

**Identification  
of Technology Clusters for  
Economic Development**

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**BUSINESS CLUSTER DEVELOPMENT**

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## Executive Summary

Identifying and focusing on clusters that capitalize upon the strengths of the University of Illinois at Urbana-Champaign and the cities of Champaign and Urbana is a proven approach to economic development and creating a vibrant community. Clusters may be defined as geographic concentrations of interconnected companies, suppliers, service providers and others in a particular industry or sector. Technology clusters are driven by innovation and yield more significant opportunities for business growth and job creation.

The University of Illinois is important to the local economy as a magnet for talent, partner to corporations, source of innovation, and a major employer. Economic development has been part of Illinois' mission since 2000, and it is one of the six critical themes in Illinois' recently released Strategic Plan. Recently, the Chancellor convened an Economic Development Advisory Group, composed of a small group of campus and business leaders, to discuss economic development for the campus and community.

Illinois retained Business Cluster Development (BCD) to identify the technology clusters that would represent economic development opportunities for Illinois and the community. In addition to a review of reports and information on the community and university, BCD interviewed more than 35 stakeholders from the campus and the community, which revealed a clear consensus on the key opportunities for cluster growth and the challenges that the university and community will face as they seek to grow the clusters. **BCD recommends a focus on the following three clusters: Data Analytics and Management, and Computing; Biomedical and Bioengineering; and Energy.**

## Key Findings and Overall Assessment

A number of factors are examined to identify clusters for economic development. They include collaboration, capital, skills, innovation, growth market opportunities, asset and resource base, business activity throughout the company lifecycle, critical mass, community support and leadership, and differentiation and positioning, in addition to the connections among the factors. Together, the factors help to encourage innovation, research and development, technology commercialization, new business start-up, and retention and attraction of businesses.

The key findings from the interviews reveal challenges to business growth, retention and attraction, and at the same time, significant business start-up activity for a community of its size and the important impact of the University of Illinois. Illinois' collaborative academic environment and culture of entrepreneurship fosters groundbreaking research, commercialized technology and spin-out of start-ups. The university has provided leadership, but at the same time, some concerns about continuity in leadership and its impact on economic development were noted. In addition, the local entrepreneurial ecosystem supports commercialization and start-up activity. Moving beyond the start-up stage in Champaign-Urbana is more challenging. Several factors restrict the growth and retention of businesses, including an insufficient

pool of skilled business and management talent (including sales), unmet capital needs by growth stage companies, limited air service, and the fact that the communities are less attractive to young singles who often provide the technology talent. Moreover, with respect to the bioengineering and biomedical cluster, the lack of an academic medical hospital and full-scale medical school program restrict the expansion of health-related research opportunities through National Institutes of Health (NIH) and private funding, and the creation of more skilled jobs. In addition, trailing spouses (who often have PhD and/or advanced degrees) are under and unemployed due to an insufficient number of technical positions. Six key assets and resources currently present in the community that will provide a foundation for all three clusters: the University of Illinois, the technical talent pool, the hospitals, the entrepreneurial ecosystem, the Research Park and Illinois' corporate relationships, and the culture of entrepreneurship at Illinois. Overall, the consensus is leveraging the assets and reputation of the University of Illinois is key to economic development in the community and growing the targeted clusters.

Technology innovation and commercialization are key drivers of successful cluster development, and Illinois has a strong track record. Illinois' research expenditures for FY 2012 total \$584 million. It leads the nation in funding from the National Science Foundation. Its College of Engineering is ranked as a top 5 engineering school. Over the past five years, nearly 300 U.S. patents have been issued and more than \$28 million in royalties have been generated from university research. During the same time period, 34 start-up companies with technologies based upon university research have been launched. In addition, the entrepreneurial ecosystem (including its incubator, EnterpriseWorks) provides support for entrepreneurs and companies developing innovative technologies and products, and is strong given the size of the community. Innovation also occurs at specialized corporate centers at the Research Park.

### **Cluster: Data Analytics and Management, and Computing**

Illinois is one of the leading universities conducting a critical mass of research in data analytics and management ("big data") and computing (including network and computer security, cloud computing, visualization, and other areas), and possessing a high level of expertise. It is home to the National Center for Supercomputing Applications (NCSA), as well the Information Trust Institute, Advanced Digital Sciences Center, and Parallel Computing Institute. Collaborations with industry include the Cloud Computing Testbed and the Boeing Trusted Software Center. This cluster focus will help the university and community to build a strong brand, and grow and attract businesses and talent.

Innovation and business activity in this cluster are strong at Illinois and Champaign-Urbana as evidenced by the number of disclosures and patents, and even more so, by the number of start-ups spun out with commercialized university technology, given the small size of the community. A number of graduates of EnterpriseWorks have chosen to reside at the Research Park and in Champaign-Urbana. Some examples of the business activity--on and off campus--include Personify, Infobright, HDF Group, Riverbed, Volition, Amdocs, and Wolfram Alpha. The number of corporations locating specialized research operations (centered on data) in the Research Park is important. A

foundation for growth exists, but the number and stage of companies in this cluster must be developed over time.

Illinois continues to attract and train students with the requisite technical experience, skills and abilities, in addition to faculty with many years, if not decades, of expertise. Local technology companies hire employees with deep technical skills in this field.

The cluster has attracted investment from local seed funds and angel investors, as well as firms in Chicago, Silicon Valley and elsewhere. Examples include RiverGlass and Infoblox.

“The global market for big data, analytics and business intelligence solutions was worth \$22 billion in 2012—and it will keep growing, at a compound annual growth rate of 12.7 percent, through 2017.”<sup>1</sup> Demand for new technology solutions will grow.

A critical mass of assets, talent, innovation, activity and support are present and form a strong foundation, and must continue to grow beyond the current level. Community support, as evidenced by the overwhelming choice of big data and analytics during the stakeholder interviews, is clear.

### **Cluster: Biomedical and Bioengineering**

Bioengineering combines the engineering profession with the biological and medical sciences. Research includes bioimaging, computational genetics and bioinformatics, tissue engineering and new materials, sensors and optics, and animal sciences and animal models. Biomedical includes medical devices, instruments and diagnostics, therapeutics, research tools and enabling systems.

Notably, both build upon the Illinois’ world-class engineering expertise and capabilities. However, to scale the cluster will require additional assets.

Research and collaboration in biomedical and bioengineering occurs at university research institutes and with partners such as Carle Hospital and the Mayo Clinic. The institutes include the Beckman Institute for Advanced Science and Technology, the Institute for Genomic Biology, and the Abbott Center for Nutrition, Learning, and Memory, in addition to Illinois’ Division of Animal Resources. Illinois receives \$71 million in NIH funding. The bioengineering department is expected to double in size over the next three to four years. The Research Institute at Carle supports clinical trials and investigator initiated research, nursing research, resident research, and translational research. However, Carle is not academic in focus and lacks a patient pool sufficient for most clinical trials. For the past four years, Illinois has partnered with the Mayo Clinic on research in computational genomics.

Innovation and commercialization are already occurring as proven by the number of disclosures, patents and start-ups in biomedical and bioengineering. Currently, 14

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<sup>1</sup> Nuca, Andrew. “Big Data: Cutting through the bullsh\*\*.” *ZDNet*, 10 October 2013. <http://www.zdnet.com/big-data-cutting-through-the-bull-7000021781/> Accessed October 21, 2013.

biotechnology companies reside at EnterpriseWorks and the Research Park. Clients and graduates include: Glucosentient, IntelliWheels, Immuven, Aptimmune Biologics, and ICyt. Biotechnology companies in EnterpriseWorks have obtained more than \$267 million in investment capital, including equity funding and SBIR. The amount and scale of innovation is especially notable given that the university does not have a full-scale medical school and an academic hospital. However, fewer growth-stage and mature biomedical and bioengineering businesses operate in Champaign-Urbana, which can be attributed to insufficient assets, business talent, and investment capital.

The market for bioengineering and biomedical innovations and products continues to increase as new technology developments aid with disease detection and treatment, a growing percentage of the population ages, and the amount of medical treatment centers grows. "...[I]n 2013, the global computational biology market was valued at USD 760 million and is expected to grow at a CAGR [Compound Annual Growth Rate] of 21.3% from 2012 to 2018..."<sup>2</sup> The global market for bioimaging technologies is projected to reach \$37.4 billion by 2017.<sup>3</sup> Tissue engineering, in which Illinois holds several patents, has a market that is expected to grow 2.5 times its 2012 value by 2018.<sup>4</sup>

A foundation for bioengineering and biomedical cluster growth is apparent. However, to grow the cluster--increasing research opportunities, attracting faculty expertise, providing facilities and resources of a size necessary for clinical trials and product testing, increasing corporate sponsored research by biotechnology and life science companies, retaining growth companies, and attracting more mature biotechnology companies to locate in the community--will require the resources of a full-scale medical program and academic hospital. (Currently, Illinois operates an MD/PhD program.) A significant number of stakeholders raised this issue and expressed support for exploring it as an opportunity to contribute to the overall quality of healthcare in the region and create jobs. At this time, some early, high-level discussions about an expanded medical school and academic hospital are occurring within the university.

### **Cluster: Energy**

While a more nascent opportunity than the other two recommended clusters, energy would provide more immediate opportunities for growth and help with diversification by adding a third, less-established cluster. Energy expertise at Illinois includes biofuels, energy storage, smart grid, and renewable energy (especially solar and wind), and includes clear linkages with big data.

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<sup>2</sup> "Computational Biology Market – New Market Research Report Published by Transparency Market Research," <http://www.prweb.com/releases/2013/5/prweb10731089.htm> 14 March 2013.

<sup>3</sup> "Global Biomimaging Technologies Market to Reach US\$37.4 Billion by 2017, According to a New Report by Global Industry Analysts, Inc."

[http://www.prweb.com/releases/bioimaging\\_technologies/medical\\_bioimaging/prweb8857230.htm](http://www.prweb.com/releases/bioimaging_technologies/medical_bioimaging/prweb8857230.htm) 10 October 2011. Accessed October 24, 2013.

<sup>4</sup> "Market Research Forecast Tissue Engineering Market at \$11 Billion by 2012."

<http://finance.yahoo.com/news/market-research-forecast-tissue-engineering-133900886.html> 5 March 2012. Accessed October 24, 2013.

Faculty and students from the materials science, chemistry, electrical and computer engineering, crop sciences, and other departments have invented energy-related technologies. Research institutes include the Energy Biosciences Institute, the ADM Bioenergy Modeling Center, and the Trustworthy Cyber Security Infrastructure for the Power Grid (TCIPG) at the Information Trust Institute. Current EnterpriseWorks clients and graduates, who have commercialized energy technology from Illinois, include Xerion Advanced Battery Corporation, Dioxide Materials, Solarbridge, and Network Perception. Twelve cleantech companies in EnterpriseWorks have received \$293.8 million in funding from angels, VCs, corporate partners, and SBIR. Examples of more established companies in the region include Power World, Prairie Gold, and Tetravita Bioscience. Business activity in the energy cluster is mostly limited to start-ups, given the nascent nature of the cluster in Champaign-Urbana, and will need to be developed over time.

Growing market opportunities exist. Renewable energy has seen growth as alternatives to fossil fuels are sought and costs have risen. “Biofuels...reached \$95.2 billion in 2012...and are projected to grow to \$177.7 billion by 2022...”<sup>5</sup> The global energy storage market is driven by the continued development of smart grid infrastructure, growing energy demand globally, technological advancements, and increased government funding. “By 2016, the world energy storage market is predicted to grow at a CARG (compound annual rate of growth) of over 9%.”<sup>6</sup> The global smart grid market is projected to grow at an average compound growth rate of more than 8 percent from 2013 through 2020.<sup>7</sup>

The combination of research and knowledge, commercialization of technology, and start-up activity starts to form a critical mass for energy cluster development. In addition, a focus on energy is aligned with Illinois’ recently released Strategic Plan, which identifies Energy and Environment as one of the six themes.

## Conclusions and Recommendations

All three clusters have strong foundations that, with the right strategy, can create economic development benefits for Illinois and the community. Yet every cluster in every community faces challenges that can hinder its development. The recommendations, which are directed at the gaps, are: (1) foster interconnectedness and enhance collaboration among businesses and the assets in each cluster; (2) build and attract business and management talent; (3) enrich technical talent; (4) increase business activity across all stages in the company lifecycle; (5) build cluster identity; (6) continue to foster a culture of entrepreneurship; (7) augment the entrepreneurial ecosystem and support the specific needs of the business in the clusters; (8) increase capital for business start-up and growth; (9) improve access to Champaign-Urbana via

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<sup>5</sup> “Clean Energy Trends 2013,” pg. 3.

<sup>6</sup> “Energy Storage Market Reviewed & Forecast by GBI Research in Cutting-Edge Report Available at MarketPublishers.com,” <http://www.prweb.com/releases/2013/4/prweb10619782.htm> 10 April 2013. Accessed October 25, 2013.

<sup>7</sup> Greentech Media, <http://www.greentechmedia.com/articles/read/smart-grid-market-to-surpass-400-billion-worldwide-by-2020>. 13 August 2013. Accessed October 25, 2013.

air and rail; and (10) provide leadership that includes the university, representation from the cities (Champaign and Urbana), and business leaders, in particular, Chief Executive Officers of successful technology businesses from the clusters. In the report, several ideas are proposed to spur a discussion on how to best create an environment at Illinois and Champaign-Urbana that will support cluster growth, promote economic development, and create, retain and attract jobs. Typically, a cluster strategy would follow as the next step.

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## 1.0 Introduction/Background

A vibrant community is important for the University of Illinois at Urbana-Champaign and the community. It creates an environment that attracts and retains businesses, a skilled workforce, innovation and entrepreneurship, arts and culture, quality K-12 education, better transportation, and greater choices for shopping and dining. A thriving community will help the University of Illinois attract top-notch faculty and students, and it will help the community to create, retain and attract jobs. The university and the community share common goals.

The University of Illinois is important to the local economy as a magnet for talent, partner to corporations, source of innovation, and a major employer. Illinois has earned an international reputation, attracting faculty and students from all over the world. More than 2,500 faculty teach and conduct research at Illinois. More than 32,000 undergraduate students and 12,000 graduate students attend the university in 17 colleges and instructional units. The College of Engineering is ranked as a Top 5 engineering school in the United States. There are more than 150 research institutes including, the Beckman Institute for Advanced Science and Technology, the Prairie Research Institute, the Institute for Genomic Biology, and the National Center for Supercomputing Applications, and other centers of excellence.

Illinois leads the nation in funding from the National Science Foundation with a total of \$126 million in FY 2012. Its total research expenditures for FY 2012 were \$584 million, according to the Research Report 2012-13 from the Vice Chancellor for Research. Industry-sponsored research and development expenditures totaled \$37 million in the same year. Illinois has a strong track record for developing ground-breaking inventions, including the integrated circuit, flat panel plasma television display, and Mosaic graphical web browser, as well as early foundational research in imaging. 76 patents were issued in 2012, and 5 start-up companies launched from research conducted at Illinois.

The University of Illinois has a track record of fostering entrepreneurship, new business start-up, and business attraction. The 200-acre Research Park provides a place for technology-based businesses to partner with faculty and students on collaborative research and commercial endeavors. EnterpriseWorks, the business incubator located in the Research Park, helps to launch technology start-ups, 89% of which are founded by entrepreneurs from the University of Illinois. Since its inception in 2003, EnterpriseWorks has launched more than 150 new companies. A host of other programs help to commercialize technology and assist with start-up success. Given the size of the community, Champaign-Urbana has a strong entrepreneurial ecosystem. Furthermore, Illinois has a culture of entrepreneurship with both entrepreneurial faculty and graduate students. Clearly, the University of Illinois is a leading source of technology research and innovation, and an important driver for economic development in the community and the region.

