Bringing Open Innovation to Economic Development in Southside Virginia

UAP 5774: Economic Development Studio

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1 INTRODUCTION

Innovation has become a necessity in order to compete in today's changing knowledge-based economy. The purpose of this report is to explore how the model of open innovation can be applied as a tool for economic development in a region. In order to fully conceptualize the model of open innovation, it is necessary to address open innovation from the university, industry, and community perspectives. This report begins by reviewing the literature on open innovation, detailing a conceptual model of open innovation, and exploring each actor in open innovation: the university, industry, and community. Specifically, we have examined the innovation enterprise present in the Southside region of Virginia that is manifested by the research being conducted at the Institute for Advanced Learning and Research (IALR) and its interaction with the associated industry thrusts (robotics, polymers, IT, biotech, and automotive engineering) and the community. We have also identified the challenges and opportunities created by open innovation that affects how local economic developers should market the region's assets to businesses considering relocating to the area. We conclude the report by outlining specific action steps that may be taken by either IALR or the community to more actively engage in open innovation.

In examining the structure of open innovation at IALR, we found that innovation at the Institute is influenced by three primary themes: 1) the innovation process, 2) incentives and policies put in place by the institution, and 3) networking and knowledge transfers. Local spin-offs and licensing are important components of the innovation process that can lead to economic development. While there are currently no spin-offs or licensing agreements in place, the labs at IALR are currently engaged in basic and applied research, some of which has been sponsored by government or industry contracts, and anticipate spin-offs in the future. Incentives and policies must be aligned within the greater institution in order to support the commercialization and economic development goals held by the labs at IALR to more effectively utilize the open innovation model. Finally, networking and knowledge transfers should be formalized among local stakeholders, including an effort to support entrepreneurialism in Southside.

The structure of open innovation within each of the industry thrusts is also affected by three themes: 1) the size of the firms, 2) market trends, and 3) the mechanisms for knowledge transfers. It is important for economic developers to understand these themes when marketing the region to potential businesses since the structure of open innovation varies depending on the industry. The size of firms in the research thrusts directly influences whether open innovation is likely to be used as a strategy for adapting to changing market demands. While larger firms may have more resources to adapt to market forces, small and medium-sized companies are more likely to rely on innovation networks for support. The size of the firm, however, does not exclusively determine whether open innovation is utilized. There is evidence that larger firms sometimes use intermediaries or knowledge brokers to facilitate knowledge transfers. When economic developers are targeting firms within the research thrust areas, it is important to understand the mechanisms used by these industries for moving from R&D to commercialization. Mechanisms include knowledge networks such as intermediaries, Small-Medium-Enterprises strategic alliances, R&D cluster strategies, and acquisition strategies. If Southside can support policies and an environment that encourages the development of these mechanisms, the region can more effectively recruit businesses that can benefit from open innovation strategies.

It is hard to dispute the value of open innovation for the sake of collaboration and knowledge sharing. But we are particularly interested in how open innovation can be marketed as a tool for economic development. The challenge is that the boundaries of open innovation are fluid and porous, which means that the economic benefits from open innovation are not regionally bound. To address these challenges, economic developers must market the specific structure of open innovation at IALR:

- Knowledge capital and networking opportunities with research experts,
- The ability to quickly bring a product to market through technology transfers,
- State-of-the-art facilities and testing equipment, and
- Cost and time savings by tapping into existing research.

Other regional assets include a large, diverse service area that may appeal to a variety of business needs and defined educational pathways that have been established (or could be strengthened) at IALR and partnering institutions. These educational partnerships will help to create a pipeline for a highly educated workforce, which may act as a powerful incentive when companies are looking to relocate.

2 OPEN INNOVATION: LITERATURE REVIEW

2.1 Definition

Open innovation is a term used by Chesbrough (2003) to describe a new process of innovation used by companies such as Nokia and Cisco. Ed Morrison defines innovation as the process of "converting ideas into wealth" (2008, pg. 18); knowledge becomes a marketable product (or process) from which firms, universities, and regions can capitalize. Regardless of the precise definition, most research seems to agree that innovation is vital to the health and growth of both companies and regional economies (Fredburg, 2008). The old system required companies to rely on large in-house research and development departments to produce new ideas and get them to market. This "closed" system meant that small firms faced significant hurdles to enter the market. Company-controlled, closed innovation processes will no longer work; knowledge must be more easily transferred among various stakeholders in order for economies to remain competitive. This transfer of knowledge can occur in a number of different forums: co-development partnerships between two firms, university-facilitated networking events and, often, through the Internet. Fredburg (2008) claims the argument for open innovation is built on several basic tenets:

- One firm does not employ all the experts in a particular field; external resources must be tapped to remain cutting-edge.
- External knowledge can be just as profitable as internal research and development.
- A strong business model, based on flexibility and innovation, is more important than being the first to market.
- Capitalizing on internal intellectual properties (i.e., selling licenses or patents) and buying others when needed helps to make the innovation process more efficient.

A recurring theme in the literature on open innovation is the idea that businesses and universities should use intellectual property rights as a tool to generate revenue rather than simply to protect new ideas (Fredburg, 2008; Lester, 2005). The open innovation model allows new firms to license technology and quickly get a product to market. Chesbrough describes the open innovation model as having a "porous" boundary between a firm and the outside environment. This porous boundary allows for new ideas to flow more freely to and from the firm. Chesbrough uses Procter & Gamble as an example of a company that has moved from a closed system of innovation to an open system of innovation.

The increase in open innovation has been brought about by several factors that have led to the necessity to move away from closed models. Bercovtiz (2006) describes four major factors as "intensifying" the move toward open innovation:

1. The development of new high opportunity technological platforms such as computer science, molecular biology, and material science.
2. The growing science and technological content of all industrial production.

3. The need for funding due to budget cuts.
4. Government policies aimed at raising economic returns.

The idea that we are in a unique transitional period in our nation's economy has been addressed by several researchers. Ed Morrison calls this transition a move from a "First Curve" economy, characterized by mass production and command-and-control management practices, to a "Second Curve" economy, which is based upon knowledge and information networks (2008). Many communities are not only witnessing the departure of standard, manufacturing-based economies, but local leaders are often ill-equipped to recognize that a new economic development strategy must be employed to focus on entrepreneurship and innovation. Leaders are faced with resistance from local residents (the "I just want my job in the factory back" mentality) and often do not know how to identify and organize potential stakeholders around a new movement toward a knowledge-based economy. Morrison stresses that globally competitive regions must support smaller networks of innovative companies rather than large hierarchical enterprises.

While research efforts concerning innovation and knowledge creation have recently increased, the suggestion that creating knowledge is central to economic development is not a new one. New Growth Theory says that economic growth is a direct result of the increasing returns associated with new knowledge (Cortright, 2001). Since knowledge and technology can be infinitely created, shared, and reused, the diffusion of knowledge becomes the primary driver of economic growth. Economic developers should no longer focus on maintaining or even expanding existing "arrangements of firms," but should support the creation of new ideas (Cortright, 2001). Universities, industries, and communities each have a responsibility for participating in the diffusion of knowledge for the sake of regional and national economic health.

2.2 Technological Change and Open Innovation

The open innovation model has challenged the linear model describing technological change (Figure 1). Instead of a step-by-step process, a more iterative process occurs, with each step performed not by one firm, but by multiple entities. Universities and outside firms could enter the process at any point on the diagram, thus following the open system described by Chesbrough (2003).

