepreneurial organizations in the Midwest to encourage a strong cycle of innovation business creation leading to superior investment opportunities. IVCA was founded in May 2000.

Heartland Angels (www.heartlandangels.com)

Heartland Angels, Inc. is a private equity network that brings together accredited investors with early stage start-up companies and real estate opportunities looking for equity and debt investments. Heartland Angels matches investors and startup companies through a process of due diligence designed specifically for start-up and early stage companies. Potential investment opportunities are presented to the network investors monthly.

The mission of Heartland Angels is to be a catalyst in the process of innovation by creating forums in which human, intellectual and financial capital are joined for a common purpose.

Heartland Angels has an extensive network of partners, alliances, entrepreneurs, investors and advisors who have successfully built business in many fields. During and after an investment, the companies and investors have access to this network. Heartland Angels leverages the expertise of this network to help build value in start-up companies and to support their management's vision.

Heartland Angels assists its investors by making available advisory support of both a technological and management nature. There additionally are management level General Partners and Network Partners who can assist in the later operation of the portfolio companies. The areas of expertise includes: operations, finance, marketing, human resources, technology and legal.

Heartland Angels' unique process has four components:

1. A Program to perform a stepped due diligence analysis to review investment opportunities.
2. A Strategy to use the multifaceted experience of professionals, academics and scientists in investigating and assessing early staged investment opportunities.
3. A Method to syndicate an opt-in funding approach so as to coordinate the interests of multiple private equity ("angel") investors.
4. A Protocol to increase the efficiency and effectiveness of negotiations. This maximizes communications and minimizes unnecessary risk and cost to the investor and to portfolio companies.

Heartland Angels operates to facilitate the investor-company matching process. Each party in the agreement has something potentially something to gain and/or to lose.

1. Deal Flow

Heartland Angels' deal flow comes from multi-tiered approach and its special relationships involving Midwest universities, research laboratories and parks, incubators, law firms, community and entrepreneurial groups, manufacturing facilities, accounting firms, financial institutions, professional, scientific and technical associations, and with other investor groups involved in seed, start-up, early stage, mezzanine and late stage investments.

2. Evaluating Opportunities

Heartland Angels' program evaluates prospective investments rigorously using a unique approach which enables it to evaluate prospective companies whose innovations range from technology based to manufacturing. Standard financial valuation criteria, e.g., Discounted Cash Flow or Real Options, supplement this approach when indicated.

3. Negotiating Terms Of the Investment

Heartland Angels provides a negotiating staff to assist in the setting and structuring the terms, valuation and equity issues involved in the investment. Input from investors is part of this process. The choice of the type of investment is determined on a deal by deal basis.

4. Portfolio Companies

After an investment, Heartland Angels continues to make its Network and Alliance available to its portfolio companies. Advice and guidance concerning operational, management, legal, and financial issues affecting the subsequent progress of the company can be sought from the investors' network during their regular meetings or on its website as needed. In addition, Heartland Angels provides its portfolio companies assistance in securing future financing when appropriate.

Appendix D

Internet Resources

BioSpace.com, DeviceSpace.com, ClinicaSpace.com

These three extensive websites are joined together and provide information on news and jobs for the biotechnology and pharmaceutical, medical device and diagnostics, and clinical research industries.

Currently available free newsletters include: BioPharm Executive (monthly), ClinicSpace Focus (daily), Device Space Daily, Insider Recruiter (bi-monthly), Career Insider (weekly), Deals & Dollars (daily), GenePool (daily). New free newsletters coming soon include: BioChemistry, Chemistry, Molecular Biology, Cell Biology, and Manufacturing.

News service includes top breaking news, featured stories, more news, and other new sources. News articles can be searched by subject or date. A video news archive is also provided. In addition, detailed information for upcoming industry events is provided along with information on career fairs, job opportunities, and extensive company profiles. A link to a trial version of Biotech Insight is included.

Several regional hotbeds are presented including BioMidwest™ Hotbed. This community highlights the organizations that comprise the biotechnology, pharmaceutical and medical device industries in Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, Ohio and Wisconsin. The BioMidwest Hotbed page keeps the BioSpace audience informed of the daily activities and events throughout the region.