Located in the twin cities of Champaign-Urbana with a combined population of more than 115,000, the University of Illinois is the largest employer with almost 11,000 employees. The twin cities are small metropolitan cities surrounded by rural communities. The predominant non-farm private employment (which excludes the university as a government employer) includes Health Care and Social Assistance (15%), Retail Trade (13%), Accommodation and Food Service (10%), Manufacturing (9%), and Professional-Scientific-Technical Services (8%).

Economic development has been part of the mission of the University of Illinois since 2000. In its recently released Strategic Plan, the University of Illinois identified economic development as one of the six critical themes. Partnering with the business community, Illinois can play a leadership role in economic development that would capitalize upon its research strengths and expertise, and help to strengthen the local community and economy. Economic development activities include entrepreneurship, company attraction, industry engagement, infrastructure, and building research magnets.

Recently, the Chancellor convened an Economic Development Advisory Group, composed of a small group of campus and business leaders, to discuss economic development for the campus and the community. The Research Park has engaged Business Cluster Development (BCD) to identify the technology clusters that would represent economic development opportunities for the University of Illinois and the community.

In this report, BCD recommends three clusters to target, based upon best practices and an assessment of local conditions and market opportunities. The report begins with a discussion of clusters and their role in economic development, a list of the key findings and assets, and then proceeds to the cluster recommendations. All clusters operate within a context and require certain essential elements and conditions to grow over time. As such, the report describes the challenges that may hinder cluster growth. It concludes with a final set of recommendations on how to begin to address some of the challenges and move forward.

## 2.0 Clusters and their Role in Economic Development

Targeting the growth of specific clusters (or sectors) for economic development continues to be a growing practice among communities and regions across the U.S. and around the world. The goal is capitalizing on the strengths and assets in a community or region, and the interconnectedness between them, to create economic development results including business creation and attraction and new jobs.

### 2.1 Regional Business Clusters

Regional business clusters may be defined as geographic concentrations of interconnected companies, suppliers, service providers and others in a particular industry or sector. A cluster may be large, involving thousands of businesses and hundreds of thousands of workers, or small, involving a handful of businesses and a few hundred workers. Clusters typically develop for a combination of reasons, including access to natural resources, research universities, an appropriately skilled workforce, access to capital, local demand for products or services, and the existence of cluster-related industries.

Essentially, industry clusters develop through the attraction of geographic proximity—the geographic concentration of similar, related, complementary, and supporting organizations offers a wide array of benefits to firms. Clusters promote knowledge sharing and innovation in products and in technical and business processes by providing robust networks of formal and informal relationships across organizations. As a result, companies derive substantial benefits from participation in a cluster’s “social structure of innovation.”<sup>8</sup>

Participants in an industry cluster include:

- Companies providing similar or related goods or services;
- Specialized suppliers of goods, services, or financial capital;
- Distributors and service providers for the sector;
- Local customers;
- Workers with related skills or technology expertise;
- Related research, education, and training institutions such as universities, community colleges, corporate research labs, and workforce training programs;
- Business incubators that provide critically needed business and technical services for entrepreneurs and early stage companies;
- Cluster support organizations such as trade and professional associations or business councils;
- Government agencies providing regulatory guidance, financing, and business support.

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<sup>8</sup> Adapted from Michael E. Porter, “Clusters and the New Economics of Competition,” *Harvard Business Review*, November-December 1998.

Regional business clusters often form when entrepreneurs and companies locate in the vicinity of research institutions, taking advantage of not only the intellectual property, but also the talented workforce and access to financing located nearby. University research parks are the most common example on a small scale. Entrepreneurs are also attracted to corporate concentrations in specific market sectors.

Emerging early-stage companies, in particular, utilizing technology from research universities often create high quality jobs and generate significant economic activity. The founders may be faculty, students or entrepreneurs licensing technology from the university. Business incubators, and specifically cluster-focused incubators that concentrate on a particular, growing industry, use a business incubation process and structure to assist in the growth of new businesses in targeted sectors, and are a common tool used to stimulate new business formation within clusters.

Paradoxically, even as innovation has globalized, the role of regions as the critical nexus for innovation-based economic growth has increased. True innovation “hot spots” emerge regionally. Regions are the building blocks of national innovation capacity because they offer the benefits of proximity. Research and development collaborations, particularly interdisciplinary and multidisciplinary efforts, are easier when one can interact with colleagues on a personal basis. The application of knowledge occurs faster when industry and universities maintain close working relationships fostered by proximity.

As talent moves from one company to the other, innovation increases. Emerging and established companies locating within the same community or region help to attract and expand the talent pool, and are necessary to grow clusters. Start-ups spin out of more mature businesses to pursue an idea or invention. Corporate research centers play a similar role by providing internal innovation and supporting the cluster as their employees move to jobs at other companies.

Successful clusters also need to encourage development of a variety of technologies that can mature over both long-term and short-term timeframes, and grow through multiple pathways. Essential innovation infrastructure for cluster development is also achieved by catalyzing more effective linkages between academia and the private sector.

Finally, the cluster ecosystem must be effective enough to significantly increase and accelerate the movement of technology to the market place. Commercialization of both academic and corporate research is an important ingredient for generating entrepreneurship and new business formation. Some regions have high levels of research and development investments and numerous specialized research centers. However, some still lag in terms of innovation output because knowledge is not effectively or rapidly transferred to companies through licensing or formation of new start-ups. More effective communication and collaborative relationships among industry,

universities and entrepreneurial companies, including clear communication of industrial needs, will increase speed to market of new technologies.

## 2.2 The Role of Clusters in Economic Development

Communities choose to pursue cluster economic development strategies to capitalize upon their strengths to produce results, including new business formation, business retention and attraction, and job creation. It is also the strategy of choice for diversifying local economies. Cluster-based economic development strategies are a focused effort to grow and attract companies throughout the lifecycle and at different levels of maturity and size. It seizes market opportunities, encouraging the growth of companies in expanding markets that will have increasing chances to develop and sell products to meet market demands. Leveraging of intellectual property (IP) and sources of innovation at universities and in industry are critical for success. Cluster strategies rely upon assets that are already in place—and those that will be developed as the cluster grows, whether driven by the leadership or developed organically—and the knowledge and expertise that make the community somewhat unique. The strategies seek to increase the interconnectedness between the assets and strengths, as that is the basis for clusters.

Technology sectors, in particular, yield more significant opportunities for business growth and job creation. Technology sectors are driven by innovation. A recent *Wall Street Journal* article cited the multiplier effect as most significant for the innovation sector: "...about three times as large as that of extractive industries or traditional manufacturing."<sup>9</sup> Communities with strong innovation sectors have more highly educated and skilled workers. Over the past 30 years, cities with strong innovation sectors have seen stronger job growth.<sup>10</sup> To be truly effective in growing technology and innovation sectors requires that the community achieve a critical mass of companies, which will then, in turn, provide job opportunities for the skilled workforce to move from employer to employer over time, and attract other companies who want to attract those skilled workers and locate alongside other innovative, technology companies. Silicon Valley is the best example of a cluster which provides synergistic opportunities for businesses and workforce, and similar examples can be seen in the Research Triangle Park area of North Carolina; Austin, Texas; and Seattle, Washington.

Moreover, cluster strategies are an efficient and effective economic development strategy. They leverage assets that already exist, and direct expenditures toward opportunities that have a greater chance for economic return. They focus on launching new businesses—"grow your own" strategy--that are more likely to stay in the community as they grow. In addition, cluster strategies require that communities address the challenges to business growth and retention. Therefore, communities turn towards a cluster strategy as an effective use of resources.

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<sup>9</sup> Moretti, Enrico. "Where the Good Jobs Are—and Why." *The Wall Street Journal*, September 18, 2013, pg. A-15.

<sup>10</sup> Ibid.

## 2.3 Framework for Identification of Clusters

A framework, developed by BCD, was deployed to identify the cluster opportunities. BCD has more than 20 years of experience in putting cluster theory into practice as an economic development approach. The BCD approach to identifying clusters assesses the community and the clusters through a framework composed of two lenses: (1) a set of best practices factors for cluster success as established by a recognized study on cluster competitiveness, and (2) a set of essential elements, based upon BCD's pragmatic model and significant experience, necessary for identifying emerging clusters to target for economic development. Together, the two lenses provide a framework for identifying the best opportunities for cluster success.

The two lenses are explained below, as well as the process used by BCD to identify the clusters.

### 2.3 (A) Lens One: Best Practices Factors for Cluster Success

When selecting clusters, consideration of the best practices factors is the starting point and the basis for the first lens of the framework. A number of studies have shown that regional business clusters have a strong impact on a diverse number of economic indicators and are a key element in stimulating local and regional economies. However, clusters can differ considerably in their growth and development. The "4 best practices factors of cluster success" include:

- 1) Collaboration (networks and partnerships),
- 2) Capital (funding and financing),
- 3) Skills and abilities (human resources), and
- 4) Innovation (capacity to generate and to take advantage of innovations).

Cluster initiatives or strategies are formally organized efforts to promote cluster competitiveness and growth through a variety of collaborative activities among cluster participants. The Global Cluster Initiative Survey (GCIS) is the only known research effort to look across a number of cluster initiatives (over 250) to identify the extent of effectiveness and success factors.

The GCIS finds that appropriately focused, effectively managed cluster initiatives have a visible, positive impact on cluster competitiveness and growth. According to the GCIS, successful cluster initiatives:

- Are industry-led;
- Involve state and local government decision makers that can be supportive;
- Are inclusive: they seek any and all organizations that might find benefit from participation, including startups, firms not locally-owned, and firms rival to existing members;
- Create consensus regarding vision and mission, objectives, and how to reach them;

- Encourage broad participation by members and collaboration among all types of participants;
- Are well-funded initially and self-sustaining over the long-term; and
- Link with relevant external efforts, including regional economic development partnerships and cluster initiatives in other locations.<sup>11</sup>

Dynamic clusters offer the market opportunities and the conditions—culture, social networks, innovation, inter-firm mobility, access to capital—that encourage new business development. Public policy and other efforts to form or grow clusters must attempt to spur the key factors for cluster success. The strongest regional clusters do not rely upon chance, but rather seek to institutionalize the innovative process by building strong universities and research centers and by taking steps to stimulate continuous innovation and entrepreneurship. However, innovation capacity rests on more than just scientific discovery or idea generation. It is a process that links together regional knowledge, assets, and networks to transform ideas, insights and invention into new processes, products and services that capture global market share.

### 2.3 (B) Lens Two: Essential Elements for Cluster-based Economic Development

To distinguish this second lens from the first one, the “essential elements” specifically help to identify clusters for targeting (versus assessing how clusters have worked over time) at the start. It seeks to pinpoint emerging opportunities that can be leveraged. Beyond collaboration, capital, skills and innovation, additional elements are necessary to grow clusters and create economic development results. The “essential elements” are:

- a) Growth Sector/Growing Market Opportunity – The cluster must be experiencing market growth and exhibit trends that suggest continued growth is expected. The cluster must have the ability to capitalize on market trends and opportunities.
- b) Asset Base – A strong base of assets and resources are critical. While the assets can be grown over time, a critical mass must exist at the start. Key assets may include educational institutions that conduct research and produce skilled graduates for the workforce, major employers that attract skilled employees and produce other community benefits, and organizations and programs that foster collaboration and connections among different participants in the sector. Unique assets and expertise can play an important role.
- c) Business Activity - Vibrant business activity within the cluster should be present or ripe for expansion. Over time, the business community for the cluster must include a range of businesses throughout the lifecycle, from start-up to mature, and a range of sizes including large, medium and small firms. In communities where research institutions and leading technology companies are present, the selection of the cluster will be driven significantly by the innovation occurring within these institutions that would provide the best opportunities for commercialization and new business formation. Entrepreneurial support and the

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<sup>11</sup> Örjan Solvell, Göran Lindqvist, and Christian Ketels, “The Cluster Initiative Greenbook” (Stockholm: The Competitiveness Institute, 2003).

entrepreneurial ecosystem itself can be considered important assets for cluster development and aids for supporting business activity.

- d) Critical Mass – This term implies that every cluster must start with a certain base level of assets and activity that can be grown over time through both organic and proactive efforts by community leadership. It is the combined essential elements that determine if a critical mass is present in order to proceed with a cluster approach.
- e) Community Support and Leadership - A community can have world-class resources and innovation, and the networks to support them, but without the consensus and support of the approach by the community, the clusters cannot succeed. Leadership is also critical. A champion, who is an individual or small team that is respected in the community, must collaborate and coordinate with others in the community to drive the effort forward.
- f) Differentiation and Positioning - To attract attention within a broader region and across the nation, and build a reputation, requires selecting clusters that help to differentiate the community. Moreover, the choice of a cluster name is important for positioning the cluster when marketing. In this case, differentiating from peer universities and communities is also important.

In summary, putting cluster theory into practice as an economic development strategy starts with the selection of an emerging, growth sector that has key assets already in place, a sufficient critical mass of innovation and business opportunities that form a foundation, a clear consensus of community support, and leadership to move the initiative forward. It also involves choosing a cluster--and cluster name--that helps to differentiate the community from others, thereby positioning it for the purposes of marketing and establishing a reputation.

### 2.3 (C) Process for Cluster Identification

In determining the clusters, BCD works to gain an understanding of the elements present within a particular community that can form a successful cluster. The process begins with a review of information about the local economy, assets and resources, and sources of intellectual property (IP) and business ideas. For the University of Illinois, as with all universities, we review a list of technology disclosures and patents, and consider technology commercialized through start-ups. Next, interviews with key stakeholders in the community—business leaders and entrepreneurs, research institutions and colleges, capital sources, service providers to business, and government leaders—constitute the core of the work. The interviews provide a range of perspectives on the assets and strengths in the community, the business climate and challenges to business growth, and the opportunities for cluster growth. More than 35 individuals were interviewed during the course of this project. (A complete list of the stakeholders interviewed can be found at the end of this report.) At the same time, the interviewing process helps to build early consensus and community support for the clusters. Finally, analysis of the information gathered--based upon the framework discussed earlier, and the experience that BCD has developed with cluster-based economic development over

the past 20 years--leads to the identification of the clusters and the opportunities, as well as the challenges that impact cluster growth.

### 3.0 Recommended Clusters

BCD recommends the following clusters to target for economic development in Champaign-Urbana:

- **Data Analysis and Management, and Computing**
- **Biomedical and Bioengineering**
- **Energy**

The identification of the three clusters is based upon analysis and review of the information gathered using the framework of two lenses discussed in the prior section. This section of the report will review the key findings from the stakeholder interviews, identify the assets and resources present on the campus and in the community that will help to support cluster growth, provide an overall assessment of three clusters using the framework, and discuss the three recommended clusters within the framework.

#### 3.1 Key Findings

The interviews of more than 35 stakeholders across the community and campus revealed that clear consensus exists among stakeholders as to the key opportunities for cluster growth and the challenges that the university and community will face as they seek to grow the clusters. Key findings from the interviews include:

- The University of Illinois has a collaborative environment with a strong emphasis on interdisciplinary research.
- The University of Illinois has cultivated a culture of entrepreneurship over the past decade or more, resulting in technology commercialized from research and start-ups launched by faculty and graduate students.
- The entrepreneurial ecosystem, which includes a number of programs such as EnterpriseWorks, the Research Park, the Technology Entrepreneur Center, the Office of Technology Management, the U-CAN angel network, and IllinoisVENTURES, as well as more community-based programs such as the Small Business Development Center, plays an important role in commercialization and start-up activity.
- University leadership is recognized as an area of strength and opportunity. At the same time, some concerns about continuity in leadership and the impact on economic development and other strategic efforts were noted. Sustained economic development efforts require long-term leadership.
- Retention and growth of technology companies in Champaign-Urbana is challenging as the pool of skilled business and management talent is insufficient.
- While inroads have been made to increase the amount of seed capital available to high-growth companies, capital needs are not sufficiently met at the next growth stage and result in companies relocating out of the community.
- Access to Champaign-Urbana is limited due to air service by a single carrier, which has repercussions for attracting talent, customers, and businesses.