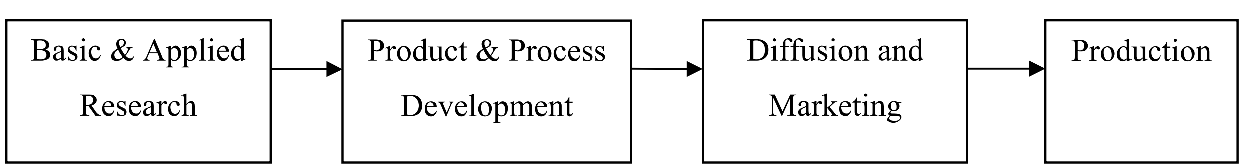

Fig. 1 The linear model of technological change (Malecki, 1997)

This change in innovation brings about opportunities and risks for universities, firms, and communities. The linear model of technological change still provides the steps that occur in getting a new idea to market, but the process is not as linear and linkages between industry, university, and community are present. Figure 2 is perhaps a better representation of an open model for technological change by showing the interactions between university, community and industry. The four basic steps are still present, but might not be performed by one single entity.

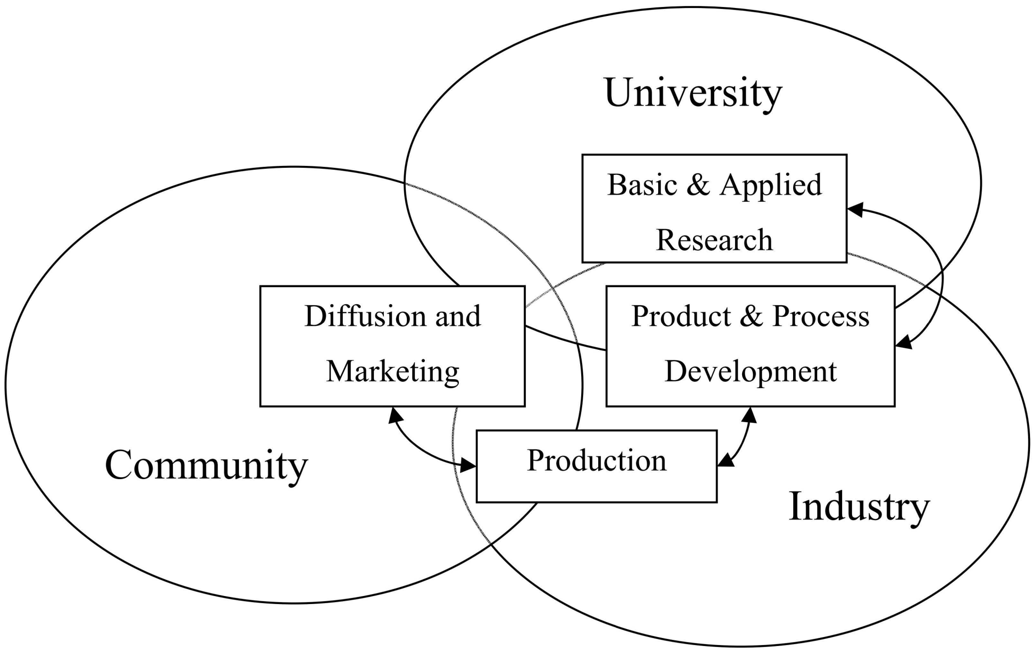

Fig. 2: Iterative and open model of technological change

The university, industry, and community can play a role in each of the basic steps of innovation. Their role in each of these steps is discussed below.

2.2.1 Basic & Applied Research

Malecki (1997) stresses the importance of linkages between the different segments in this process. In Figure 2, we see that basic and applied research might happen strictly at the university level, strictly at the industry level, or at some interface between the two, such as through sponsored research. Sponsored research provides a way for companies to directly research, train students, and screen students for hiring at a later point (Bercovitz, 2006). Communities may not be involved directly in research, but may influence research that is performed through social movement pressure.

2.2.2 Product & Process Development

Malecki points out that product and process development may be one in the same or they may be separate processes that occur, depending on whether one is producing or using the product. This step would primarily be occurring within the university or the industry, more often occurring at the industry level. Here universities and industry might interact on the level of licensing or spin-offs. Community involvement could come in the form of demanding that a process or product meet certain social requirements, such as being environmentally friendly.

2.2.3 Production

This step is referring to the production of the product. At this step, the involvement of the university would only be through a spin-off. Industry and firms are directly involved in production. Community involvement comes in the form of the location of production. This is what makes it advantageous for industries to be located near universities.

2.2.4 Diffusion & Marketing

This is the last step in the model for technology transfer. Malecki's (1997) discussion of diffusion provides significant insight into diffusion for developing countries and the economics behind diffusion. This step takes place at the industry level, but can directly impact the community. Malecki borrows from Markusen (1985) and uses a profit cycle to look at product life cycle. This profit cycle can directly impact a community's economic development. As the product goes through the four stages of the product life cycle (innovation, growth, maturity, decline), so too can a community where the production of such a technology is located.

3 OPEN INNOVATION: A WOVEN TAPESTRY

Open innovation does not fit a nice, neat mold. Instead, it manifests itself in various ways depending on the industry, the community, and the university involved. However, there are central tenets and characteristics evident in the examples. One of the easiest ways to discuss open innovation is in how it differs from closed innovation, but this fails to capture the breadth of how open innovation may be structured. Instead, if we imagine open innovation as a woven tapestry we begin to see the different patterns that emerge with open innovation. Each actor in the open innovation model can be thought of as a color of thread. There are various interaction points between actors and within actors. As detailed in Figure 2 on page 9, a firm, university or community may contribute and perform tasks at any or many levels. This leads to a different woven pattern depending on where the interaction points (where threads cross and interact) occur.

Within the woven tapestry are various threads that shape open innovation. There are four threads that have been identified at this time that impact the tapestry. The university thread is influenced by how the innovation process is occurring at the university level, the incentives and policy in place at the university, and networking and knowledge transfers. For the Institute for Advanced Learning and Research (IALR), the thread is influenced by the fact that faculty tenure and promotion is not based upon innovation but rather research dollars and publications. The advantage of faculty having a background in industry provides contacts and relationships that are already established, allowing for faculty to immediately be able to reach out and access industry partners.

There is a technology thread that is influenced by the type of technology involved in open innovation. Thus, the weight, color, and type of technology thread used in the tapestry are influenced by the above characteristics. For Danville, the specific technologies of polymers, high-value horticulture, robotics, and motorsports/vehicle performance will influence the tapestry of open innovation in Danville. Also influencing the tapestry is the industry thread. The industry thread is influenced by different characteristics pertaining to the size of the firms in the industry and market trends. Also the design of the tapestry and the intricacy of the weave depend on the type of mechanisms that connect research with existing companies, such as intermediaries or corporative agreements, or the level of industry and university/community's acceptance of these mechanisms.

The last thread in our tapestry is the community/government thread. This thread has many characteristics that impact its weight, color and type, including the social infrastructure that is present in the region; the built infrastructure such as housing; the political infrastructure or the ease with which new businesses can be established and the "buy-in" by local and regional decision makers; the civic infrastructure such as the quality of schools and other public services; the technology infrastructure; and the geographical location, including access to airports and the natural beauty and pull of area. The characteristics of the threads involved in the tapestry will determine the final picture that is woven of open innovation.

4 UNIVERSITY THREAD

4.1 Roles of the University in Open Innovation

Universities' direct involvement in the innovation process is a recent phenomenon and there is still considerable resistance and hurdles that must be overcome. University policy and incentives play a major role in the degree to which faculty members participate in product or process innovation (Bercovitz, 2006). Policy and incentives also affect the cost to the individual researcher to participate in the model. Bercovitz provides three reasons that researchers do not participate in the process: 1) Researchers specialize in basic research and are not willing to spend time on the research and development needed, 2) Patent processes may delay publishing, and 3) Belief that universities should not be involved in commercial activity. These three factors are offset by a new generation of researchers who are more open to the ideas of cross-contamination between industry and the university and are more aware of the budget and funding concerns that can be alleviated by the process (Bercovitz, 2006).