Midwest Business.com

MidwestBusiness.com (formerly *ePrairie.com*) is a leading source of business and technology news and information in Chicago and the greater Midwest. It is a user-driven community distributed via the Web, podcasts, the wireless Web and free daily e-mail newsletters.

Midwest Business.com provides information for Illinois, Michigan, Wisconsin, Missouri, Indiana, Minnesota, and Ohio. Services include: breaking news, blogosphere, photo galleries, event calendar, press releases, job board, and marketing opportunities.

TechWeb.com

TechWeb is a global business technology media company and owns media brands including: InformationWeek, Interop, VoiceCon, Light Reading, Dark Reading, Black Hat, and Web 2.0 Summit. TechWeb operates as an independent division of United Business Media Limited.

According to TechWeb.com, more than 13.3 million business technology professionals actively engage with TechWeb brands, content, and services. Their community of professional technology decision makers spans across the entire industry and includes CIOs, senior-level IT managers, developers, communications service providers, and business executives from small and mid-sized organizations to global enterprises across all vertical industries. TechWeb.com's goal is to provide the content and tools business technology professionals need to make strategic technology decisions. Participation is reported as 202 million minutes a year on the web sites, 6.3 million subscribe to the newsletters, more than 700,000 request and subscribe to the magazines, 400,000 participate in web-based events, and hundreds of thousands attend the 180+ global live events.

TechWeb's Portfolio Of Leading Networks And Brands

- Global Face-to-Face Event Brands – Interop, Web 2.0 Expo, Web 2.0 Summit, VoiceCon, Black Hat, CSI, Software Conference, Enterprise 2.0 Conference, Mobile Business Expo, GTEC, InformationWeek 500, TelcoTV, Optical Expo, Ethernet Expo, and Banking, Insurance, and Advanced Trading Executive Summits
- Online Resources – InformationWeek, Light Reading, Intelligent Enterprise, bMighty, ByteandSwitch, Internet Evolution, No Jitter, Plug into the Cloud, UNstrung, Dark Reading, Network Computing, Cable Digital News, and Contentinople
- Multimedia Brands – InformationWeek, Wall Street & Technology, Advanced Trading, Insurance & Technology, Bank Systems & Technology, MSDN Magazine, and TechNet Magazine
- Research & Analyst Services – Heavy Reading, InformationWeek Analytics, and Pyramid Research

To address the needs of targeted business technology communities, TechWeb is organized by five networks: InformationWeek Business Technology Network, TechWeb Events, Light Reading Communications Network, Financial Technology Network, and Microsoft Technology Network.

TechWeb also provides end to end services for technology decision makers and marketers worldwide ranging from next generation performance marketing services, custom media, content generation, exclusive market research and analysis.

GreenBiz.com

GreenBiz.com, an online information resource on how to align environmental responsibility with business success, is a part of Greener World Media, Inc. Daily news, tools, and resources to corporate executives and sustainability directors at large and small businesses is provided through a combination of websites, electronic newsletters, online

events, briefing papers, and other means. GreenBiz.com, offers more than 8,000 resources, including news stories, reports, blogs, checklists, case studies, and links to best practices, organizations, technical assistance programs, government agencies, and recognition programs.

GreenBiz.com provides extensive news, reports, podcasts and videocasts on a variety of issues including energy and climate, business operations, design and innovation, resource efficiency, marketing and communications, small business, greener careers, and resources.

GreenBiz.com is connected to other Greener World Media websites including: ClimateBiz.com, GreenerBuildings.com, GreenerComputing.com, and GreenerDesign.com.

Science Resource World.com

ScienceResourceWorld.com provides information on science and engineering, and a technical directory of resources is included with news and reference information, products, and services. Educational references and resources are also provided. Science news and media are divided into general science and technology news, news by field and industry, and publications, magazines and journals.

Specific subject areas covered include anthropology and archaeology, biology, chemistry, computers, earth and climate, energy, engineering, geology, health, mathematics, optics, paleontology, physics, and robotics. Each subject area provided detailed resources, data archives and technical resources, companies, organizations, institutes and societies, educational resources and tools, and publications.

Industries covered include aerospace, space, biotechnology, computers and information, and energy. Information for each industry includes news and information, organizations, products, companies, publications, and other resources.