- The communities of Champaign-Urbana are attractive to families for lifestyle reasons, but less so for singles, which has a negative impact on attracting and retaining technology employees and graduate students (since they are often 20s-30s and single).
- The lack of an academic medical hospital and full-scale medical school program restrict the expansion of health-related research opportunities and National Institutes of Health (NIH) and private funding, and the creation of more skilled jobs.
- Trailing spouses (that have PhD and/or advanced degrees) are a concern since it impacts recruitment and retention of graduate students and faculty. An increased number of skilled jobs would help to address this issue.
- Consensus that leveraging the assets and reputation of the University of Illinois is key to economic development in the community and growing targeted clusters.

The findings impact each of the three recommended clusters and will be discussed during the course of the report.

### **3.2 Assets and Resources**

All clusters have assets and resources that help to encourage innovation, research and development, technology commercialization, new business start-up, and retention and attraction of businesses. The University of Illinois and Champaign-Urbana have assets and resources that benefit all three of the clusters recommended in this report, and provide the essential elements for the growth of the cluster. Several gaps exist currently, as well, as seen in a few of the key findings and the cluster discussions. Yet clear opportunities exist that can help to spur the cluster.

The following are the six key assets and resources currently present that will significantly impact the development of all three clusters:

#### (1) University of Illinois

Universities are important assets for clusters because research is a source of potential innovations that may be commercialized, and faculty members possess expertise and knowledge that are a source of inventions and new ideas. Universities also attract businesses to the area that derive benefit from the research and trained employees. Throughout the interviewing process, stakeholders consistently pointed to the University of Illinois' research strengths and the expertise of their faculty as key assets for cluster growth.

The University of Illinois has a strong track record of attracting substantial research dollars and producing a significant intellectual property portfolio. Illinois had \$584 million in research expenditures in FY2012, and receives more National Science Foundation funding than any other university or college. Illinois is ranked as a top five engineering school by *U.S. News & World Report*. Illinois has more than 150 centers, laboratories

and research institutes with experience in interdisciplinary research. It is a world leader in supercomputing.

The Office of Technology Management (OTM) engages with faculty researchers and plays a proactive role in identifying technology for commercialization and licensing. In FY 2012, 223 disclosures were made and 76 patents issued. The Electrical Engineering and Computing Department led the way in number of disclosures and patents issued. Five start-ups were launched from technology developed at Illinois in FY 2012, and 11 launched in FY 2011. In 2012, OTM created the Share the Vision event to showcase technologies to venture capitalists and corporate executives.

## (2) Technical Talent Pool

Champaign-Urbana has a talent pool with deep technical knowledge, mostly residing at the university and technology businesses. In particular, the University of Illinois has world-class engineering expertise with strong capabilities in data analytics and management (“big data”). It has more than 2,000 tenured faculty members who have earned honors including the National Science Foundation CAREER Awards and entrance into the National Academy of Sciences. Faculty and alumni include 23 Nobel Laureates. Illinois has more engineering students than the top four engineering schools combined. The University of Illinois is a magnet for technical expertise, attracting faculty and graduate students to teach and conduct research. In addition, highly technical staffs work at companies such as Yahoo!, ADM, State Farm and Raytheon in the Research Park.

## (3) Hospitals

The hospitals in the community are important assets as they provide opportunities to increase bioengineering and biomedical research. In particular, Carle Hospital has on-going research relationships with several faculty members including research in cancer, cardiac diseases, neurosurgery, and gastroenterology. The Research Institute at Carle supports clinical trials, investigator initiated research, nursing research, resident research, and translational research. Carle also has a Cancer Center and Heart and Vascular Institute providing patient care as well as research. Recently, Carle launched the Carle Tissue Repository, which allows patients to donate tissue for research, and the Biomedical Research Center, which is a partnership with the University of Illinois on joint research. In addition, Carle is the second largest employer in Champaign-Urbana with 6,000 employees. A second hospital is Presence Covenant Medical Center, a smaller, 210-bed community hospital which is part of the largest Catholic healthcare system in Illinois. Christie Clinic Association is a large physician group with 750 employees.

## (4) Entrepreneurial Ecosystem: Support for Technology Entrepreneurs

For a community of its size, Champaign-Urbana has a well-developed entrepreneurial ecosystem that provides assistance and support to technology start-ups and early stage

companies. The ecosystem plays an important role in commercializing technology developed at the University of Illinois and helping to increase technology start-ups' chances for success.

The university's incubator, EnterpriseWorks, has launched more than 145 new companies since its inception in 2003. In 2013 it was named one of *Inc. Magazine's* "Three College Town Incubators to Watch". EnterpriseWorks coaches its client companies and hosts weekly events for education and networking. It assists clients with applications for the Small Business Innovation Research (SBIR) program. Its 43,000 square foot facility has office and lab space for entrepreneurs and early stage companies. 89% of the client company founders are University of Illinois entrepreneurs. 40% of the companies are information technology (IT), and almost 30% are biomedical. Most clients spend 3 to 5 years in the program before graduating.

In addition to EnterpriseWorks, I-Start, the Entrepreneurs-in-Residence (EIR) program, Designer-in-Residence, Student Shared Services program, the Technology Entrepreneur Center, NSF I-Corps, and an Economic Development Administration (EDA) University Center are aimed at fostering start-up and early growth. Available to faculty entrepreneurs licensing university technology, the I-Start program provides a range of professional services through service providers including free legal services, business planning, SBIR assistance, financial and payroll services, and access to the student shared services center. The EIR program provides management consulting by experienced business professionals at no charge, and is a recognized tool to mentor young companies. Recently, a Big Data EIR with experience as an entrepreneur and at the NCSA has been added to the program. The Chair of the Industrial Design Program in the School of Art and Design has been designated the Designer-in-Residence to assist university inventors and entrepreneurs to incorporate product design in their technology development as a means to help improve user experiences and performance of products to meet customer needs. The Student Shared Services Program hires university students from a number of colleges to assist start-ups with short-term projects that include market research, business planning, website development, public relations, user interface design, and lab set-up service. The Technology Entrepreneur Center (TEC) assists students and faculty in the College of Engineering to become innovators, entrepreneurs, and leaders. I-Corps is an NSF-funded program aimed at commercializing university research through a program providing market validation and mentoring based upon Lean Start-up model.

Finally, the East Central Illinois EDA University Center partners with Champaign County, the Regional Planning Commission, Parkland College, the Village of Rantoul, and the Research Park to promote entrepreneurship (non-technology and technology) in the region. It offers FastTrac courses and consulting services through the Small Business Development Center.

### (5) Research Park and Corporate Relationships

Resources like the Research Park that assist companies beyond the start-up stage are important for growth and retention, as well as providing a landing pad and network for more established companies. They help to support the development of a thriving business community composed of companies throughout the stages of the lifecycle and of different sizes and maturity. In addition, strong relationships with leading corporations, such as those exhibited in the Research Park and industry-sponsored research at the University of Illinois, are important for spurring innovation, attracting and retaining talent, and forging relationships with corporations that can lead to new business ventures.

Created in 2001, the 200-acre Research Park advances the economic development mission of the University of Illinois at Urbana-Champaign. Atypical of most university research parks, it is located adjacent to the central campus, making the park more successful in engaging students and faculty with the technology-based businesses in the Park and fostering collaborative research and commercial endeavors. The Association of University Research Parks (AURP) recognized the Research Park as Outstanding Research Park of the Year in 2011. 90 companies are located in the Research Park, and include Fortune 500 companies such as Yahoo, Caterpillar, John Deere, ADM, State Farm, Sony, Raytheon, Abbott, Dow and Citrix. For many of these firms, the Research Park location serves as one of their innovation centers, including the ADM Sustainable Bioenergy Modeling Center, the Caterpillar Simulation Center, the Raytheon Trusted Computer Solutions operation, the State Farm Research and Development Center, and the Yahoo! Hadoop Center for Excellence. The Research Park has recently launched an expansion phase of development.

Corporate support at the University of Illinois totaled almost \$100 million in FY 2012, according to the Office of Corporate Relations 2012 Annual Report. More than 70% supports research at the university. The corporations sponsoring research are a diverse group including Apple, Bayer Healthcare, DuPont, Kraft Foods Group, Novartis, Palantir Technologies, SAP, Boeing, TIAA-CREF, and Wal-Mart. Corporate sponsored research institutes is described further in Section 3.3 under the collaboration heading.

### (6) Culture of Entrepreneurship

A culture of entrepreneurship has been cultivated at the University of Illinois over the past decade or more, and it plays an important role in attracting entrepreneurial faculty and graduate students to the campus, and spurring faculty and students to pursue entrepreneurial endeavors. While no formal policy exists to facilitate entrepreneurship, the tone from the Office of Technology Management, the programs that have been established for commercialization and start-up, and the valued staff working with the faculty, graduate students and entrepreneurs all help to encourage new business ideas and find pathways to put them into action. Graduate students and younger faculty educated in collaborative environments that focused on interdisciplinary research come

to campus seeking to collaborate. They are already thinking about inventing and commercialization when they arrive. In addition, faculty with industry experience help to nurture the culture. Graduate students are often the ones that launch the businesses, but they continue to work closely with faculty teaching at the university. Faculty, administration and businesses can easily point to examples of success, which in turn, helps to promote the culture across campus and in the community. The lack of serial entrepreneurs, noted several stakeholders in their interviews, impacts the culture since role models for “been there, done that” are fewer and the experience that they could share is missing. In other words, success breeds more success and the culture must be nurtured and more entrepreneurship encouraged. It is an organic process that will greatly benefit the clusters.

### **3.3 Overall Assessment of the Recommended Clusters**

At the start of the assessment using the first lens of best practices factors, it became clear that a number of the factors are present across *all three clusters* and are not associated with any specific industry cluster. This situation is not unusual for a community of the size of Champaign-Urbana where the population and business community size could not support as many specialized resources. Consequently, the assessment of all three clusters against the four best practice factors is described below. Then, in the following section, each of the three clusters will be assessed under the two lenses of the framework and the attributes *specific* to those clusters will be evaluated and discussed.

#### **3.3 (A) Collaboration**

While having the right assets in place is important, the connections and collaboration among the assets are equally important. Synergies are created by businesses partnering with universities to solve technical problems and validate ideas. Universities connect with private firms developing solutions and help those products reach the marketplace. The connections and networks are informal and formal. Relationships must be formed that foster business development and connections across specific industry clusters.

In a university setting, collaboration is important across academic disciplines to find solutions to problems. Faculty members from one college or department work with others in different, and sometimes rather diverse, colleges or departments to address a particular research issue and work together to find solutions.

Interdisciplinary research institutes are created and supported to foster collaboration and institutionalize these types of relationships. The Beckman Institute for Advanced Science and Technology, for example, conducts interdisciplinary work in the physical sciences, computation, engineering, biology, behavior, cognition, and neuroscience. “More than 600 researchers from 40 U of I departments contribute to Beckman Institute

research.”<sup>12</sup> The Institute for Genomic Biology focuses on agriculture, health, the environment, and energy, bringing together faculty from several schools and departments. During the course of the interviews, the theme of collaboration across the campus was prevalent. It is ingrained in the culture at the University of Illinois, and helps the university to continue to attract faculty interested in interdisciplinary research.

Collaboration with private industry is demonstrated by the almost \$100 million that the University of Illinois received from corporations for research in FY2012. The corporations are diverse, as described in the Section 3.2. Some of the best examples of corporate sponsored research include the Abbott Center for Nutrition, Learning, and Memory (which will receive \$50 million over 5 years) focused on the understanding of nutrition’s impact on brain cognition; the Energy Biosciences Institute, a \$500 million partnership with BP (and the University of California Berkeley and Lawrence Berkeley National Laboratory) dedicated to bioenergy research and specifically for overcoming the barriers to sustainable second-generation biofuels; the Boeing Trusted Software Center focused on research topics related to security, privacy, reliability, availability, correctness, safety and survivability of information systems, software, networks, and applications; the ADM Institute for the Prevention of Postharvest Loss (which received \$10 million of funding) researches systems that reduce postharvest loss in staple crops such as corn, wheat, and oilseeds; and Dow Chemical’s pledge of more than \$13 million to the Departments of Chemical and Biomolecular Engineering, Chemistry, Materials Science and Engineering, and the Library to pursue the design, synthesis and characterization of new materials for encapsulation and targeted release, design new emitters for optoelectronic applications, and study research effectiveness. In addition, in an effort to further connect the ideas and inventions developed by faculty with industry funding and partnerships, the University of Illinois has recently launched the Applied Research Institute, which will be located at the Research Park. Clearly, several of these institutes and their collaborative research are directly aligned with the three clusters.

The Research Park and EnterpriseWorks provide tangible opportunities for collaboration between business and the university. Their physical proximity to the campus and engineering school greatly help to facilitate these connections. Leading companies, including Caterpillar, Dow, John Deere, State Farm, and Yahoo!, choose to locate in the Research Park to take advantage of the expertise and collaboration opportunities. Faculty and graduate students often work one-on-one with companies in the Research Park and EnterpriseWorks. In addition, a group of 25 to 30 executives from local technology companies gather for regular meetings of the CEO Roundtable, which provides an important networking function.

Successful collaboration within clusters also requires leadership. As we mentioned at earlier in this report, research shows that the most successful regional innovation clusters are industry led. At the start, the university may champion the effort, but private sector leadership must be engaged and the two must work together to move the effort forward. The Chancellor is taking the lead in economic development and engaging key

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<sup>12</sup> “Research Report University of Illinois at Urbana-Champaign 2012-13”, Office of the Vice Chancellor for Research. Pg 5.

business leaders in the community, creating an Economic Development Advisory Group to kick-off the effort. Turnover in the university administration, however, is a concern that arose during the interviews and can affect long-term economic development efforts. To sustain the effort will require a continued and visible role for the business community.

The strongest economic clusters are defined by the interconnectedness among the assets, private sector leadership, and the synergies that are created among networks. In Champaign-Urbana, the university and faculty have strong connections with industry, and other relationships that develop through EnterpriseWorks and the Research Park.

### 3.3 (B) Capital

A successful cluster has funding available to support businesses across the full lifecycle, from start-up through maturity. It can come in the form of investment capital, loans and other forms of financing, and the source can be private or public. Without capital, growing businesses may need to relocate to the places where the sources of capital exist, or they may not grow as fast, or they may fail without the funding. Also, entrepreneurs may choose to start their businesses in other regions or states if they recognize that the funding, especially early stage capital, does not exist. To develop and maintain a strong cluster, funding must be available to support early stage businesses, growing businesses and more mature companies.

For science-based start-ups, the first source of funding may be through the SBIR/STTR program. EnterpriseWorks clients and graduates have obtained \$49 million in SBIR/STTR funding.

In Champaign-Urbana, significant inroads have been made to create sources of seed stage capital for high growth (typically, technology) companies. Illinois Ventures, which invests seed and early stage in research-based companies in information technology (IT), physical sciences, life sciences and clean technology, was created by the University of Illinois to fill a gap. Recently, Illinois Ventures' Board of Directors has approved the formation of Fund III. Local, private firms include Serra Capital which funds IT and software, life sciences, clean technology and agriculture technology, and Open Prairie which funds life science, medical device and agricultural technology. Each firm has funded companies in EnterpriseWorks. An angel network, the Urbana-Champaign Angel Network (U-CAN), actively invests, as well. Several of the interviewees acknowledged themselves as active angel investors, as well as recipients of angel funding.