The literature on open innovation suggests that there are multiple direct and indirect ways that universities can participate in and have an impact on the open innovation process (Bercovitz, 2006; Lester, 2005; Morrison, 2008). Some of these methods are outlined in the table below.

Table 1: Direct and Indirect Participation by Universities in Open Innovation

Direct v. Indirect Impact	Method	Explanation
Direct	Sponsored Research	Firms or government provides funding to university on specific research topic; agencies include National Science Foundation (NSF) or Dept. of Defense (DoD).
	Licensing Technology	Provides revenue and prestige to the university; revenue can then be funneled back into research.
	Training Students	Transfer of knowledge occurs when students move from university setting to an industry job, taking knowledge and ideas with them.
	Spin-off Companies	Universities can provide a labor force with specialized skills, lab space and/or specialized equipment, and expertise from researchers.
	Entrepreneurial Training	Entrepreneurial training programs for faculty and students supports culture of risk-taking and encourage small, innovative start-ups.

Direct v. Indirect Impact	Method	Explanation
Indirect	Attract Resources	Universities attract individuals and financial resources just by being in the area; small firms may want to locate closer to the center of research.
	Integrate Research Areas	Universities are encouraging more collaboration and interdisciplinary programs are being supported by funding agencies.
	Use of Public Space	Universities can be seen as a civic space, which can act as a forum through which stakeholders can meet, explore connections, and generate practical partnerships. Universities represent neutral places of learning and professors may be ideal facilitators of networking forums because of their ability to synthesize information.

Lester (2005) points out universities provide the two things in a knowledge-based economy that matter: highly educated people and new ideas. University participation in the transfer of knowledge and product innovation is a natural one with advantages to both universities and communities. Universities benefit from outside funding which can alleviate some of the pressure caused from budget cuts and universities provide a central place of people and knowledge which is beneficial to industries in the area and the community.

Benefits to the community from these knowledge transfers is seen in the local education system and reaches the local residents at every level from elementary up through university students. When the community and educational institutions work together to create defined educational pathways, a pipeline of highly skilled workers is the result. This critical mass of educated residents may act as an incentive for companies that are considering relocating to a community, which carries with it additional economic benefits for the community. The Virginia Economic Development Partnership (VEDP), for example, helped to establish formal networks among educational partners in order to fulfill the workforce needs of a specific industry partner. Educational pathways that begin in the K-12 public school system, move to the community colleges and university training, and ultimately result in employment at a partnering business, provides clear economic benefits to local residents. Industry partners also benefit from a streamlined workforce pipeline because it reduces their training costs and the time associated with recruiting qualified workers.

Ed Morrison also notes the importance of education in the new knowledge-based economy, particularly in regards to the prevention of high school dropouts (2008). As high school dropout rates continue to climb nationwide, we will find it harder to compete in a global economy that requires new technologies, cutting-edge skills, and increased knowledge. The idea that youth must be supported while they gain the necessary 21st century skills presents an opportunity for local universities and communities to work together. Universities should expand its outreach programs for middle and high school youth to encourage appropriate college preparation skills, particularly for those students at risk of dropping out. Incentive programs could be established to reward those students who successfully complete a college prep academic program with partial tuition scholarships or unique research opportunities. As stewards of higher education, universities must take the initiative to ensure that the nation's high school students are moving on to college and will be prepared to participate fully in a knowledge-based economy.

Opening the innovation process does not come without considerable challenges. The idea that companies should sell their intellectual properties defies the notion that firms must "own" an original idea that no other firm has in order to be competitive with other firms. Fredburg (2008) has coined this problem the "Not-Invented-Here" syndrome; established firms believe that they already possess all relevant knowledge and will, therefore, reject ideas that were not generated internally. Open innovation fundamentally challenges the concept of competition. If competing firms collaborate for the sake of innovation, how does that change the boundaries of each collaborating firm? In other words, how can each firm maintain a corporate identity if its products and processes are available for other innovators to use? While there is no "right" answer, the challenge may necessitate complex inter-firm agreements designed to protect some intellectual properties while opening others up for use by other collaborating partners. It is important to note that the same problem exists within the university setting. The challenge will dictate that a significant culture change must take place within firms and universities in order for the open innovation model to be successful. Research suggests that increased permeability of corporate boundaries (i.e., the ability for ideas to flow freely from internal to external environments) ensures an efficient use of research and development resources, as well as a better match between ideas and market needs (Fredburg, 2008). Corporate retraining may be necessary to enable leaders to embrace open innovation; universities may play a key role in facilitating the retraining.

4.2 Case Examples

Literature has suggested multiple ways in which the open innovation model may be applied by universities, communities, and industries to drive economic growth (Chesbrough, 2003; Morrison, 2008; Fredburg, 2008; Bercovitz, 2006). As many regions nationwide are struggling to adapt to a new knowledge-based economy, creative partnerships have emerged, often with the help of federally-mandated innovation funding. The key to adopting a region-specific approach to open innovation is to recognize that a number of partners and approaches must be employed to successfully facilitate economic change. Universities and communities, in particular, should implement both entrepreneurial training that focuses on moving innovations to the marketplace and workforce development training that concentrates on training incumbent and new workers for 21st century challenges. The Michigan Initiative for Innovation and Entrepreneurship (MIIE) has adopted an open innovation model that uses the state's university assets to move academic research to new business start-ups. MIIE's funding initiatives fits many of the basic tenets of open innovation: a focus on commercialization, entrepreneurial training, and industry partnerships. OneKC WIRED is a federally-funded 18-county, bi-state workforce development program that aims to provide new skills training and an educational continuum to ensure that Kansas City's residents are prepared to meet the economy's future needs.

4.2.1 Michigan Initiative for Innovation and Entrepreneurship

Background/History

The Charles Stewart Mott Foundation awarded a $2 million planning grant to the University of Michigan in July of 2007 for the Michigan Initiative for Innovation and Entrepreneurship (MIIE). The Initiative represents a consortium of 15 state universities who are dedicated to raising $75 million over a seven-year collaboration period in an effort to ease Michigan from a manufacturing-based economy to one rooted in innovation and the diffusion of new knowledge. The funds will then be redistributed for specific projects under three funding priorities: the Technology Commercialization Fund, the Industry and Economic Engagement Fund, and the Talent Retention and Entrepreneurial Education Fund. In July, the Initiative awarded 20 grants totaling $1.3 million, which was matched by a $2.2 million investment from universities and the private sector. Funding for the first round of awards was provided by the pilot grant obtained from the Mott Foundation.

The heart of this initiative lies in recognizing that the state's universities offer significant assets to the changing economy. Michigan's 15 public colleges and universities capture more than $1.5 billion in research and development funding from federal and other sources. MIIE attempts to speed up the commercialization process, moving the universities' research assets to the marketplace by facilitating collaborations and encouraging entrepreneurialism. The Initiative proposes to reach its goal of rebuilding Michigan's communities based on knowledge-based industries by implementing the following activities:

- Developing sustainable partnerships between universities, industry, venture capitalists, and government,
- Generating risk capital devoted to founding new start-ups within the state,
- Investing in entrepreneurial education on and off university campuses, and
- Creating a culture of innovation and supporting the entrepreneurial environment at all Michigan campuses.

MIIE's goal of supporting smaller networks of innovative start-up companies in an effort to become a globally-competitive region is touted as a best practice in the literature on open innovation. According to Ed Morrison, new "Second Curve" economies can no longer be built on the backs of hierarchical corporations; economic growth will be driven by innovative start-ups in the future (2008). MIIE's strategy highlights the importance of the interaction between universities, industries, and communities. Universities must be provided the opportunity to move research into the development of practical products and processes. Industries must take advantage of the assets provided by university innovations to increase profitability and competitiveness. Communities may have the highest stake in the open innovation process, as they are ultimately hoping that their residents are afforded with the high-level skills necessary to compete in today's workforce.