The next stages of funding which are necessary to scale the company are very limited in Champaign-Urbana. Without funding at this next (Round B) stage, companies will seek capital from outside the region—from Chicago to Silicon Valley to Boston—and they will be pulled away as they grow. The direct impact on business growth and retention will be ongoing until a solution is found. For companies seeking more

traditional sources of funding, banks are present to provide loans for business growth and expansion.

EnterpriseWorks clients and graduates have raised more than \$576 million in venture capital investment from 2005 to 2012. A track record for funding of incubator companies clearly exists.

In summary, the early sources of investment capital--angel and seed—can be found locally and are aligned with the three sectors. However, as the clusters grow, the supply of early stage capital must increase with the demand. At the same time, the post-early stages of funding must be available in order to help companies in all three clusters to scale. Insufficient supplies of capital will make it difficult to retain growth companies over time.

### 3.3 (C) Skills and Abilities

Starting, growing, retaining and attracting businesses in all three of the recommended clusters will require a workforce with the requisite skills. The skills generally fall into two categories: technical and business.

With leading programs in engineering and the sciences, the University of Illinois possesses and attracts top talent with technical skills. This is especially true in data analysis and management, as Illinois is a pre-eminent institution. Conducting and analyzing research to solve a problem, and formulating a technology based upon the research are among the technical skills present. These skills and expertise enable the creation of new and groundbreaking technologies and products, and drive the launch of new start-ups. They provide the talented and skilled individuals—faculty and students—to start these ventures.

The University of Illinois plans to add 500 net, new faculty members over the next 5 to 7 years. The positions will be in science and technology fields, thus increasing the pool of skilled and knowledgeable individuals.

In addition, the technology companies that have formed or been attracted to Champaign-Urbana generally require that employees have deep technical knowledge and expertise. They are drawn to the community and stay because they rely upon this knowledge and skill. Technology companies use the university as a resource for hiring graduates and interns, in addition to collaborating with faculty.

However, the growth of new ventures and early stage businesses is dependent upon building a team with strong management (top and mid-level), marketing, and sales skills. The community falls short in this area. It lacks the experienced people with the business skills necessary to build, grow and attract businesses. Attracting a workforce with these types of skills also presents a challenge, as the small size of the community (and its distance from other communities that might offer technical job options) affords fewer opportunities to move from company to company. Throughout the interviews, the

lack of a workforce with business management and sales skills was indicated as holding back economic growth in the community. Business owners spoke of work-arounds they must make to stay in Champaign-Urbana (e.g. locating their sales offices in other cities), or described how their colleagues have moved away to get the talent that they needed. The lack of management/business skills is a significant challenge for all three clusters.

Other technical skills will be necessary to grow the clusters. The equipment operators and lab technicians are important positions to fill. Parkland College, with its technical training programs, is a resource for growing these skill sets.

A related issue is “trailing spouse”. When the University of Illinois hires a faculty member or recruits a graduate student, often the spouse has an advanced degree and seeks work in a technical field. Frequently unable to find a suitable position that utilizes their education and experience, the spouse either accepts a position requiring lesser skills or remains unemployed. As a result, recruitment and retention of faculty and graduate students can be challenging. Helping to foster the growth of the three recommended clusters can be a way to create more technical jobs in the computing, data, bioengineering, biomedical and energy fields to provide more technical job opportunities for spouses.

On the technology side, the skill set is strong in Champaign-Urbana. Additional skilled talent will be required for the bioengineering and biomedical cluster as it grows. The more significant issue is the lack of a sufficient pool of experienced business and management talent necessary to grow, retain and attract companies.

### 3.3 (D) Innovation

Technology innovation is a key driver of successful cluster development. Clusters must have the capacity to generate innovation and to take advantage of those innovations. Innovation can be found at universities conducting ground-breaking research or seeking solutions to address technical or market issues. It is also found in start-ups and early stage companies innovative developing products with significant market potential. More mature companies innovate as they create new generations of products and seek to capture greater market share and new markets. A successful cluster has innovation at all of these levels.

At the University of Illinois, the most significant research strength and source for innovation is electrical and computer engineering. According to the Vice Chancellor of Research’s 2012 Research Report, 37% of the total 223 disclosures came from the College of Engineering. The total number of disclosures from the entire university increased 22.5% over the prior year. A total of 76 patents were issued during the same time period, and represents an increase of 11.7% from the previous year. Over the past five years, nearly 300 U.S. patents have been issued and more than \$28 million in royalties have been generated from university research. The University of Illinois is an important innovation asset, and patents are just one indicator of the potential for innovation and commercialization.

In FY 2012 the largest market concentrations of research at Illinois, according to the Office of Technology Management, occurred in the areas of electronics, therapeutics, software applications, advanced materials, crop sciences and mechanical engineering. This fact bodes well for a cluster focus on data analytics and management, and computing; bioengineering and biomedical; and energy. The definitions of these clusters (which appear later in this section) will demonstrate how they capture the significant innovation developed by the university in these market areas.

Commercialization of research (bringing innovation to the market) is a difficult, and essential, ingredient for generating entrepreneurship and the start of new technology businesses. Some regions have high levels of research and development investments and numerous specialized research centers, but still lag in terms of innovation output because knowledge is not effectively or rapidly transferred to companies. At the University of Illinois, a track record of commercialization exists in all three sectors. Over the past five years, 34 start-up companies with technologies based upon university research have been launched. Five companies were launched in FY2012. A recent article in *The Atlantic* noted Champaign-Urbana as one of the nation's leading centers for start-up activity on a per capita basis (placing it alongside Boulder, Colorado; Ann Arbor, Michigan; Charlottesville, Virginia; and Lawrence, Kansas).<sup>13</sup> The majority of the start-ups at Illinois originated from the following university departments: chemical sciences, computer science, electrical and computer engineering, materials science, and mechanical engineering. They include companies like Intelliwheels, Immoven, Share This, and Solarbridge. This effort must continue and increase in order to create a vibrant economy and community.

Support for innovation is necessary to actively foster commercialization and new business start-up. The strength of the entrepreneurial ecosystem, including a number of programs developed by the university to support commercialization and business start-up, was described earlier. The Research Park, in addition, provides the space and connections for growth beyond the start-up stage. These programs support all technology companies.

A number of companies that are focused on developing innovative technologies and products in data and computing, biomedical and bioengineering, and energy are present in the community, and especially in EnterpriseWorks and the Research Park. Most are early stage and some are growth stage. At the same time, several leading corporations, as described in the earlier section on collaboration, have located innovation centers at the Research Park and are an innovation asset.

Innovation in Champaign-Urbana is strong at the university with a significant number of start-ups spun-out of the university. Some growth stage companies remain in Champaign-Urbana to grow their businesses. Innovation occurring at specialized

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<sup>13</sup> Florida, Richard. "The Boom Towns and Ghost Towns of the New Economy," *The Atlantic*, October 2013. <http://www.theatlantic.com/magazine/archive/2013/10/the-boom-towns-and-ghost-towns-of-the-new-economy/309460/2/>

corporate centers at the Research Park is important, as well. Nevertheless, the number and growth of these types of companies will be limited by the factors already discussed, including lack of a significant workforce with management and business skills and investment capital. Without a critical mass of innovative companies across all levels—large and small, early and mature—the growth of the clusters will be more limited.

### 3.3 (E) Overall Assessment

Overall, when evaluated against the first lens of best practices factors, Champaign-Urbana demonstrates a strong base for the 3 three recommended clusters. A core of collaboration, capital, skills and abilities, and innovation are present that help to set the growth of all three clusters on the right path. At the same time, challenges exist that will require proactive intervention to increase the rate of growth of the clusters and their success. They include the addition of more formalized networks of collaboration for each cluster, increasing the sources for investment capital, a focus on attracting experienced business/management talent, and working towards increasing the number of businesses throughout the lifecycle to further spur innovation.

### **3.4 Cluster: Data Analysis and Management, and Computing**

BCD recommends a focus on the data analysis and management and computing cluster since it leverages three key areas of expertise at the University of Illinois that present clear opportunities for economic development. Of the three recommended clusters, it is the most advanced and ready for development. Its strengths and opportunities are revealed during the assessment described below.

The cluster itself is three, interrelated sub-sectors. Data management is defined as the development and execution of architectures, policies, practices and procedures in order to manage the information lifecycle needs of an enterprise in an effective manner.<sup>14</sup> Big data management is the organization, administration and governance of large volumes of both structured and unstructured data.<sup>15</sup> Data, in this case, is measured in exabytes and petabytes. “Data analysis is the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data.”<sup>16</sup> Based upon BCD’s experience, the two sub-sectors are intentionally labeled, “data analysis and management”, instead of “big data” to avoid a change in cluster name later if this now popular name now goes out of favor. (Several of the interviewees already cited potential issues with the term, “big data”.) Computing is a broad term and intended to capture the range of expertise within the university sub-disciplines including computer engineering, software engineering, computer science, information systems, information technology, and other areas that might emerge. Computer and network security,

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<sup>14</sup> TechTarget. <http://searchdatamanagement.techtarget.com/definition/data-management> 02 August 2010. Accessed October 22, 2012.

<sup>15</sup> Ibid.

<sup>16</sup> Northern Illinois University, Responsible Conduct of Research. [http://ori.dhhs.gov/education/products/n\\_illinois\\_u/datamanagement/datopic.html](http://ori.dhhs.gov/education/products/n_illinois_u/datamanagement/datopic.html). 2005. Accessed October 22, 2012.

visualization, programming and complex computing applications are among the research areas included in the sub-sector of computing.

Illinois is one of the leading universities conducting a critical mass of research in data analysis and management and computing, and possessing a high level of expertise. In particular, Illinois has significant and deep strengths in the data sciences and analytics, high performance computing, modeling/simulation, computer and network security, and complex-computing applications, as identified during the stakeholder interviews. Faculty research covers architectures, compilers and parallel computing; systems and networking; theory and algorithms; artificial intelligence; program language, formal systems and software engineering; database and information systems; graphics and visualization; scientific computing; bioinformatics and computational biology. Illinois has an established, world-class reputation for big data.

As can be expected given the expertise and research funding levels, the University of Illinois exhibits a high level of collaboration in this cluster. It has research partnerships with government and industry. Illinois is home to the National Center for Supercomputing Applications (NCSA), which provides high-performance computing, data, networking, and visualization resources and services for scientists and engineers across the U.S. Blue Waters, expected to be one of the most powerful supercomputers in the world, is located at the NCSA. In addition, the Coordinated Science Lab houses the Information Trust Institute, Advanced Digital Sciences Center, and the Parallel Computing Institute, combined they have more than 150 faculty members and about 70 researchers. Collaborations with industry include the Cloud Computing Testbed (an experimental testbed for data-intensive systems and applications created from resources jointly provided by NSF, Yahoo!, Intel, Hewlett-Packard and the University of Illinois), and the Boeing Trusted Software Center (a research collaboration between researchers at Boeing and Illinois). Then, as described earlier, a number of Fortune 500 companies operate innovation centers at the Research Park and collaborate with the university on data analysis and management and computing projects. Furthermore, the collaborations extend beyond the community to Silicon Valley and other regions.

The cluster has attracted research funding and investment, as described earlier in the section on capital. Local seed funds and angel investors invest in local, early stage firms in this cluster. Examples include RiverGlass and Infoblox. Yet, as the cluster grows, more seed capital and investment capital for the next stage of company growth will be necessary in order to grow and retain the companies in Champaign-Urbana.

Given the expertise of the university in this cluster, it continues to attract and train students with the requisite technical experience, skills and abilities, in addition to faculty with many years, if not decades, of expertise. With the ability to meet the growing demands of industry, the university and community are well positioned. A May 2011 study by the McKinsey Global Institute on big data points to a shortage of analytical talent that will grow over time. "The United States alone faces a shortage of 140,000 to 190,000 people with deep analytical skills as well as 1.5 million managers and analysts

to analyze big data and make decisions on their findings.”<sup>17</sup> This point illustrates that Illinois has specialized skills that will be in significant demand by industry and government, and therefore has an asset that can attract businesses in this cluster and provide a strong incentive to remain here. On the other hand, a critical shortage of the business management and sales skills necessary to grow these scientific and technology-based businesses in Champaign-Urbana exists and must be addressed.

Innovation in data analysis and management and computing is strong at the University of Illinois as evidenced by the number of disclosures and patents, and even more so, by the number of start-ups spun out with commercialized university technology, the growing number of companies who choose to reside at the Research Park, and the more established companies that are attracted to partnering and locating near the university. A recent addition to the support for entrepreneurs and commercialization in big data is an Entrepreneur-in-Residence with experience at the NCSA.

According to the Illinois Science and Technology Coalition, which interviewed large corporations in Illinois, cybersecurity, data analytics and machine-learning applications were reported as some of the strongest technology needs. The University of Illinois is positioned to address these needs with its research and expertise.

The market opportunities for data analysis and management and computing are clear as the sheer amount of data collected increases and the need to manage, mine and analyze grows. Demand for new technology and solutions to meet industry and government demands will be required. The McKinsey Global Institute “estimates that enterprises globally stored more than 7 exabytes of new data on disk drives in 2010, while consumers stored more than 6 exabytes of new data on devices such as PCs and notebooks. One exabyte of data is the equivalent of more than 4,000 times the information stored in the U.S. Library of Congress.”<sup>18</sup> IDC estimates that the amount of data more than doubles every two years.<sup>19</sup>

“The global market for big data, analytics and business intelligence solutions was worth \$22 billion in 2012—and it will keep growing, at a compound annual growth rate of 12.7 percent, through 2017,” as forecasted by Frost & Sullivan.<sup>20</sup> A recent report by the McKinsey Global Institute (MGI) discusses the how the use of big data will have economic and market implications:

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<sup>17</sup> Manyika, James, Michael Chui, Brad Brown, Jacques Bughin, Richard Dobbs, Charles Roxburgh, and Angela Hung Byers, “Big data: The next frontier for innovation, competition, and productivity,” McKinsey Global Institute. May 2011, pg. 3.

<sup>18</sup> Manyika, James, Michael Chui, Brad Brown, Jacques Bughin, Richard Dobbs, Charles Roxburgh, and Angela Hung Byers, “Big data: The next frontier for innovation, competition, and productivity,” McKinsey Global Institute. May 2011, pg. 3.

<sup>19</sup> Lohr, Steve. “The Age of Big Data,” *The New York Times*, 22 February 2012: <http://www.nytimes.com/2012/02/12/sunday-review/big-datas-impact-in-the-world.html?pagewanted=all>. Accessed October 21, 2013.

<sup>20</sup> NucsA, Andrew. “Big Data: Cutting through the bullsh\*\*.” *ZDNet*, 10 October 2013. <http://www.zdnet.com/big-data-cutting-through-the-bull-7000021781/> Accessed October 21, 2013.

The amount of data in our world has been exploding, and analyzing large data sets—so-called big data—will become a basis of competition, underpinning new waves of productivity growth, innovation, and consumer surplus...Leaders in every sector will have to grapple with the implications of big data, not just a few data-oriented managers. The increasing volume and detail of information captured by enterprises, the rise of multimedia, social media, and the Internet of Things will fuel exponential growth in data for the foreseeable future.<sup>21</sup>

MGI further explains that big data can be used to create value across many sectors of the global economy. MGI believes that we have reached an “inflection point” in which the expansion of big data will be significant. Companies will use big data to better compete and governments will boost their efficiency through big data. For example, businesses could use big data to create highly specific market segmentations and then tailor products and services to meet those needs. While not a new practice, big data can be used to tailor marketing and advertising. Analytics involving sophisticated algorithms can improve decision-making, including inventory management and pricing. Use and analysis of data is already allowing companies to outcompete their competitors and to innovate in new ways.