Current Projects

As previously mentioned, the Michigan Initiative for Innovation and Entrepreneurship organizes its grantmaking activities into three thematic funding streams: the Technology Commercialization Fund, the Industry and Economic Engagement Fund, and the Talent Retention and Entrepreneurial Education Fund. Two-thirds of the funding is currently allocated to the Technology Commercialization Fund with the remaining money supporting the other two funds, which broadly encourage entrepreneurialism inside and outside of the university setting.

The Technology Commercialization Fund, also called the Gap Fund, provides important funding at the pre-seed and seed stages of development. These resources are available to help move academic ideas into a phase that attracts venture capital and ultimately results in a new start-up business in the state. Funds can support: market research, commercial assessment, proof-of-concept studies, IP enhancement, prototype development and testing, feasibility studies for production scale-up, and business model development. The Technology Commercialization Fund reinforces the best practices that were presented in open innovation literature. Fredburg (2008) and Lester (2005) emphasize the opportunity that universities in particular have to use intellectual property rights as a way to spur economic growth. Breaking down the boundaries between the entities conducting the research (and developing IP) and those utilizing and marketing new technologies is the foundation of Chesbrough's open innovation definition (2003); this is exactly what the Technology Commercialization Fund attempts to accomplish.

Five Michigan universities were awarded funds from the Technology Commercialization Fund in July 2008, ranging from a $10,000 award to more than $125,000. The Fund has a unique payback mechanism that will help to sustain the program beyond the initial funding years. Three times the award amount must be repaid as a small percentage of start-up revenue in the early years of commercialization. The following innovative ideas were selected for funding:

- New antibiotic to treat drug-resistant infections,
- A handheld diagnostic device to conduct white blood cell counts in HIV/AIDS patients,
- A new printing system that measures production gains,
- A procedure to synthesize biodegradable plastics from agricultural waste, and
- The development of a Commercialization Center at Wayne State's Center for Molecular Medicine and Genetics.

The Industry and Economic Engagement Fund encourages an open exchange of ideas among university researchers and industry practitioners with the intent of fostering commercial success and regional economic growth. Funds will support project-specific collaborations, which may lead to the creation of joint IP, or broader partnerships that are expected to have impact over time. Projects may include faculty or student groups working with partnering businesses and providing forums for university and industry experts to share information. Again, literature on open innovation supports the notion of using the university setting as a public space to exchange ideas and build innovative collaborations (Lester, 2005; Morrison, 2008). Seven universities were awarded funding, ranging from $40,000 to $100,000. Projects include collaborations such as training materials science and engineering students to meet the needs of the private sector, developing and testing a "wearable video" system that may be used for military reconnaissance, and the establishment of a Functional Design Incubator to increase Michigan's competitiveness in the textile and apparel industry.

The Talent Retention and Entrepreneurship Education Fund is geared toward entrepreneurial training for faculty, as well as undergraduate and graduate students. As part of this entrepreneurial training, faculty and students should learn innovative techniques to move ideas to commercial success. Projects may include entrepreneur-in-residence programs, internships with economic development agencies, or the development of an entrepreneurship curriculum. Eight Michigan universities received funding under the Talent Retention and Entrepreneurship Education Fund, ranging from $22,000 to $80,000. Projects include the establishment of the Haworth College of Business Center for Entrepreneurial Studies and Innovation at Western Michigan University and the creation of an Entrepreneurship Internship Program at several state universities.

Future Goals

The main goal of MIIE is to encourage entrepreneurial partnerships and, ultimately, result in as many as 200 new start-up firms in the next decade in the state of Michigan by tapping into the state's philanthropic resources and utilizing a unique payback system for established start-ups. The second round of grant awards is planned for the fall of 2008 and the program is expected to continue for seven years.

Marvin Parnes, the chair of the MIIE Management Committee, highlights the need to "retool the state's economic infrastructure to the new realities of the knowledge economy." According to organizers, the formation of MIIE is the first step; researchers, educators, and businesses have already had to join forces to apply for grant money and communication will only grow stronger. This program recognizes the university's responsibility and opportunity to act as an organizer to mobilize the community and industry to proactively invest in the economic future of the region.

Lessons Learned

The Michigan Initiative for Innovation and Entrepreneurship highlights several university best practices found in the literature on open innovation:

- Universities assist in the establishment of small, innovative start-up firms,
- Universities act as a convener of collaborative partnerships between researchers, industry, and government leaders,
- Universities use IPs to spur economic development and open the boundaries between its research practices and practical applications,
- Universities act as a public space to exchange ideas and establish networks.

While it is too early to measure the successes of MIIE, the fact that universities and businesses are already discussing how they can work together to participate in the new knowledge-based economy means that they are committed to opening the innovation process.

MIIE can act as a model for Danville's Institute for Advanced Learning and Research (IALR) of how universities can be engaged in open innovation, but it is also important to note the differences or challenges that will be unique to IALR. As will be discussed in further detail later in this report, IALR does foresee spin-offs as a core part of their mission, which is regarded as a best practice in both the literature and MIIE. While IALR recognizes the value of collaborative partnerships between industry leaders, government officials, and the university, it is currently not operating as a primary *convener* of these partnerships. The geographic location of the Danville region may influence IALR's ability (or inability) to facilitate large-scale collaborative efforts with industry leaders, in particular. However, since most of the faculty has industry experience, past relationships help to keep faculty connected even if they are not convening formal networking events. IALR is not currently using IPs as a method of stimulating economic development for a number of reasons. IALR has as its mission to facilitate economic growth in the Southside region, yet the selling of IP, while it may be a best practice in the open innovation model, may not necessarily result in regional economic gains. IP could be sold to firms across the country and may, therefore, not have a direct impact on Danville. While MIIE may employ model open innovation practices, the model may be applied differently depending on the region and the mission of the university.

4.2.2 OneKC WIRED (Workforce Innovation in Regional Economic Development)

Background/History

Kansas City WIRED (Workforce Innovation in Regional Economic Development) is one of 13 initial regions to receive a grant from the U.S. Department of Labor. WIRED is founded on the idea that regional economies benefit from a highly skilled workforce. OneKC WIRED straddles the Missouri-Kansas border and spans 18 counties between the two states. OneKC began in 2003 and has been focused on training and providing a workforce appropriate for the region. WIRED has recognized an appropriately trained and skilled workforce is a necessity for regions to be competitive at the global level. A recent report (Missouri Economic Research and Information Center, 2008) on the region showed industry strengths in Advanced Manufacturing, Health Care, and Biotechnology. There is a history of these industries in the Kansas City area and training workers, developing technology, and facilitating relationships is designed to keep these industries in the area and make companies and the region competitive.

Current Projects

OneKC has focused on five project areas at this time; three of these are focused primarily on workforce development and are currently being implemented through various avenues. The first of these project areas is a focus on building up the workforce available for current industries in the area. This project labeled “Building Capacity”, has sought to link industry, education and training, and economic development through programs such as “Making It in KC”. “Making It in KC” is a career-training program that trains students in a 16-week time period focusing on the following skills: computer literacy, problem solving, teamwork, applied math and key manufacturing principles. Students receive training for jobs that are located and in need in the area and firms have access to a workforce with skill sets that match their needs. “Making It in KC” fills the workforce need for companies involved in advanced manufacturing. Additionally, they have developed a Clinical Faculty Academy. This project trains current clinical nurses as instructors to staff nursing schools and train the next generation of nurses. This project is focusing on the need for instructors in the health care industry. These two are an example of how OneKC is focusing on specific industry and the labor needs of those industries.

OneKC’s second project area is focused on making sure that workers are trained in the latest technological advances. OneKC has identified industries with technological gaps. In particular, OneKC has focused on workers in the life sciences/biotechnology sector and has set up LiLAs (Lifelong Learning Accounts) which allow for workers and employers to invest in continued education classes for employees[1].

OneKC has also looked down the pipeline of upcoming workers and has focused on education, support and encouragement for elementary, middle, and high school students. These projects (Partnership for Regional Education Preparation-KC (PREP-KC), Project Lead the Way, KC Science Initiative, and the Center for Excellence in Bioscience) work to encourage students in careers that focus on science, technology, engineering, and mathematics. In these three areas, OneKC has spanned the spectrum of learning and workforce development needs for industries concentrated in the area. This focus on workforce development combines two necessities of the knowledge-economy: investment in education and investment in people.

[1] More information on LiLAs is available on the OneKC website at http://www.onekcwired.com/lilas.cfm.

The final two project areas focused on by OneKC include “Creating Infrastructure and New Platforms” and “Regionalism”. It is through these last two initiatives that the open innovation model, as defined by Chesbrough, is evident. There is the recognition of the fact that 30% of the $15 billion world animal health market is in some way present in the region (www.onekcwired.com). They also cite the research and veterinary schools’, at Kansas State University and the University of Missouri-Columbia, close proximity to the area. OneKC provides grants that they state “support new partnerships between industry and academia, expand awareness for scientists in both communities regarding research interests and industry needs, and accelerate innovation and technology transfer/commercialization activities” (www.onekcwired.com). This focus on innovation of research and capturing those benefits for the region is the exact idea that Chesbrough and others are pushing. The involvement of the regional universities allows for new innovation and provides growth to these various sectors.

Besides the Animal Health Innovation Grants, there is also a concern about technology transfer in general. OneKC has recognized the need for an organization that can help facilitate technology transfer. There is no information as to how the organization will actually fulfill their goals or operate, but it appears that goals of the organization will be to provide infrastructure (it is not explained what type of infrastructure) for “efficiently and knowledgeably” moving technology into the marketplace and will also develop strategies to identify technologies.

The focus of the final project area is on creating an identity for the region. This regional identity is more than just thinking and indentifying as a region, but focusing also on relationships and partnerships that reach the other three goals listed above. There is little discussion as to the effectiveness of these programs, but this idea of regionalism and social networking should help facilitate some of the factors that SRI identified as being important to successful open innovation.

Future Goals

OneKC does not explicitly discuss goals for the future, but the statement regarding regionalism and the desire for the region to become a place that is “thinking, acting, growing, and working as OneKC”, indicates an interest beyond simply workforce development (www.onekcwired.com). The website acknowledges the fact that innovation and regional growth will occur long after the grant money has expired. Development of the regional networking and partnerships with the nearby universities is important for their long-term sustainability. A key component of the open innovation model is the involvement and use of outside research. This model only begins to embrace that through the final two projects. It is in those two projects that long-term competitiveness will be achieved.

Lessons Learned

Bercovitz (2006) and Lester (2005) defined four primary areas that universities can be involved in the open innovation model: sponsored research, hiring of students, licensing of technology and spinoffs. OneKC has involved the local community colleges in training students and through their Animal Health Innovation grants are engaging in sponsored research. OneKC only lists the University of Kansas under their partnerships, indicating no formal relationship with the University of Missouri-Columbia, Kansas State or other research entities. While there seems to be a desire to work with these research institutes, it is not apparent that it is happening at this point in time. Instead the primary focus has been on workforce development. Barriers to including the various universities may be a function of policy and incentives at these universities as well (Lester, 2005). Overall, this aspect of the open innovation model is lacking in OneKC and could highlight the difficulty in including a university when the drive and initiative is coming from the community.

Community involvement in OneKC is evident and benefits to the community are more easily seen than at the university level. The community benefits from investment in the workforce. If companies have access to a trained and available workforce, this leads to a desire to stay in an area. In addition, a workforce that knows there are jobs available which meet their levels of training are more likely to stay in the area and invest in the community socially and economically. The Institute for Advanced Learning and Research in Danville has developed a number of workforce development initiatives, as well. The intent is that through defined educational pathways and community outreach activities, the Institute will assist the Southside community in becoming a highly trained workforce that will attract investment by companies and firms looking to locate in the area. A discussion of these workforce development initiatives can be found later in this report. The community's role in this model is to provide the social networking necessary between the various groups and the infrastructure needed to support the industry and the workforce. This support of infrastructure is not detailed for OneKC, but policies that help companies or individuals meet their goals, such as affordable housing for workers or adequate schools, can only increase the chance that individuals and companies will stay in the area. Government involvement is evident as both the governor of Missouri and Kansas has recognized the importance of the program and support at the local and state level is evident.

4.2.3 Summary – Michigan and OneKC

MIIE and OneKC are vastly different programs, yet both desire to make their region attractive for current industries to invest and remain in the community while attracting new firms. Their approaches are very different and the location of initiative is also different. OneKC has primarily been initiated at a community or government level while MIIE has been initiated at the university level. Strengths and weakness of each are different because of this.

MIIE Strengths & Weaknesses:

- Strength – funding at all levels of research

- Strength – facilitating networks and partnerships for technology development and innovation
- Strength – financial resources to reach goals
- Weakness – engaging and investing in elementary, middle, and high school students
- Weakness – direct community involvement

OneKC Strengths & Weaknesses:

- Strength – involvement of the local and state governments
- Strength – transfer of knowledge and technology to workforce (elementary school through current workforce)
- Strength – innovation of technology through an educated workforce
- Weakness – failure to involve the university through licensing and spin-offs
- Weakness – failure to focus on the development of new technology

These case studies were chosen both for their similarity to the Danville region and their dissimilarity in their approach compared with the Danville region. OneKC has the regional perspective that will be important for Southside. OneKC's focus on a regional identity, as well as the active participation of local and state governments in the initiative are an aspect that could benefit Danville. Additionally, OneKC's devotion to developing the local workforce is the kind of long-term education and retraining that will be necessary to bring residents of Southside into the knowledge economy. MIIE provides an example of how funding and support for spin-offs is vital to spin-off success. Their state-wide approach and collaboration between universities is another characteristic that IALR may want to consider. The case studies also provide a glimpse as to what partners IALR is missing in their desire to facilitate open innovation. The biggest missing pieces are venture capitalists or funding sources for spin-offs and a major industry cluster. Additionally, a critical mass of people and firms is a striking difference between Southside and the case studies mentioned here.

4.3 IALR and Open Innovation

The Institute for Advanced Learning and Research (IALR) in Danville, Virginia was established in 2004 by Virginia Tech to reinvigorate the regional economy through strategic research and community outreach. Its vision states: "The IALR is to be a catalyst for regional transformation to an innovative, high-tech economy that creates new opportunities for the citizens and businesses of Southside Virginia."[2] Four strategic research areas, including polymers, high-value horticulture and forestry, robotics and unmanned systems, and motorsports and vehicle performance, are located at the Institute and each research thrust has some

[2] IALR, Summary Annual Report, Fiscal Year 2007.

connection to a regional asset located in Southside. For instance, the motorsports and vehicle performance research thrust is able to take advantage of its proximity to the Virginia International Raceway by using its facility for testing. Beyond their traditional research interests, IALR faculty is dedicated to increasing regional economic growth through active research. The following research centers have been established at IALR to date:

- Advanced and Applied Polymer Processing Institute (AAPPI) – polymers
- Institute for Sustainable and Renewable Resources (ISRR) – high-value horticulture
- Joint Unmanned Systems Test, Experimentation, and Research (JOUSTER) – robotics
- Vehicle Terrain Performance Laboratory (VTPL) – motorsports/vehicle performance
- Intelligent Transportation Laboratory (ITL) – motorsports/vehicle performance
- Performance Engineering Research Lab (PERL) – motorsports/vehicle performance
- Virginia Institute for Performance Engineering and Research (VIPER) – motorsports/vehicle performance.