Cloud computing, includes applications, platforms and infrastructure, serves as another example of a market opportunity within this cluster. “The worldwide cloud computing market will grow at a 36% compound annual growth rate (CAGR) through 2016, reaching a market size of \$19.5B by 2016”.<sup>22</sup> Enterprises, large and small, are adopting cloud solutions at a faster pace. Software-as-a-Service (SaaS) is proliferating over the traditional model of software packages.

Network and computer security are another area of expertise for the University of Illinois and an example of the strength of the cluster. Network and computer security take physical and software preventative measures to protect networking and computer infrastructure from unauthorized access, misuse, malfunction, modification, destruction, or improper disclosure. Companies and government continue to expand the technologies they use to perform critical functions in a secure environment. According to Gartner, “...the worldwide security technology and services market is forecast to reach \$67.2 billion in 2013, up 8.7 percent from \$61.8 billion in 2012. The market is expected to grow to more than \$86 billion in 2016.”<sup>23</sup> Furthermore, Gartner anticipates three main trends that will shape the security market in the future: mobile security, big data and

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<sup>21</sup> Manyika, James, Michael Chui, Brad Brown, Jacques Bughin, Richard Dobbs, Charles Roxburgh, and Angela Hung Byers. “Big data: The next frontier for innovation, competition, and productivity.” Report by McKinsey Global Institute. May 2011.

<sup>22</sup> Columbus, Louis. “Predicting Enterprise Cloud Computing Growth,” *Forbes*. <http://www.forbes.com/sites/louiscolombus/2013/09/04/predicting-enterprise-cloud-computing-growth/> 04 September 2013. Accessed October 25, 2013.

<sup>23</sup> “Gartner Says Worldwide Security Market to Grow 8.7 Percent in 2013,” Gartner Security and Risk Management Summit 2013. <http://www.gartner.com/newsroom/id/2512215> Accessed October 25, 2013.

advanced targeted attacks. Analytics is an important component of network security, and points to an area of opportunity for Illinois in this cluster. All of these—cloud computing, computer and network security—are just a few examples of the sub-sectors in this cluster that offer clear market opportunities that can spur the growth of the cluster.

Assets already exist that will benefit the continued growth of this cluster, from the university research and faculty to the programs designed to commercialize technology and support the start-up and early growth of data analytics and management and computing businesses. The NCSA is a significant asset, as well as the other research institutes cited. The presence of leading corporations conducting collaborative, innovation projects with faculty and students is an important innovation asset. Connections to a larger, statewide network of companies through the Illinois Technology Association are also valuable. In addition, the UC2B broadband initiative by the City of Champaign is an infrastructure asset that could be leveraged by businesses by providing lower cost broadband capacity. These assets form the foundation for the cluster.

Another element that makes the data analytics and management and computing cluster a strong one for economic development in Champaign-Urbana is the level of business activity in the sector. For a community of its small size, activity among entrepreneurs starting companies and commercializing technology is quite significant. The number of corporations choosing to place a specialized research operation centered on data in the Research Park is important. Some examples of the business activity--on and off campus--include video collaboration company Personify, data analytics company Infobright, big data storage and analysis company HDF Group, network company Riverbed, game developer Volition (Koch Media), software provider Amdocs, and software company Wolfram Alpha. A critical mass exists to create a foundation for growth, but it must be grown over time. The biggest hurdle will be growing and retaining these businesses without the necessary business management talent available.

The critical mass of assets, talent, innovation, and activity form a foundation for cluster growth. It will require addressing the challenges noted in order to grow beyond the current level of activity. To achieve this will require proactive leadership, a clear strategy, and community support.

Community support, as evidenced by the overwhelming choice of big data and analytics during the stakeholder interviews, is clear. Support for computing and the various opportunities that fall under this umbrella category is evident, as well. Leadership will be required to leverage the community support and move the effort forward. At this point, the university, under its economic development mission, is beginning to take the lead and has pulled together an Advisory Group of business and campus leaders.

One final, and important factor, is the differentiation and positioning of the cluster. Competition is a factor whether it is competition among companies and where they choose to locate and grow, or among universities and the reputations that they develop

over time. Therefore, when selecting the name for a particular cluster, consideration must be given to differentiation and positioning. In particular, the name helps to distinguish one community or university's efforts from another's. While they may certainly overlap, the choice of a name and key sub-sectors help to set a community or university apart from another community or set of peers. In this case, the focus is on Illinois' world-class areas of expertise: data analytics and management. Most of the peer communities (Ann Arbor, Madison, and Chapel Hill) do not have expertise in these particular fields. At the same time, the broader label of computing helps to capture a wide array of research activities and company activity including enterprise software, trusted computing, cloud computing, open source, and other new technologies that will develop over time. The focus on data analysis and management and computing will help the university and community to create a brand that would be recognized by others and help to attract businesses and expertise to the community.

A number of the critical best practices factors and essential elements to support economic development are already present in the data analytics and management and computing cluster in Champaign-Urbana and form a strong foundation. Collaboration occurs across the university, and between the university and industry. The availability of seed capital is good given the community's size. The technical expertise and talent needed to develop new inventions and build products is evident. Innovation occurs at the university and in companies locally. Commercialization results on its own and with support from a number of programs in the entrepreneurial ecosystem. The market and demand for solutions in data analytics and management and computer are increasing and growth is expected to continue over the next several years. Key assets are present and business activity from entrepreneurship to corporate innovation centers is happening in Champaign-Urbana. The elements coalesce to form a critical mass that can be leveraged for success.

Challenges must be overcome to achieve success over time. The key ones are insufficient investment capital beyond the seed stage and lack of managers with experience and business skills. Both challenges will restrict the size and maturity of the companies in Champaign-Urbana. They cannot grow beyond early stage with the necessary capital and business skills. In addition, more mature companies in the data analytics and management and computing cluster will be less likely to choose to locate in Champaign-Urbana if management, marketing and sales skills are not available. Companies may continue to bring more limited, technical and innovation functions—as they do now—to the community, but more significant business operations will be located elsewhere. To meet the challenges and begin to solve the issues will require a proactive effort by leadership working closely with key stakeholders, both public and private sector.

### **3.5 Cluster: Biomedical and Bioengineering**

BCD recommends a cluster focus on biomedical and bioengineering due to the significant amount of research, commercialization, start-up activity and collaboration between the university and the private sector that has developed in these fields.

Notably, both build upon the engineering strengths of the University of Illinois. However, to scale the cluster will require additional assets and support. An assessment of the cluster assets and opportunities, as well as the challenges, is reviewed using the two-lenses framework.

The terms, biomedical and bioengineering, are sometimes used interchangeably, but in this case are intended to include a broad spectrum of the research currently conducted at the University of Illinois as well as future work that would occur if additional assets were created (as described later in this section). Bioengineering, as defined by the University of Illinois, is combining “the analytical and experimental methods of the engineering profession with the biological and medical sciences to achieve a more detailed understanding of biological phenomena and to develop new techniques and devices.”<sup>24</sup> Research extends across six colleges including the College of Engineering; College of Agriculture, Consumer, and Environmental Sciences; and College of Liberal Arts and Sciences. Bioengineering research involves more than 50 faculty members conducting interdisciplinary research, and includes bioimaging, computational genetics and bioinformatics, tissue engineering and new materials, sensors and optics, and animal sciences and animal models.

Biomedical includes medical devices, instruments and diagnostics, as well as innovative devices such as artificial limbs and organs, imaging, and advanced prosthetics, in addition to therapeutics, research tools and enabling systems. It may include electromedical apparatuses, analytical laboratory instruments, and surgical and medical instruments. Nanotech devices, which draw upon expertise in material science expertise, fall in this category, as well. One unique area of expertise at Illinois, assistive technology, which draws upon the capabilities of mechanical engineering, would also be a focus.

In many ways, bioengineering and biomedical intersect with Illinois’ world-class engineering expertise and capabilities. In particular, computational genetics and bioinformatics leverage data analytics and management know-how, creating an opportunity for Illinois to lead in the field and distinguish it from other universities and communities. Several of the sub-areas—such as medical devices, new materials and sensors--also intersect with engineering and, therefore, create opportunities to leverage one of the university’s key research strengths and expertise.

Attracting more research funding and partnerships in bioengineering and biomedical has been limited by the lack of a full-scale medical school and academic hospital. Currently, the Medical Scholars Program at the University of Illinois is an MD/PhD program. The program has approximately 150 MD/JD and MD/PhD students. It has the largest cadre of academic MD/PhD students in the U.S. who are pursuing MD/PhDs in the Social Sciences and Humanities. Students pursue graduate study and then add the MD courses in later years. To grow the cluster--increasing research opportunities in the cluster, attracting faculty expertise, providing facilities and resources of a size

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<sup>24</sup> “University of Illinois, Department of Bioengineering, About Us,” <http://bioengineering.illinois.edu/about-us>. Accessed October 23, 2013.

necessary for clinical trials and product testing, increasing corporate sponsored research by biotechnology and life science companies, and attracting more mature biotechnology companies to locate in the community--will require the resources of a full-scale medical program and academic hospital. A significant number of stakeholders pointed to this issue and indicated an interest in exploring the development of a full-scale medical school and academic hospital. It is recognized as a significant asset that would impact the development of the cluster.

Collaboration in biomedical and bioengineering occurs at university research institutes and with partners such as Carle Hospital and the Mayo Clinic. The research institutes on campus include the Beckman Institute for Advanced Science and Technology, which has particular expertise in imaging science and technology; the Institute for Genomic Biology, which conducts research in systems biology, cellular and metabolic engineering, and genome technology; and the Abbott Center for Nutrition, Learning, and Memory, which studies nutrition's impact on brain cognition. The Micro and Nanotechnology Laboratory in the College of Engineering and the Frederick Seitz Materials Research Laboratory also foster multi-disciplinary research that will benefit the bioengineering and biomedical cluster. In addition, the University of Illinois' Division of Animal Resources is a resource for use of animals in laboratory research.

Illinois has been Carle's research collaboration partner for some time. The Research Institute at Carle supports clinical trials, investigator initiated research, nursing research, resident research, and translational research. Carle has recently launched the Carle Tissue Repository, which allows patients to donate tissue for research, and the Biomedical Research Center, which is a partnership with the University of Illinois on joint research. While Carle has provided opportunities for collaboration, the hospital is not academic in focus, is limited in size, and lacks a patient pool sufficient for most clinical trials.

For the past four years, the University of Illinois has had a relationship with the Mayo Clinic focused on research in computational genomics. Currently, 40 Illinois faculty are actively working with the Mayo Clinic's Center for Individualized Medicine. Some of the work uses the NCSA to process genetics data. The Mayo Clinic relationship is an example of the collaborative research relationships between Illinois and private and public organizations.

Investment capital, as described previously, is available at the seed stage, but insufficient at the growth stage. All of the local seed funds, Illinois Ventures, Serra Capital, and Open Prairie Ventures, invest in life science companies. Biotechnology companies in EnterpriseWorks have obtained more than \$267 million in investment capital, including equity funding and SBIR. Yet companies like Vanquish Oncology will continue to be lured away in order to obtain investment capital for growth.

In terms of skills and abilities, faculty and graduate students have technical talent in bioengineering and biomedical fields, as evidenced by the amount of disclosures, patents and research. The bioengineering department is expected to double in size over

the next three to four years, with the addition of 30 faculty members. If an academic medical hospital were created, it would increase the skills sets in these fields and the number of trained individuals. In addition, Parkland College can play a role in training nursing and allied health professionals for the hospital. However, the community's shortage of regulatory and compliance expertise will have an impact. As with the data and computing cluster, the lack of business management expertise will also limit the growth and expansion of bioengineering and biomedical companies in Champaign-Urbana. Growth will require additional technical skills and a significant expansion in the number of experienced business managers.

Innovation is already occurring as proven by the number of disclosures, patents and start-ups in biomedical and bioengineering. 14 biotechnology start-ups at EnterpriseWorks have received investment and/or SBIR funding. Currently, 14 biotechnology companies reside at EnterpriseWorks and the Research Park. Some examples of current clients and graduates include: Glucosentient, founded by a chemistry professor, which has developed a technology that transforms the personal glucose meter into a device that is capable of quantitatively and conveniently detecting non-glucose targets; IntelliWheels, which has created a patent-pending technology for geared wheels for manual wheelchairs designed to make pushing a wheelchair easier; Aptimmune Biologics, founded by a professor in the Department of Veterinary Pathobiology, is developing the Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) vaccine for swine based upon on a proprietary cell line; Vanquish Oncology, which targets molecular defects in specific cancer cells to create personalized oncological therapeutics for unmet or underserved cancer markets; and ICyt, developed by a faculty member and later acquired by Sony (and still located in the Research Park), which manufactures the Reflection droplet cell-sorting instrument using Highly Automated Parallel Sorting (HAPS) modules as an affordable solution for most flow cytometry, cell counting and particle sizing applications. The amount and scale of innovation by faculty and entrepreneurs in Champaign-Urbana is especially notable given that the university does not have a full-scale medical school and an academic hospital.

The market for bioengineering and biomedical innovations and products continues to increase as new technology developments aid with disease detection and treatment, a growing percentage of the population ages, and the amount of medical treatment centers grows. To begin to get an idea of the market potential, which encompasses a broad range of sub-sectors and markets, necessitates a look at a few key sub-sectors that are aligned with the expertise at the University of Illinois.

Computational biology, which draws upon Illinois' deep expertise in big data, continues to see market growth due to its increased role in improving the success rates for drug discovery, reducing research and development costs, and growing research in personalized medicine. "...[I]n 2013, the global computational biology market was

valued at USD 760 million and is expected to grow at a CAGR [Compound Annual Growth Rate] of 21.3% from 2012 to 2018...<sup>25</sup>

Personalized medicine relies upon tremendous amounts of data and analysis of the data. It is already the focus of Illinois' work with the Mayo Clinic, and clearly draws upon Illinois' area of expertise. According to the Harvard Medical School, personalized medicine is defined as "the ability to determine an individual's unique molecular characteristics and to use those genetic distinctions to diagnose more finely an individual's disease, select treatments that increase the chances of a successful outcome and reduce possible adverse reactions...[It] is also the ability to predict an individual's susceptibility to diseases..." It is dependent upon electronic medical records, personalized genomic data for clinical use, and decision support tools for physicians, and has significant implications for patient care and treatment. The growth of this approach creates substantial opportunities for Illinois and for the cluster.

Bioimaging is a field in which Illinois has made significant advances since its advent, and the university has specialized facilities. The fast growth in the bioimaging market, for example, is due to technological innovations, an increase in the number of diagnostic centers, and an aging population. Advances in imaging equipment are improving disease detection, health monitoring, and surgical procedures. Additionally, portability of equipment improves accessibility. The use of radiopharmaceuticals will increase demand. The global market for bioimaging technologies is projected to reach \$37.4 billion by 2017.<sup>26</sup>

Tissue engineering is creating new ways of treating a range of medical diseases from Parkinson's to cardiovascular conditions. Tissue engineering is a multidisciplinary field that involves biology, medicine, and engineering, and has both therapeutic and diagnostic applications. Illinois holds several patents in this field. Tissue engineering is defined as the use of a combination of cells, engineering and materials methods, and suitable biochemical and physio-chemical factors to improve or replace biological functions.<sup>27</sup> This market is expected to grow 2.5 times its 2012 value by 2018.<sup>28</sup> Tissue engineering and the other sub-sector examples provided serve as illustrations of the technological advances and market growth that will help to drive the cluster.

It is clear that growing the biomedical and bioengineering cluster in Champaign-Urbana will be driven by technological developments at Illinois and creation of the necessary

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<sup>25</sup> "Computational Biology Market – New Market Research Report Pulished by Transparency Market Research," <http://www.prweb.com/releases/2013/5/prweb10731089.htm> 14 March 2013.

<sup>26</sup> "Global Biomimaging Technologies Market to Reach US\$37.4 Billion by 2017, According to a New Report by Global Industry Analysts, Inc." [http://www.prweb.com/releases/bioimaging\\_technologies/medical\\_bioimaging/prweb8857230.htm](http://www.prweb.com/releases/bioimaging_technologies/medical_bioimaging/prweb8857230.htm) 10 October 2011. Accessed October 24, 2013.

<sup>27</sup> Tissue engineering, [http://en.wikipedia.org/wiki/Tissue\\_engineering](http://en.wikipedia.org/wiki/Tissue_engineering). 20 October 2013. Accessed October 24, 2013.

<sup>28</sup> "Market Research Forecast Tissue Engineering Market at \$11 Billion by 2012." <http://finance.yahoo.com/news/market-research-forecast-tissue-engineering-133900886.html> 5 March 2012. Accessed October 24, 2013.

assets for expansion. Currently, the largest concentration of non-farm private employment in the Champaign-Urbana MSA is healthcare and social assistance that employs 14.5% of the population.<sup>29</sup> However, these positions are, for the most part, delivering services to patients. To grow the cluster will require a transition to healthcare product discoveries and commercialization, nurturing the growth of early stage product development companies, and attracting more mature companies who will collaborate on research with Illinois and other companies locally.

Currently, a set of assets exists in the community that has helped to create a foundation for cluster growth. The University of Illinois has developed a rather extensive list of patents, commercialization activity, and start-ups in bioengineering and biomedical. The most significant assets present in the community are the research and knowledge at Illinois (and, in particular, the bioengineering and biomedical research that creates collaborations with engineering, big data and computing), the interdisciplinary research institutes focused on this field (Beckman, Institute for Genomics, and Abbott), the relationship with the Mayo Clinic, the collaborative research with Carle Hospital, the MD/PhD program, and the programs such as EnterpriseWorks which support commercialization and start-up.

Statewide assets also help to grow bioengineering and biomedical companies in Champaign-Urbana. iBio's PROPEL provides early stage companies with access to specialized resources and expertise in the life science sector, and the Chicago Innovation Mentors provides mentor teams—many with life science experience--to assist with technology commercialization and entrepreneurship. The University of Illinois at Urbana partners with both of these programs.

However, without the presence of an asset like a more expanded medical school and an academic hospital with additional research capacity, the cluster growth will be much more restricted. Carle and the University of Illinois currently collaborate on a number of research projects, but Carle lacks the capacity and academic affiliation to increase those efforts. Start-ups need local hospital facilities to test their products, or they take those efforts (and, many times, their entire business) outside the region and state. Fortune 500 companies, including pharmaceutical companies and healthcare companies, are less likely to develop relationships and sponsor research at the university, as they do with data analytics.

University faculty have been successful in attracting funding from the National Institutes of Health (NIH), but are limited without a full-scale medical school and academic hospital which would offer a larger patient pool, expanded laboratories, and increased medical expertise. NIH is one of the largest sources of research funding among the federal agencies, with a budget of more than \$30.9 billion annually for medical research. 54% of all NIH research awards are made to medical schools annually; only 27% of the awards are made to higher education institutions. Illinois currently receives \$71 million in NIH funding and Champaign-Urbana ranks number 63 of all U.S. cities.

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<sup>29</sup> Champaign County Regional Planning Commission, "Regional Condition of Employment & Economic Climate: A Comparative Analysis of 12 Metropolitan Statistical Areas", October 2011, pg. 12.

Based upon the stakeholder interviews, widespread support exists for the creation of an academic medical center and expanded medical school. The need for this type of an asset was raised independently during a number of the interviews. It is viewed as a job creator, for both skilled and unskilled positions. It was also identified as a potential asset that could help to address some of the trailing spouse issues by offering more high-skilled positions in the life sciences. It would contribute to the overall quality of healthcare in the region.

At this time, some early, high-level discussions are occurring within the university regarding the idea of creating an expanded medical school and academic hospital. The medical school would be small and focus on leveraging Illinois' strengths in engineering. The goal would be increasing opportunities for research and collaboration, including expanded research relationships with Carle.

Nevertheless, the decision on the creation of an academic hospital and full-scale medical school would be made based upon a number of factors and conditions beyond the scope of this report, but the point here is to recognize that this type of an asset is important to grow this cluster. It would provide the resources and facilities to enable expanded research; help to attract faculty expertise and students who could assist with research; encourage corporate-sponsored research into new technological developments; create opportunities for the testing of devices and clinical trials by early stage companies; help to retain bioengineering and biomedical companies as they grow; and aid in attracting bioengineering and biomedical companies to locate in the community. It would contribute to the overall economic vitality of the community. Without it, the cluster cannot move beyond a small scale.

A thriving cluster has businesses ranging from start-up to growth stage to more mature. It includes businesses launched and grown locally, as well as companies attracted from outside to locate in the community. It increases the opportunities for collaboration and employment.

At one end, the start-up activity is significant given the small size of the community (and even impressive despite the lack of a full-scale medical school and academic hospital). A track record of companies launched with products based upon university research has been established. A few examples include Immuvon, Aptimmune Biologics, PhiOptics, Diagnostic Photonics, Accelerated Genomics, Glucosentient, and Intelliwheels. Start-ups receive support and guidance from several programs.

However, fewer growth-stage and more mature biomedical and bioengineering businesses operate in Champaign-Urbana, which can be attributed to insufficient support and assets. One example is iCyt, which was developed by a faculty member and later acquired by Sony (and still remains in the Research Park) iCyt's droplet cell-sorting instrument is currently used by major research institutions and hospitals. ISS Inc., another example, develops biomedical, fluorescence, and microscopy instrumentation. Acoustic Medical Systems designs ultrasound and radiation therapy

systems and instrumentation for treatment of localized diseases. Mc10, founded by Materials Science Professor John Roberts, invented stretchable, wearable circuits that are used for diagnosis and remote health monitoring. The expertise, research and testing opportunities found at an academic medical center and hospital would be required to grow and attract businesses. Without this type of an asset, the range of bioengineering and biomedical companies in Champaign-Urbana will be more concentrated in early stage, with much fewer growth and mature stage firms.

Yet, Champaign-Urbana has a foundation for the required critical mass. The University of Illinois conducts a significant amount of research in the field, and clear examples of commercialized research and innovation are exhibited in local start-ups. Technical expertise is available. More resources will be required to build upon this foundation.

Community support is demonstrated for this cluster, as many of the stakeholders believe room exists for significant growth and economic opportunity. University leadership has expressed a clear interest in growing the cluster proactively and exploring the dedication of additional resources towards it, as evidenced throughout the consulting project. Carle would be an important partner in helping to move this forward. The Advisory Group convened by Illinois will help to bring together business leaders for this type of an effort.

To differentiate, the cluster designation focuses on bioengineering and biomedical, instead of the broader biotechnology term. In particular, the intersection of data analytics/management and engineering with medical is designed to leverage Illinois' strong expertise as applied to medicine. In particular, computational genetics and bioinformatics leverage data analytics and management know-how, creating an opportunity for Illinois to lead in the field and distinguish it from its peer universities and communities.

In conclusion, when bioengineering and biomedical are viewed through the two lenses framework, the foundation for cluster growth is apparent. Already, the cluster has grown rather significantly despite a full-scale medical school and academic hospital. Research, the number of patents, and start-up activity are significant. A clear market opportunity exists. The community is supportive of this cluster, and leadership is present that can move this approach forward. But growth will call for more technical expertise in bioengineering and biomedical and regulatory and compliance issues, along with the need for skilled and experienced business managers. It will require more investment capital availability, and a greater number of companies throughout the lifecycle. Collaboration and the formation of networks among companies locally will be important as the number of companies in the cluster grows. If a significant asset like an expanded medical school and academic hospital are created, it would serve as a magnet, attracting more talent, research (and funding), and more mature companies.

### 3.6 Cluster: Energy

While a more nascent opportunity than the other two recommended clusters, energy would provide some immediate opportunities for growth that capitalize upon university research, enable further collaboration across several colleges, launch more start-ups, and leverage market growth opportunities. The market, domestically and globally, is growing as new energy solutions, particularly those that are “clean,” are sought to meet growing global demand. Several stakeholders pointed to the opportunities in energy as a sector for the university and Champaign-Urbana. It will not require the establishment of a significant asset (medical school and hospital) which would take years to develop, and therefore, can be acted upon more quickly. Additionally, a focus on energy helps with diversification by adding a third, less-established cluster, while simultaneously growing the more established data and bioengineering/biomedical clusters.

Energy expertise at Illinois includes biofuels, energy storage, smart grid, and renewable energy, especially solar and wind. The cluster is defined more broadly as energy in order to capture other sub-sectors that may develop as the industry grows.

Biofuels are produced from living organisms or metabolic by-products. To be considered biofuels, they must contain over 80 percent renewable materials. Generally, biofuels use chemical reactions, fermentation, and heat to break down starches, sugars and other molecules in plants. The fuel is produced from the products leftover from these processes. Biofuels research at Illinois includes new feedstocks, plant genetics, and fermentation.

Energy storage is an important and growing industry as demand for energy fluctuates throughout the day, while the amount of electricity that is generated is relatively fixed throughout the day. Renewal energy sources, such as wind and solar, do not produce a steady stream of power and therefore require energy storage capabilities. As a result, technology that will solve the problem of storage is important to meeting electricity demand. Storage technologies include batteries, flywheels, electrochemical capacitors, superconducting magnetic energy storage, power electronics, and control systems. Advanced materials research is utilized for energy storage and solar photovoltaic (PV) technologies.

Smart grid uses computer-based remote control and automation in utility electricity delivery systems. It connects devices to the grid, providing two-way digital communication. Sensors on the devices gather data, enabling control of the grid by the utility.

A connection exists between energy and big data, which will enable the University of Illinois to leverage its core expertise. Energy efficiency and smart grid utilize data to create more reliable and cost effective energy transmission and use. Big data also enables new ways to manage energy in buildings. In its 2013 Clean Energy Trends report, Clean Edge points to the use of big data and smart devices as driving new

opportunities for companies of all sizes in energy management and efficiency. For example, C3 Energy, founded by Thomas Siebel, "...epitomizes Big Data in the building efficiency sector. C3's software-as-a service aggregates and analyzes millions of energy-use data points for use by residences, small and large businesses, and especially utilities."<sup>30</sup> Data can drive energy efficiency at the utility and building levels.

As in the case of the other recommended clusters, energy research is interdisciplinary and collaborative. It involves the College of Engineering, College of Liberal Arts and Sciences, and the College of Agriculture, Consumer and Environmental Sciences. Faculty and students from the materials science, chemistry, electrical and computer engineering, crop sciences, and other departments have invented energy-related technologies. The Energy Biosciences Institute, which is part of the Institute for Genomic Biology, is dedicated to bioenergy research and funded by BP. It is a collaboration between the University of Illinois, the University of California Berkeley, and Lawrence Berkeley National Laboratory. The ADM Bioenergy Modeling Center employs students to perform computational work, conceptual engineering, and modeling in biofuels. The Trustworthy Cyber Security Infrastructure for the Power Grid (TCIPG) at the Information Trust Institute focuses on power grid cyber security, and is funded by the U.S. Department of Homeland Security and the U.S. Department of Energy. In addition, the University of Illinois has teamed with Argonne National Laboratory, four universities, and four national labs on a U.S. Department of Energy funded research institute focused on battery technology called the Joint Center on Energy Storage. These types of university and industry collaborations provide a good foundation for the cluster. To increase collaboration will require attracting more partnerships with industry.

Capital is available locally for seed stage companies, but not for the growth and later stages, as such for the other two clusters. Twelve cleantech companies in EnterpriseWorks have received \$293.8 million in funding from angels, VCs, corporate partners, and SBIR. While not all of these companies are designated as energy companies, it is an indication of the funding available and the ability of start-ups to obtain funding. Increased capital and sources for later stages must be developed to help retain and scale energy start-ups.

Another important factor for scaling companies and growing the cluster is skilled and experienced talent. As true for the other recommended clusters, technical skills are available, but management and business skills, necessary for company growth are difficult to find.

Innovation in energy is already occurring at the University of Illinois. Innovation, as with the other clusters, occurs through university research, commercialization of the research, and launching of start-ups. University-based programs help to facilitate the process. Current EnterpriseWorks clients and graduates, which serve as examples of commercialized energy technology at Illinois, include Xerion Advanced Battery

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<sup>30</sup> Pernick, Ron, Clint Wilder and Trevor Winnie, "Clean Energy Trends 2013," Clean Edge. March 2013, pg. 8.

Corporation in which a Materials Science professor developed advanced battery cells for use in military and consumer electronic applications that increase the speed of charging; Dioxide Materials, which has technology to use low cost sensors to reduce energy use in building HVAC systems; Solarbridge, in which Electrical and Computing Engineering department faculty developed a module-integrated microinverter for the solar industry to make rooftop solar simpler, more cost-efficient and reliable; and Network Perception, in which a professor at the Information Trust Institute commercialized a tool to provide in-depth security analysis capabilities for utilities. The most successful example is Semprius, founded at EnterpriseWorks by Materials Science Engineering Professor John Rogers, developed high-efficiency PVs and raised \$60 million in venture capital.

Next, turning to market opportunities for growth, a few sub-sectors in which Illinois has expertise serve as examples. The increased interest and demand for biofuels results from the rise in oil prices, concerns about global warming, and needs for energy independence. According to Clean Edge, "Biofuels (global production and wholesale pricing of ethanol and biodiesel) reached \$95.2 billion in 2012, up from \$83.0 billion the previous year, and are projected to grow to \$177.7 billion by 2022...Market size growth over the next decade is expected to be driven by added production, but also by modest price increases."<sup>31</sup>

The global energy storage market is driven by the continued development of smart grid infrastructure, growing energy demand globally, technological advancements, and increased government funding. "In 2011, the global market for energy storage was evaluated at above USD 39.5 billion...By 2016, the world energy storage market is predicted to grow at a CARG (compound annual rate of growth) of over 9% to amount to almost USD 62 billion."<sup>32</sup>

The global smart grid market, according to an August 2013 report by GTM Research, is projected to grow at an average compound growth rate of more than 8 percent from 2013 through 2020. By 2020 the global smart grid market is expected to surpass \$400 billion.<sup>33</sup> The application and implementation of smart grid technologies is expanding to Europe, Asia, China and Latin America.

Renewable energy has seen growth as alternatives to fossil fuels are sought and costs have risen. While the market for solar PV has slowed as the price has dropped, global interest in wind technology has increased. "Wind power (new installation capital costs) is projected to grow from \$73.8 billion in 2012, up from \$71.5 billion the previous year, to \$124.7 billion in 2022."<sup>34</sup> Overall, market-driven alternatives will be sought in the energy field and provide opportunities for Illinois.

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<sup>31</sup> "Clean Energy Trends 2013,"pg. 3.

<sup>32</sup> "Energy Storage Market Reviewed & Forecast by GBI Research in Cutting-Edge Report Available at MarketPublishers.com," <http://www.prweb.com/releases/2013/4/prweb10619782.htm> 10 April 2013. Accessed October 25, 2013.