In addition to its strategic research areas, IALR also has broader workforce development goals including traditional academic programs and community outreach programs, which will be discussed in the Community Thread section of this report.

4.3.1 Methodology

IALR's mission of catalyzing regional change through innovation certainly suggests that an open innovation model would be embraced by the associated research centers and faculty. Our task was to investigate whether an open innovation model is being utilized at IALR and to determine the structure of innovation among the research centers. We initiated our research by exploring the IALR website and gaining a general sense of the type of research being conducted within each of the centers through a review of various organizational documents, including the 2007 Annual Report. We developed a questionnaire consisting of eleven questions that were used during phone interviews with research center directors; the questionnaire included questions pertaining to innovation process, policies and incentives, and knowledge transfers. Six of the seven research directors provided one-on-one interviews; one Project Engineer (for JOUSTER) was also interviewed since the research director had only been with IALR since the end of August. To complement the primary data gathered from the interviews, we searched the Virginia Tech Intellectual Properties (VTIP) database to determine which associated technologies were available for purchase. We also searched Virginia Tech's Office of Sponsored Research website to establish how many sponsored research grants were currently being administered by the research centers at IALR (see the Appendix for a complete listing).

Through the lessons learned from the literature review and case studies, as well as our research regarding the innovation structure at IALR, we have identified three primary themes affecting open innovation in the university setting: 1) the innovation process, 2) the policies and incentives in place at the university, and 3) networking and knowledge transfers. Our findings are also based upon the comments from our interviews and the supplemental research on the research thrust areas located at IALR.

4.3.2 Innovation Process at IALR

Open innovation supports the idea that knowledge is a marketable product or process from which firms, universities, and regions can capitalize (Morrison, 2008). As previously mentioned, universities can participate in the open innovation process in a number of ways: sponsored research agreements, licensing of technology, training students for industry jobs and supporting entrepreneurial education, and facilitating commercial spin-offs. IALR is still in the early stages of its development and should be commended for its commitment to innovation for the sake of economic growth. IALR is currently involved in sponsored research and ultimately plans to license technology and support spin-off ventures. To determine the structure of open innovation at IALR, we first explored how the research institutes participated in each of the steps in the model for technological change.

The open model for technological change, Figure 2, retains the basic steps of Malecki's (1997) linear model, but suggests that universities, industries, and communities can participate and collaborate in any number of the steps: basic and applied research, product and process development, production, and diffusion and marketing. Within open innovation, basic and applied research normally occurs at the university level. All of the research directors agree that basic and applied research is their primary responsibility, but the interviewees also acknowledge that industry partners also engage in active research through sponsored research programs. However, the research centers at IALR are uniquely positioned to lead basic and applied research efforts as their centers are equipped with state-of-the-art equipment, are led by high-level former industry professionals, and have access to graduate research assistants. This allows them to effectively participate in the technological change model at this initial step. The difference, however, between the basic research done by some of the "home" departments located at Virginia Tech's Blacksburg campus and the IALR research centers is that the research conducted in Southside is expected to lead to product development and, eventually production. This is where the open innovation model enters the picture.

Among the ways that universities participate in basic and applied research, sponsored research is the most prevalent. There are numerous sponsored research contracts between the IALR research centers and industry and government sponsors. Industry partners are engaged in the polymer, horticulture/forestry, and automotive research areas. Likewise, government agencies have sponsored research in the polymers and robotics research thrusts; sponsors include the U.S. Army Research Office, NASA/Langley Research, and Naval Air Systems Command (see Appendix for complete list of sponsored programs). European agencies have even contacted researchers at one of IALR's centers to discuss the possibility of subcontracting commercial research. Research directors have acknowledged that there are a range of possible sponsored research agreements that could be developed depending on the needs of the sponsoring agency. The Institute for Sustainable and Renewable Resources, for example, is currently contracting with a biotech agency that will eventually patent the technology developed at ISRR. However, the research center will still be allowed to use the technology for non-competing products. In other arrangements, the research centers at IALR may retain IP ownership or allow for co-ownership of IP.

Sponsored research is only one way that universities can participate in open innovation and may be the easiest form of participation. Unfortunately, none of the research directors currently engage in any sort of production or marketing of a specific product; some of them are, however, engaged in product and process development. Several of the interviewees stated that they are currently developing protocol and/or prototypes that will enable them to move to the product development and production stage when key pieces of research are complete. One research director pointed out the importance of establishing key industry relationships while in the basic research stage so that when the "right" piece of technology comes along to move the research into the product development stage, the transition between the university/research side to the industry/production side is seamless. All of the research directors expressed a desire to move their research to market. In fact, several interviewees said that this ability to develop innovative products, facilitate spin-off ventures, and ultimately create jobs in the region is the core measure of IALR's success in fulfilling its mission. While he did not point to a specific policy or structure, one research director stated that the credibility of his research depends on his research area's ability to move research from out of the laboratory and into the market, particularly through spin-offs located in Southside. In addition, many feel that grant and research money is dependent on proving that the technology could ultimately be developed into a final product. This insures that while researchers at IALR may only be engaged in the first step of technology transfer, it is with an eye toward the final product.

While the various research thrusts are all involved in basic and applied research, the innovation process looks different depending on the industry. For example, VIPER and PERL work together through a research lab (PERL) that feeds into a customer based lab (VIPER) where technology is introduced to industry partners and is tested in a lab setting. With PERL and VIPER we also experience the iterative process of open innovation suggested in Figure 2. Feedback and interaction with VIPER influence research conducted in PERL. Technology in the automotive research thrusts seems to be more closely connected with specific industry partners and the feedback loop between the university and industry is close and among only a few different players. Additionally, while interviewees in this research thrust talked about licensing, patents and sponsored research, they saw spin-offs as being much further in the future. VTPL (Vehicle Terrain Performance Laboratory) has approached the innovation process as a series of "building blocks". Research in this lab is moving linearly through several steps leading to a final research goal and involves various partners at each of these steps. They first began with developing technology that improved the ability to measure terrain. This step involved research partners such as the Army. Next, they developed mathematical algorithms for determining the type of terrain. This step involved the Army, NASA, and Chrysler. They are currently working on tire and vehicle modeling and will eventually move into researching performance. As is evident from these examples, the primary partnerships with the automotive thrusts are government agencies or the large automobile makers. VIPER and PERL work with the racing industry, but here to the application of the technology is specific to that industry.

Contrast the automotive research thrusts with polymer and value-added agriculture and the innovation process looks different. In these two research thrusts, the customer base is larger and innovation of the technology could come from various industry partners. Additionally, spin-offs were discussed as a real possibility. The Institute for Sustainable and Renewable Resources is expected to have a commercial tissue-culture lab spin-off within the next year. ISRR has already established an important relationship with the Virginia Nursery and Landscape Association (VNLA), which will hopefully aid the spin-off venture in moving products from test tubes to local test beds and, eventually, to the commercial market. Once a product has been determined to be commercially viable and a buyer or marketer has been identified, ISRR hopes to recruit local farmers with existing greenhouse infrastructure leftover from Southside's tobacco history to produce novel plant products. The director of ISRR states that this sort of relationship is still several years away, but may have the potential to pay economic dividends to Southside farmers. The other research center directors also reiterated the importance of moving their research to a commercial spin-off. Since IALR is still in its early stages of development, most interviewees believed that spin-offs may still be a long way out, but some graduate research students have expressed an interest in commercialization in the future.

IALR is young and this shows in how the directors participate in open innovation. Their participation in sponsored research does not directly bleed over into benefits for the community. Job creation will rarely come from sponsored research. Instead, spin-offs and licensing to local companies would be a better way to facilitate economic development in Southside and this goal may be difficult to obtain. The boundaries of open innovation are fluid and porous. This means that the economic benefits from open innovation are not regionally bound. This could be an impediment for economic development through open innovation in Southside.