<sup>33</sup> Greentech Media, <http://www.greentechmedia.com/articles/read/smart-grid-market-to-surpass-400-billion-worldwide-by-2020>. 13 August 2013. Accessed October 25, 2013.

<sup>34</sup> "Clean Energy Tech Trends 2014", pg. 3.

Like the other recommended sectors, research assets exist, from institutes to expertise and commercialization support. Assets for testing and demonstration of energy technology are necessary to help entrepreneurs obtain their first customers. The university campus could serve as a testbed, from deploying biofuels in the fleet to installing energy efficiency devices or energy management systems in buildings.

Business activity in the energy cluster is mostly limited to start-ups, given the nascent nature of the cluster in Champaign-Urbana. Several of these companies were mentioned earlier. An example of a more established company that was launched by a professor conducting research in power and energy systems is Power World, which continues to operate in Champaign. Other companies in the region are Prairie Gold, which creates bioproducts for ethanol producers, and Tetravitae Bioscience, a developer of renewal chemical, which was recently acquired by Eastman Renewable Materials. In addition, wind power company Invenergy operates wind farms in East Central Illinois, and MUTI, which sells and installs wind turbines, has its corporate headquarters in Champaign. Growth and retention of the companies will need to be a focus, as well as attraction of more mature companies to collaborate with them. As the number of companies grow, fostering networks among the companies is important.

The combination of research and knowledge, commercialization of technology, and start-up activity starts to form a critical mass for energy cluster development. Support for energy companies is available through the various support organizations in the entrepreneurial ecosystem, in addition to mentoring and connections through the Chicago-based Clean Energy Trust. Again, this sector is in an earlier stage than the other two recommended clusters, but nevertheless opportunities exist.

A number of stakeholders expressed support for a focus on energy and cited the activity already occurring. A focus on energy, in addition, is aligned with the University of Illinois' recently released Strategic Plan. Energy and Environment are one of the six themes in the Strategic Plan, and the development of the Institute for Sustainability, Energy and the Environment is identified as a goal. As such, community support and leadership are already present.

Energy, when reviewed through the framework, is another promising cluster for the University of Illinois and Champaign-Urbana. While not as established as the other two clusters, significant university research and expertise exists, collaboration occurs across several academic disciplines, several start-ups have launched from technology spun out of the university, and a number of stakeholders identified energy as an emerging opportunity. The opportunities for increasing the number of industry collaborations and funded research are present. The global and national markets for energy solutions continue to grow. Developing technologies that leverage data analysis and management is one important avenue to fuel the growth of this cluster. Like the other clusters, more investment capital and individuals with business management experience will be necessary for this cluster. Associated with the capital and talent issues, fostering the growth and retention of start-ups in order to increase the number of

growth and mature companies will be required. As the number of companies grows and the level of business activity increases, networks should be established among companies. Clearly, this cluster is still nascent as compared to the other two recommended clusters, but has the elements to build upon for growth.

## 4.0 Summary of Conclusions

BCD recommends a focus on three clusters for the University of Illinois and Champaign-Urbana: (1) data analysis and management, and computing; (2) bioengineering and biomedical; and (3) energy. Together, innovation, commercialization, company start-up, and technical skills and expertise create the basis for each of the clusters. The community has six key assets already in place: the university, the technical talent pool, the hospital, the entrepreneurial ecosystem which supports commercialization and company start-up, the Research Park and corporate relationships, and the culture of entrepreneurship on the campus. Illinois is a recognized leader in the field of data analysis and management (“big data”). Illinois already leverages its engineering expertise in bioengineering and biomedical discoveries and inventions. Focusing on data and bioengineering/biomedical will also help to differentiate the University of Illinois and Champaign-Urbana from its peer universities and communities. To build from this point will require leadership and a strategy that builds upon the strengths, creates additional assets and resources, and addresses the challenges that will affect cluster development.

Every cluster in every community faces challenges that can hinder its development. For Champaign-Urbana the key challenges overall are investment capital for growth stage companies; the shortage of mid-level and senior-level business managers, including sales and marketing professionals; the retention of growing technology companies, specifically those started locally; and the attraction of more mature technology companies. An additional challenge is access, specifically limited air service to the local airport. More trained technical talent will also be required as the clusters grow. Specialized support for data, bioengineering and biomedical, and energy must be added to the services offered in the ecosystem. Then, as the clusters grow, interconnectedness among the business and assets in the clusters should be fostered.

To grow the bioengineering and biomedical cluster will also require the addition of an important asset, a full-scale medical school and academic hospital, which would create new research and funding opportunities as well as attract and train skilled professionals. Without this asset, the community will continue to struggle to retain early stage bioengineering and biomedical companies as they will seek capital and test facilities outside the region and state. The amount of technical talent in this field will also be limited. Early discussions on the possibility of creating this asset are already underway.

The community recognizes the challenges, but all three clusters have clear community support, as evidenced in the stakeholder interviews. Continuity of leadership, and a coordinated effort between the university, business and community leaders will be required to move forward. The University of Illinois’ Economic Development Advisory Group is a step in this direction, but inclusion of key city leaders and technology business leaders is important.

In summary, all three clusters have strong foundations that, with the right strategy, can create economic benefits for the university and the community. Over time, they can spur

new business activity and attract talent that can contribute to a vibrant community. Recommendations on some ideas for approaches and programs that would help to move the clusters forward are provided in the next section, and are designed to start a dialogue on potential strategies for cluster development.

## 5.0 Recommendations

Each of the recommendations described in this section addresses a particular challenge or gap, as identified in the report, that is directly and significantly affecting cluster development. The bullet points under each of the recommendations are ideas proposed to spur discussion on how to best create an environment that will support cluster growth and economic development. They balance both shorter term and longer term solutions. Some may be relatively easy steps to take, e.g. reallocation of resources and leveraging of existing resources. Others may require changes to structure and policies, or development of new resources to support new programs. No single recommendation can adequately address the challenges; instead a number of approaches must be taken in order to create an environment in which the clusters will thrive.

Support for the clusters must occur both in the university and the community. Outreach to the community and inclusiveness is important. Programs and services for cluster businesses should be available to businesses that have university connections and those without. Leadership should be a public and private sector partnership in order to be most effective. Working together, the local economy can be strengthened.

Clearly, a vibrant community plays an important role in building clusters. Without it, the attraction and retention of businesses and employees would be difficult. The recommendations help to address the issue, but it will require consistent efforts over time and economic development initiatives (e.g. downtown redevelopment, quality of life, housing, education, etc.) that extend beyond this report.

In terms of process, a strategy and plan typical follow this type of report. The strategy and plan outline the specific approaches and actions to take to work toward growing the recommended clusters. It would describe the specifics of programs and steps for implementation.

### **(1) Foster Interconnectedness and Enhance Collaboration**

The power and value of clusters is the interconnectedness between businesses and the assets, and the collaboration that occurs among them. While collaboration occurs within the University of Illinois at its research institutes and among faculty, connections between the university and technology businesses located in Champaign-Urbana (that are not connected to the university) are not present. In addition, formal networks do not exist that help to connect the businesses and the assets, and facilitate working relationships and possible innovations.

- ***Convene cluster roundtables and events.*** These gatherings create opportunities to discuss shared issues and plan actions to tackle issues affecting businesses in the cluster. In particular, CEO roundtables for each cluster build relationships among business leaders in each cluster. For example, if the bioengineering and biomedical group identifies recruitment as an issue, they could decide to make a joint recruitment trip to Chicago to pool their efforts in

attracting talent. Another example is visiting corporate investors together to demonstrate the multiple opportunities for corporate investment in the data analysis and management sector in Champaign-Urbana. Also, biomedical businesses can help one another to understand the clinical trials process, and perhaps arrange a joint trip to the FDA to better understand the process and issues. Moreover, members of these groups share contacts and make referrals. For the past several years at Purdue University's business incubator, companies in the same industry choose to get together to discuss common issues and share information. Gatherings are organized and facilitated by incubator staff. Current cluster gatherings include life sciences, defense and software. On a regional scale, Nortech in the Cleveland area convenes cluster meetings for its members. Roundtables and events not only provide the value of collaboration and shared ideas and resources, but also aid marketing and attraction as cluster businesses join together to promote the cluster and attract other businesses and resources.

- ***Conduct specific outreach by the University of Illinois to technology businesses in the community.*** Connections should be forged across all business—university and non-university connected—throughout each cluster. Invite technology businesses without a university connection to participate in events and networks, and connect them to faculty and research at the university and to corporate partners. Be inclusive in programs for cluster businesses.
- ***Increase interaction between corporate sponsored research partners and technology companies, and in particular, use coworking as a tool to foster informal collaborations.*** Technology companies can benefit from introductions to corporations that sponsor research at the University of Illinois, which may lead to identifying projects for collaboration or joint venture opportunities. Coworking space, in particular, can be a vehicle for connections. Coworking is a shared work environment and a community of often entrepreneurs, freelancers, and professionals. They are successful because they provide not only workspace, but also opportunities to meet and connect with others. In this case, the lobby of EnterpriseWorks could be set up on a temporary basis with tables and chairs to host coworking events. EnterpriseWorks would enlist one of the Research Park tenants or a university corporate research partner to send a few key staff people to circulate throughout the day coworking with companies as an opportunity to get to know them and learn about their work. Advertised as “Come to EnterpriseWorks to work with XX company on [date]”, the coworking event would attract technology companies, entrepreneurs and faculty to either drop in for a brief period of time or spend the day working. Events could be held monthly, featuring a different company each time. Social networking tools like Twitter would attract participants and build a following.

## **(2) Build and Attract Business And Management Talent.**

Perhaps the most critical issue is the lack of business and management talent. Without it, companies cannot grow in Champaign-Urbana. Over time, the community must build

a cadre of business expertise, including skilled senior and mid-level managers, business developers, and sales experts. It appears that the shorter-term solution is attracting skilled employees from outside of the community. While some programs can be deployed to try to grow your own talent pool, the results in the short term would still be insufficient to meet company demands. Nevertheless, finding ways to better leverage the MBA program at Illinois can be a longer-term approach for developing talent.

- **Create a job portal that leverages the MBA program at the University of Illinois College of Business.** Students in the MBA program with business experience should be encouraged to work on entrepreneurial activities while getting their degrees and stay after graduation by connecting them to job opportunities in the community. The program is an underutilized resource. Create a portal and referral program to connect MBA students with job opportunities in the community.
- **Establish a scholarship program for MBA students (“MBA Entrepreneur Scholars”) that would be similar to a Teaching Assistant position.** This recommendation takes the leveraging of the MBA program one step further by establishing a program to attract MBA students with the appropriate experience and skill sets to Illinois, and incentivizing them with a scholarship to study and work. Each year two or three scholars would work at local technology company on a part time basis while earning a degree. The goal would be retention of the students after graduation. This type of a program could potentially be funded by an alumni or technology corporation.
- **Conduct outreach to alumni, especially those with engineering degrees, to come back to Illinois to earn an MBA.** Leverage alumni’s strong connections with Illinois to encourage them to return to Champaign-Urbana and earn their business degree, and from the beginning, tell them that they will receive assistance with job placement at technology companies during their studies and upon graduation.
- **Use alumni contacts to recruit management talent.** Conduct recruiting trips to Chicago and other places with a significant number of alumni, and attract alumni to recruitment fairs in Champaign-Urbana encouraging them to “Come back to Champaign”. The State of Michigan has had some success with its MichAGAIN program aimed at attracting former Michiganders to move back to the state to live and work. Ann Arbor SPARK does targeted recruitment events in Silicon Valley to encourage tech-savvy professionals to move to Ann Arbor for specific job opportunities and a lower cost of living. Coordinate with the twin cities, technology businesses, and real estate developers in the community to show off the attractiveness of the communities.
- **Create a relationship with a recruiter to provide discounted services to early stage companies.** Early stage cluster businesses need to attract the necessary talent, but the cost of a recruiter can be out of reach. Creating a

preferred, discounted relationship with a recruiter would give emerging companies a recruitment option. It should be available to university and non-university connected companies.

- ***Coordinate talent recruitment efforts for both university and non-university-connected technology companies.*** Coordinating efforts helps to aggregate the needs and shares information among companies. In addition, a coordinated effort helps to demonstrate to potential recruits that a number of job opportunities exist in Champaign-Urbana, which helps to promote the community as a longer-term location. Currently, coordination occurs on an informal basis with information shared based upon personal connections. A more formalized approach is needed. Job opportunities among companies would be aggregated and marketed inside and outside the community. Job fairs would go “on the road” to Chicago, Silicon Valley, and other places, as well as held in Champaign-Urbana. Also, a job portal could be created on the EnterpriseWorks web site, similar to Ann Arbor SPARK’s portal.

### **(3) Enrich Technical Talent.**

The University of Illinois and the community have a wealth of engineering and technical talent, but the demand for this talent will increase as the clusters develop. In particular, growth of the bioengineering and biomedical sectors will require more significant expansion in skill bases that support this cluster.

- ***Create a coordinated Trailing Spouse Program across the University of Illinois.*** Trailing spouses can be an important asset to help enrich the local technical talent pool. To improve efforts to connect trailing spouses with technical skills to jobs at the University of Illinois and in businesses in the community, a single point of contact should be established for better coordination and exposure of opportunities. Currently, individual departments assist spouses, and informal information sharing occurs. A coordinated effort, in addition, would be more attractive to potential faculty or staff recruits.
- ***Work with Parkland College to develop computer science and technical skills development courses, as well as allied health and biotechnology lab-related skills.*** As companies grow, they will have increased needs for technical talent that can be filled with the help of the local community college. For example, lab and medical technicians can be trained at Parkland College.
- ***Create Professional Development Technical Skills Certificate Programs at the University of Illinois to provide opportunities for professionals to learn and refine technical skills.*** This type of continuing education and professional development program can help employees to build their technical skills to prepare for changing market needs and to enhance their value within a company. Companies will need more skilled workers as they grow, as well as workers who can expand and adapt their skills as needs change. Certificate programs can

help to fill these needs. The University of California's Extension Program, for example, is a rather extensive program designed to provide professional development across a number of areas that is responsive to market and technology trends.

- ***Establish a relationship with a recruiter to attract technical talent.*** As mentioned earlier, creating a relationship with a recruiter who would offer services at a discount to early stage companies would help provide access to these types of services.
- ***Coordinate talent recruitment efforts for both university and non-university-connected technology companies.*** As described earlier, coordinated efforts should focus on technical as well as management talent.

#### **(4) Increase Business Activity.**

Thriving clusters require business activity at all stages in the lifecycle, and therefore efforts and initiatives must be made to foster entrepreneurship, support and attract growth or expansion stage companies, and attract more mature businesses in the three clusters. However, at this point, focusing on entrepreneurship and retention of companies as they grow is most important for Champaign-Urbana because the current environment can best support companies at these stages. Once other issues (e.g. business talent, access) are better addressed, then attention can shift to attraction of more mature businesses. Both university-based and non-university connected businesses should be encouraged. Entrepreneurship by faculty, trailing spouses, and graduate students should be supported.