4.3.3 Policies and Incentives at IALR

The policies and incentives at a university can have a direct impact on the acceptance and involvement of faculty and students in the innovation process. There are three areas where the policies and incentives of universities have an impact. The first of these is at the hiring level. About half of the laboratories at IALR are directed by faculty with a background in industry instead of academia. One interviewee believed that a background in industry was crucial to the success of innovation. It was stated that contacts, credibility and relationships with industry partners are all stronger and developed more easily because of industry experience. It is believed (although not officially confirmed at this time) that hiring occurs at the IALR level, not at the department level. Thus it is believed that the hiring committees likely share a similar belief that industry backgrounds are important to nurturing innovation.

The second area where policy and incentives matter are at the promotion and tenure level for faculty. There is not uniformity in the role that IALR faculty has with Virginia Tech. Several of the interviewees are full-time faculty in departments at Virginia Tech, others are only adjunct faculty. The adjunct faculty does not feel the pressure to "publish or perish" and may be able to focus on the innovative process and technology development in a manner that is different from full time faculty. Interviewees stated that their promotion and tenure is based through their home departments at Virginia Tech. There was not a consensus among the interviewees as to whether they felt the incentives for promotion and tenure should be lined up with the missions and goals of IALR. A brief review of mission statements at the College level and then down to the department level at Virginia Tech indicates that the goals and mission of IALR are not perfectly in line with the goals and missions back at Virginia Tech. For example, the College of Engineering does list in its vision that they want to "develop strong working relationships between faculty, students, and industry partners" (http://www.eng.vt.edu/overview/mission.php). They also state that they desire to "forge new links with industry and government to facilitate economic development" (http://www.eng.vt.edu/overview/mission.php). While these two statements seem to line up with the innovation and economic goals of IALR, they are vague and at the department level, similarly expressed views are not found. It is also valid to note that there is no mention of the associated laboratories (VIPER, VTPL, ITL, PERL) within the other listed institutes, centers or laboratories mentioned by the Department. This indicates that the home departments do not feel any ownership in the labs established at IALR. Additionally, interviewees stated that the geographical distance meant that many faculty in the home department were not aware of the faculty at IALR and that the interviewees felt that the VT faculty did not know them to the extent that other VT faculty were known. This was cited as a concern for promotion and tenure committees which are made up of VT faculty and do not have an IALR representative. One interviewee suggested that promotion and tenure committees should be changed for all departments to include innovation goals.

For the other research thrust similar findings occurred and in fact the linkage between Virginia Tech and IALR was more difficult to see. The Department of Forestry and the Department of Horticulture, home departments for ISSR do not have the same focus on economic development and innovation as the College of Engineering or the Department of Mechanical Engineering. AAPI at IALR mentions an affiliation with Virginia Tech, but does not provide specifics about collaborations with them. A statement made by one of the interviewees sums up the idea best; he stated that there is "buy-in" at the higher levels of Virginia Tech, but that perhaps at the lower level (promotion and tenure committees) faculty are unaware and possibly unappreciative of the specific scope and focus of IALR faculty.

The third area where policies and incentives can have an impact on innovation surrounds the issue of funding. While the directors of the laboratories believed that funding from outside sources is important and in fact is often the only source of funding for their labs, it was primarily in the area of sponsored research. There were a few that saw licensing and spin-offs as funding sources, but the focus was primarily on grants and sponsored research to provide funding. There was the acknowledgement that IALR's budget and success is dependent on spin-offs and licensing, but for some the thought of trying to add the development of a spin-off to their already busy schedule seemed ridiculous. As budget cuts continue to occur, this may impact faculty's view of licensing and spin-offs to provide funding at a larger scale, but at the present, it is not getting as much attention as sponsored research.

Time and effort to pursue open innovation beyond sponsored research is vital for the economic development aspect of open innovation. Spin-offs and licensing of technology may be difficult for faculty that is juggling different commitments to IALR and home departments. This should be considered when discussing the overall goals of IALR and expectations of faculty.

4.3.4 Knowledge Transfers at IALR

As the literature has supported, the transfer of knowledge and the porous nature of the boundaries between universities and industries is a central tenet in the open innovation model. The degree to which IALR participates in the transfer of knowledge from research to production can, in part, tell us the degree to which IALR engages in open innovation. Universities can facilitate the transfer of knowledge and technology in a number of ways, including nurturing commercial spin-off ventures, licensing technologies, and sponsoring networking forums designed to encourage interaction among university and industry stakeholders. Lester (2007) discusses the university role in knowledge transfer in detail. He emphasizes that while the focus is typically on IP and licensing, there are other knowledge transfers that the university can facilitate. His study suggests that the presence of universities can also attract new human knowledge to the area. IALR has experienced this with NextGen Aeronautics moving into research space on IALR's campus. Attracting other firms to the area would continue to build the mass of human knowledge present in the area. IALR has a good start on this as they have hired highly motivated and successful industry leaders. This lays the foundation of knowledge capital that benefits the community and could attract other individuals to the area or encourage local individuals to stay in the area. IALR is also participating in building human capital through the recruitment and training of local students (see opening section on IALR). Lester also found that universities attract financial resources to an area. Based upon the interviews it is not clear that this attraction of financial resources is occurring outside of the university at this time; this may be a component that happens in the future after/as spin-offs are realized. Lastly, Lester believes that universities can also facilitate collaboration or integration of technology that in the past had not been connected. The university provides a place for conversations and discovery to occur. Follow-up interviews with high level administration would provide an idea of whether or not

IALR is marketing their human capital and their common space to provide for knowledge transfers among individuals, firms, and industries.

Licensing technologies is another way that universities can be directly involved in the transfer of knowledge. A review of the Virginia Tech Intellectual Property (VTIP) database reveals four technologies originating in the research centers at IALR are currently available for licensing, patenting, or copyrighting. Two polymer-related technologies and two vehicle performance-related technologies are available. While the IALR research directors confirm that licensing may become a part of their mission in the future, most research areas are not actively licensing technologies at this point. One interviewee cited the difficulty of controlling IP and trade secrets as the primary reason licensing has not occurred yet. Some of the research directors recognized licensing as a valuable revenue-generating tool and one interviewee also pointed out that selling licenses to companies located across the country would do little to expand economic development in Southside.

Universities can also sponsor collaborative forums or networking opportunities to facilitate the sharing of ideas and the brokering of collaborative research partnerships. One of the interviewees stated that co-location of industry and university researchers helps to facilitate an informal networking and sharing of ideas. An example of this is the relocation of NextGen Aeronautics to IALR. The California-based company chose to open its East Coast location in Danville because of the high-tech programs already in operation at the Institute, especially JOUSTER and AAPPI. NextGen has opened the office with three researchers, but expects to increase to 20 staff members and the project progresses. The research thrust directors and NextGen currently engage in an open dialogue to determine their respective capabilities and challenges and to determine whether research collaborations may be forged in the future. While there are few established defined networking opportunities, most research centers recognize the value in recruiting collaborative partnerships. IALR does sponsor a “show-&-tell” for alumni. This allows the labs to showcase their current research as well as maintain relationships with previous students. Informal knowledge transfers at this level could lead to formal knowledge transfers through sponsored research, licensing or spin-offs. ISRR has made a concerted effort to attend national industrial trade shows and other national networking groups in an effort to stay abreast of the newest technology and to develop potential sponsored research partnerships. The JOUSTER program faculty is involved in two industry groups designed to facilitate interaction between research institutions, industry representatives, and government officials: the Robot Venture Group and the Robotics Technology Consortium. While these groups are not regionally based, they do provide faculty the opportunity to interact with national industry leaders and government sponsors of robotics research. Regional IALR-sponsored networking events may provide a more meaningful opportunity for the research centers to engage in open innovation. Graduate students moving to industry maybe one of the best knowledge transfers that will come out of IALR. Graduate students are working on contracts with government agencies and as the faculty has a background in industry, they have the advantage of being mentored by industry savvy faculty. Currently, the majority of networking occurs through contacts and relationships that the directors are nurturing.