- ***Create a Proof-of-Concept Program that provides funding.*** Proof of concept and market validation are essential steps in vetting technologies as the basis for viable businesses. Many universities have programs and a process that help faculty to vet, test and validate ideas, and then assist with early commercialization steps. The goal is to support university researchers with continued IP development and commercialization activities. Assistance might include proof-of-concept experiments, prototype development and testing. Some provide funding (from private donors, state funds, and/or licensing revenues) to support the efforts. Funding typically purchases access to specialized lab facilities, hiring of staff, expert business advice, and business plan development. Funding per project often ranges from \$30,000 to \$100,000. Some examples include the Massachusetts Institute of Technology's Deshpande Center, Harvard University's Accelerator Fund, Princeton University's IP Accelerator Fund, the University of California San Diego's von Liebig Entrepreneurism Center, the University of Colorado's Advanced Industries Accelerator (which has been revised in 2014 to focus on targeted industry clusters), and the QED Program at the University City Science Center that includes the University of Pennsylvania and several other universities and hospitals in the Greater Philadelphia region as participants. At Illinois, proof-of-concept programs and assistance exists but

funding is not available. Vetting is currently done through the Office of Technology Management, I-Corps, and EnterpriseWorks. To help to accelerate the process and increase efforts would require the creation of a formal program at the University of Illinois that also has funding support. It would be aligned with the clusters---similar to the University of Colorado's newly reframed program—to specifically support their growth.

- **Create a “faculty entrepreneur” track.** Add a track for two or three faculty per year to focus on conducting research with commercial potential that provides dedicated time to pursuing a start-up to commercialize innovations developed from the research. They would be relieved of some basic research and teaching responsibilities in order to focus on the research with commercial potential and business opportunities. Arkansas State University used this type of approach a few years ago and allowed up to 6 positions who could spend half of their time on commercial pursuits.
- **Assist trailing spouses with business start-up.** The coordinator for the trailing spouse program (recommended earlier) would refer interested individuals to resources on campus and off campus that support business start-up, and check on the progress of their businesses to help ensure success.
- **Incentivize graduate students to start ventures while studying at Illinois.** Fund a cash prize that can be awarded to a graduate student each year for starting a successful venture. Funding for the prize could be solicited from alumni and philanthropists and businesses in the community.
- **If Illinois decides to proceed with the creation of a full-scale medical school and academic hospital, increase research in the bioengineering and biomedical fields, create programs that target the launch of new start-ups in this cluster, and attract more established companies.** Leveraging of this key asset will be essential to growing the cluster. Not only must start-ups be encouraged, but also more mature firms should be attracted as research partners similar to those focused on big data that are currently located in the Research Park.
- **Create mezzanine space in the Research Park to accommodate companies graduating from EnterpriseWorks and retain them in the community.** Companies moving beyond early stage to scale-up and growth often have space—and lab--needs that are too small for commercial properties. If they remain in the incubator during this phase, they prohibit other start-ups from joining. Yet, they may not have many options in the community. In order to encourage and support their growth in Champaign-Urbana and continued connections with the university, BCD recommends dedicating “mezzanine” space in the Research Park for these types of companies. Space would range from 1,500 to 5,000 SF or more, and in particular, offer much-desired lab facilities. The BioCenter in San Jose, California, in partnership with a private developer, had

planned to build-out space in the same facility for growth stage companies, offering between 1,000 and 5,000 SF. The goal was keeping the companies in the same facility so that they could then grow to a larger space in the industrial park where the BioCenter was located. It can be important for retention strategy.

- ***In the near future, focus attraction efforts on locating corporate partners in the Research Park.*** Currently, the more likely targets for attraction are those companies who either have research relationships with the University of Illinois or want to create a research relationship that would require a dedicated space and staff in the Research Park. If the university chooses to proceed with an expanded medical school and hospital, then attracting bioengineering and biomedical companies would be a likely target. In the future, once more of the challenges are addressed (e.g. access, management talent) and more cluster businesses exist, then emphasis on attraction strategies should be increased.

#### **(5) Build Cluster Identity.**

Branding and positioning with a cluster identity enhances the attractiveness of Champaign-Urbana for businesses working in the clusters, and helps to distinguish it from other universities and communities.

- ***Develop marketing, branding and messaging around the clusters.*** Promote the University of Illinois and Champaign-Urbana as the place to start and grow your data, bioengineering or biomedical, or energy business. Gather success stories from university and community-based businesses in the three clusters. Develop a marketing plan and utilize consistent messaging to recruit companies and talent, and promote the community in general. The message becomes part of the vibrant community story.
- ***Organize around the clusters and promote the clusters.*** Actions can include deploying a cluster focus at EnterpriseWorks and at the Research Park, deploying cluster roundtables and events (as described earlier), and holding annual showcases or events for each of the clusters. The showcases would provide opportunities to highlight research with promising commercial applications, present companies, and invite strategic or corporate partners, investors, and more established businesses. Participants would include faculty, early stage companies and more mature businesses. They would build awareness, promote university IP, support businesses in the cluster, and create business opportunities. Such efforts would help to establish the community's cluster identity.

#### **(6) Continue to Foster a Culture of Entrepreneurship.**

Currently, the University of Illinois has a strong culture of entrepreneurship created by the attraction of younger faculty interested in collaboration and innovation, as well as encouragement from staff at OTM, EnterpriseWorks, and the administration. The

continuance of this culture, in addition to stepping up the efforts, is essential to create thriving clusters.

- **Target and recruit entrepreneurial faculty.** Fill faculty positions with faculty that have a track record of success with commercial innovations and entrepreneurship. Even filling a few positions with these experienced individuals will have an impact on the entire campus, as they inspire others to be innovative.
- **Incentivize faculty and graduate students to pursue innovations with commercial potential and entrepreneurial pursuits.** Create prizes and rewards for those faculty and graduate students who develop innovations that lead to the formation of a new start-up. Competition can encourage those who otherwise may not have pursued their interests. Also, it helps to create more examples that can inspire others.
- **Institutionalize the culture.** A culture of entrepreneurship currently exists at Illinois and is fostered by the people involved in technology transfer and commercialization, administration and faculty. Consider creating policies that specifically support entrepreneurship to ensure that the culture will continue beyond the tenure of the administration and staff.

#### **(7) Augment the Entrepreneurial Ecosystem and Support Business in the Clusters.**

While the community has a strong entrepreneurial ecosystem and support network for entrepreneurs, more specialized support and programs geared toward the specific needs of cluster businesses will be required.

- **Develop specialized expertise, programs and networks that will benefit and support the clusters and their businesses.** Specialized knowledge and networks of expertise must be developed for each of the clusters. To support businesses in the data, biomedical and energy fields will require providing specialized knowledge and expertise about these industries, business models and practices. For example, knowledge and experience with regulatory issues, clinical trials, and FDA assistance must be developed and available to bioengineering and biomedical businesses. If the university proceeds with creating a full-scale medical school and academic hospital, assistance with clinical trials and testing of medical devices at the hospital should be provided to innovators and entrepreneurs. In addition, developing a network of potential customers and helping to connect cluster businesses to them would be very valuable. At EnterpriseWorks, create specialized programs and knowledge in the three sectors. Similar to the Big Data EIR position, bring on board an experienced entrepreneur who has successfully completed clinical trials and obtained FDA approvals as the Biomedical EIR. An Energy EIR could be established, as well. Also, leverage the university's experience with clinical trials and engage university staff to provide guidance to businesses. Developing and

marketing programs with a cluster focus are proven ways to attract entrepreneurs and companies who may not have considered joining the incubator or seeking assistance otherwise. Taking a step further, consider adding the three clusters as foci for EnterpriseWorks.

- **Enhance mentorship through Illinois alumni.** The Chicago Innovation Mentors program currently provides experienced mentors to science-based businesses. Expand this type of a program to include alumni mentors across the U.S., including Silicon Valley, with a focus on the three clusters. Enlist alumni with technical and business experience in the three clusters. Mentors can help to increase the success rate of entrepreneurs.
- **Connect technology businesses in the community with Illinois' network of corporate partners and alumni.** The University of Illinois has an extensive network that can benefit technology businesses that are not connected with the university. Businesses can be screened and then selected for introductions to the network. Connections can help businesses to access potential customers and technology development partners.
- **Make the campus a testbed for new energy technologies.** Through testbed opportunities right on campus, the University of Illinois can help early stage energy companies to test and validate their products, which is a necessary step to obtaining funding and customers. Possibilities include energy management systems for buildings, energy efficiency devices for lighting, solar-powered lighting, wind-generated power, and clean vehicle fleet. This program could be extended to city-owned facilities, if Champaign and/or Urbana join as partners. For several years, the City of San Jose (California) operated a program where clean energy solutions were screened and deployed in city-owned buildings, and is currently gearing up to re-launch the program. The win-win goal is to increase the use of clean and renewable energy technologies in the City, and help emerging clean businesses test and validate their products, which helps to retain them in the City.
- **Expand data infrastructure for businesses.** Work with a private provider to offer data colocation services, which are in high demand by businesses. Find ways to utilize the broadband capabilities available through the City of Champaign's UC2B program and make them affordable and accessible to businesses in the community.

### **(8) Increase Capital for Business Start-up and Growth.**

Champaign-Urbana has a significant amount of early stage investment capital given the size of the community, but lacks sufficient capital to move companies beyond the early stage to growth and scale-up. Without the next level of funding, companies will be pulled to other regions where capital is more readily available. At the same time, as

seed investment funds are deployed, new funds must be raised in order to continue to provide capital for early stage companies.

- **Focus on creating access to post-seed capital.** Sufficient deal flow will be required in order to attract venture capital firms to spend time in Champaign-Urbana. As the cluster grows, the community may become more attractive to VCs from Chicago and other regions to seek companies for investment. For now, continuing to forge relationships with VC firms in Chicago is the best bet.
- **Expand Illinois Ventures.** Illinois Ventures has recently approved the creation of a Fund III. Some of the need for early stage capital for university-based innovations can be met through this fund.
- **Create and manage an angel network through EnterpriseWorks.** By creating an angel network and managing it through EnterpriseWorks, the incubator can play an important role in both increasing angel investment and the participation of angels investing in cluster businesses. EnterpriseWorks can recruit and educate angels and provide information on investment. EnterpriseWorks would be lending its brand reputation to the network, which would help to increase investor and company participation. Last year, TECH Fort Worth, a technology incubator in Fort Worth, Texas, created Cowtown Angels, an angel network. Membership in Cowtown Angels continues to grow and several investments have already been made. In addition, it has created new contacts and interest in the incubator that would not have been present without the angel network. Investment is available to companies regardless of whether they are members of the incubator or not. MidAmerica Angels, which was launched and is managed by the Enterprise Center of Johnson County (Kansas), is another good example.
- **Build relationships with corporate venture capitalists and strategic investors.** These investors can be an important source of growth and late stage capital, as well as present opportunities to create partnerships and joint ventures between major corporations and local companies. Specifically, invite them to showcases and events that show-off local technology businesses and innovations and to meet with local companies that might be a fit for their business models, or bring groups of companies to visit a corporate investor (who tend to be located at corporate headquarters or in a place like Silicon Valley where they can access many businesses). For economic development purposes, find corporations that are seeking partners (versus acquisition targets which may lead to relocation out of the community) and/or financial gain. These opportunities tend to increase when economic times are good.
- **Consider funding from international sources.** The EB5 visa program for immigrant investors provides green cards for foreign nationals who invest a minimum of \$100,000 in an enterprise in the U.S. that creates or preserves at least 10 jobs for U.S. workers. Investments can also be made into a Regional Center that assumes the responsibility for making the investment and creating

the jobs. This program could be researched and a determination made as to whether it would help address the capital issue. At the same time, the University of Illinois has a significant number of alumni overseas, which could prove to be good connections for potential investment capital.

### **(9) Improve Access.**

A frequent complaint, and constraint, is the airport and remote location of Champaign-Urbana. It impacts businesses by distancing them from their customers, funding sources, and testing locations, as well as makes it less attractive to their employees. A group has convened recently to examine the airport and how to address the issue. Recognizing that it will take time and money to resolve, access is nevertheless a critical issue that impacts cluster development and must be addressed.

- ***Increase the number of flights and carriers at the airport.*** Increase the number of carriers beyond the current one to provide more options and connection opportunities to reach the East and West Coasts. Understand the needs of the local business community (including destinations frequented by them), and the needs that will be developed as the clusters grow, and then increase the number of flights and destinations based upon those needs.
- ***Improve rail access to Chicago and access to University of Illinois Chicago.*** Work to get high-speed rail service to Chicago to lessen commute times, which is important to attract employees and build many of the connections discussed in these recommendations. In addition, improve connections between the train station in Chicago and UIC with a shuttle service.

### **(10) Provide Leadership.**

Leadership must be active in encouraging and promoting the growth of the clusters. While the University of Illinois has convened an advisory group that includes high-level university officials and community business leaders, local government and technology leaders are missing and necessary.

- ***Add leadership representation from the cities, Champaign and Urbana, and Chief Executive Officers of successful technology businesses from the clusters in the Advisory Group or other team focused on economic development.*** Effective collaboration requires direct participation from the two communities. It also requires two or three CEOs from successful businesses in the three technology clusters, who can bring their knowledge of business and technology to the discussions and plans. Overall, the group should remain small—8 to 12 members—in order to be effective.

## Stakeholder Interview List

BCD interviewed the following individuals to gain input and perspectives for this project:

- Ilesanmi Adesida, Vice Chancellor for Academic Affairs and Provost, University of Illinois
- Spencer Atkins, Director, Atkins Group
- Bob Ballsrud, EVP and CIO, Busey Bank
- Ben Barbieri, President and Founder, ISS
- Dennis Beard, Principal, Serra Ventures, and Partner and CFO, Open Prairie Ventures
- Laura Bleill, Assistant Director, Research Park and EnterpriseWorks, University of Illinois
- Brandon Boys, Economic Development Coordinator, City of Urbana
- Dan Cermak, General Manager, Volition
- Dorothy David, City Manager, City of Champaign
- Lisa Dhar, Director, Life Sciences and Senior Technology Manager, Office of Technology Management, University of Illinois
- Mark Dixon, Director of Real Estate, Atkins Group
- Gary Durack, Founder, iCyt
- Jennifer Eardley, Associate Vice Chancellor for Research, University of Illinois
- Peter Fox, Chairman, Fox Development Corporation
- Laura Frerichs, Director, Research Park and EnterpriseWorks, and Director, Economic Development, University of Illinois
- Brian Jurczyk, President, Starfire Industries,
- Pradeep Khanna, Associate Chancellor, University of Illinois
- Bruce Knight, Planning and Development Director, City of Champaign
- Dr. Jim Leonard, President & CEO, Carle Foundation Hospital
- Ali Mabel, Program Coordinator, Research Park, University of Illinois
- Cameron Moore, Chairman, Champaign County Economic Development Corporation, and CEO, Champaign County Regional Planning Commission
- Mark Nolan, Director, Office of Corporate Relations, University of Illinois
- Tom Ramage, President, Parkland College
- Seamus Riley, Vice President for Institutional Advancement, Parkland College
- Craig Rost, Manager, Economic Development, City of Champaign
- Dr. Peter Schiffer, Vice Chancellor for Research, University of Illinois
- Dr. Lawrence B. Schook, Vice President for Research, University of Illinois
- Rob Schultz, Managing Director, Illinois Ventures
- David Sholem, Attorney and Shareholder, Meyer Capel
- Cathy Singer, Senior Director, Yahoo!
- Chris Shroyer, CEO, Busey Bank
- Charlie Smythe, Member, City Council, City of Urbana
- Cody Sokolski, Futurist and Founder, One Main Development LLC
- Rick Stephens, Founder, Horizon Hobby

## Identification of Technology Clusters for the University of Illinois

- Dr. Suzann Trupin, MD, Owner, Women's Health Practice, and former Chief of Obstetrics and Gynecology, University of Illinois College of Medicine
- Steve Wille, Director and Senior Technology Manager, Office of Technology Management, University of Illinois
- Mike Welge, NCSA, and Big Data Executive-in-Residence Research Park, University of Illinois

The process also included a discussion at a meeting of the external relations and corporate relations officers at the University of Illinois.