Knowledge transfers to the local population are limited, except through its workforce development initiatives. IALR promotes workforce development by encouraging an educational continuum that will move local students from high school dual-enrollment programs to graduate study in the affiliated research thrusts, in addition to sponsoring a number of broader community outreach programs. In addition to supporting the model for open innovation, educational pathways have been identified by the Virginia Economic Development Partnership (VEDP) as a key driver for economic development in the Commonwealth. VEDP supported a model educational partnership between industry and research universities when it facilitated the location of Rolls Royce's jet engine facility in Prince George County. Partners include the K-12 system, community colleges, and undergraduate and graduate programs located at Virginia Tech and the University of Virginia. The defined educational pathway that leads the high school student to higher education directly serves Rolls Royce by training its workforce for engineering and other jobs at its facility in Prince George County. In this case, the industry partner has already been defined. IALR cites as part of its educational mission a desire to create an educational pathway that will attract industries to Southside Virginia, yet it does not yet have a specific company with which it is partnering. It is easy to see the movement and create the support systems for the resident moving from high school to higher education to a job at the Rolls Royce facility. It is also easy to see how that continuum economically benefits the local community. In IALR's case, however, it is less defined. Since there is not a specific industry partner, IALR must hope that its educational programs and research thrusts generate a critical mass of workforce development to encourage industry to locate in the area or actively pursue a industry partner.

While IALR is adequately engaged (or ultimately plans to be engaged) in several steps of the open model for technological change, it has not yet formalized any entrepreneurial training, which would engage IALR with the local community. Entrepreneurial training has been described by the literature and the case studies as an essential piece to open innovation. SRI International (2008) states that universities should take the lead in providing entrepreneurial training programs to undergraduate and graduate students, including developing technical assistance programs and increasing access to venture capital. The Michigan Initiative for Innovation and Entrepreneurship puts this ideal into practice through its Talent Retention and Entrepreneurship Education Fund. One of the research directors at IALR has stated that entrepreneurship is certainly encouraged among its researchers and should ultimately result in commercial spin-offs, yet there is no formal entrepreneurial education program in place to support entrepreneurs that do not fit within the specific research interests of the centers. Interviewees did mention that IALR leaders had close contacts with local and state political leaders. One of the interviewees is working with the local extension agency and local farmers, but this is one of the only examples of direct interaction with the local population. Instead the interaction was through faculty at the higher levels of administration.

4.4 Major Findings

IALR's mission is to help generate economic growth in Southside Virginia. Open innovation, when embraced collaboratively and structured appropriately, can be used as a tool for economic development. As we have examined the structure of innovation at IALR in the context of our three major themes, we have identified opportunities that IALR may have to strengthen its participation in open innovation.

- Innovation process
    - Opportunity to focus more on spin-offs and licensing
    - Opportunity to develop entrepreneurial training
    - Opportunity to attract venture capital
- Incentives and policies
    - Opportunity for alignment of missions
    - Opportunity to think beyond sponsored research
- Networking and knowledge transfers
    - Opportunity to formalize networking events
    - Opportunity to strengthen interaction with local industry – seeker/solver interactions

Implementation and specific programs to target the opportunities listed above is the key to seeing economic growth from open innovation in Southside. The table below provides specific ideas for implementation of each of these opportunities.

Table 2: Implementation of Opportunities for IALR

Opportunities	Specific Action
Innovation process	
Opportunity to focus more on spin-offs and licensing	1. Provide administrative and technical support for faculty that are considering spin-offs. Make process of developing a spin-off easy and accessible for faculty and graduate students. 2. Make spin-offs and licensing an integral part of incentives for faculty.
Opportunity to develop entrepreneurial training	1. Develop entrepreneur-in-residence program or entrepreneurial training curriculum (modeled after Michigan case study).
Opportunity to attract venture capital	1. Market technologies of research labs to venture capitalist. 2. Hold conferences or "show-and-tell" for venture capitalists to increase knowledge of investment opportunities.
Incentives and policies	
Opportunity for alignment of missions	1. Work with home departments to increase knowledge of IALR and its mission. 2. Increase collaboration between faculty at IALR and in home departments. 3. Consider IALR representative on P&T committees.
Opportunity to think beyond sponsored research	1. Provide incentives, through funding or through P&T for innovation that goes beyond sponsored research. 2. Highlight and showcase examples of research that is beyond sponsored research.

Networking and knowledge transfers	
Opportunity to formalize networking events	1. Sponsor industry specific “show & tell”. Include faculty from home departments.
Opportunity to strengthen interaction with local industry – seeker/solver interactions	1. Monthly seminars with faculty, community leaders and business leaders to exchange ideas. Allow any one from these three areas to present ideas. 2. Sponsor a “bar camp”. “Bar camps” are informal one-day conferences that bring together a community of people to share ideas.

5 INDUSTRY THREAD

5.1 Role of Industry in Open Innovation

According to Ed Morrison, industries are transitioning from a research process of self-reliance and the traditional command-and-control hierarchical organization. In this old model, closed innovation industries generate, develop and commercialize their own ideas. This transition could be considered as moving from a "First Curve Economy" to a "Second Curve Economy" based on "knowledge and networks, powered by technology" (Morrison, 2008). The research labs at IALR and affiliated industries reflect this shift as emerging technologies are the focus and increased networking is evident. As the value of technology products grow, industries should consider the potential for competitive advantage gained by exchanging technology ideas with networks of complementary firms.

Viewing the industry thread of our Woven Tapestry in the context of current strategies for innovation, we seek to understand how the various actors such as researchers, entrepreneurs and companies interact in their specific sectors. A company's participation in open innovation depends on various factors such as industry size and company structure, market trends, competition and customer demand, internal competency and technology transfer. Evidence is offered that either identifies open innovation opportunities through various collaborative business models such as (networks, alliances, clusters, etc.), or recognizes that traditional R&D strategies continue to exist.

We incorporated our findings through the lens of our open innovation conceptual model recognizing that technological change does not move through linear steps of innovation but is created and influenced through external and internal interactions. Technological change flows through the various stages (research and development, process development, product design to production and diffusion) through backward and forward linkages that do not necessarily follow a straightforward progression. The following industry analysis will offer a picture of how the industry thread of this tapestry pattern is influenced by the business environment of open innovation.

5.1.1 Methodology

In order to provide background and perspective for analyzing the existing research areas of IALR, the team researched the corresponding industries, namely Robotics, Polymers, IT, Biotech and Automotive Engineering. Specifically the team sought to identify the process by which industries move R&D to market. The included a review of academic papers, websites, and industry journals. Research focused around understanding 1) how the size of firms impacted innovation, 2) how market trends influenced innovation and 3) the mechanisms used by companies for knowledge transfers.

5.1.2 Size of Firms, Market Trends, and Knowledge Transfers

Companies seeking open innovation strategies hope to gain an advantage by diversifying their R&D approach, and to benefit from the cost savings that may result when R&D originates elsewhere. Firms today face higher costs for technology development and shorter product life cycles, making full investment in R&D harder to justify. Industry responses to market obstacles are often reflective of the size and technological capability of the company in question. For example, larger companies may utilize more in-house R&D resources than smaller enterprises, while small and medium sized companies are able to benefit from specialization and partnerships with larger entities such as the Department of Defense.

The ability to use networks to gain ideas from other sources reflects aspects of open innovation and is evident in the research for both large companies and small and medium enterprises (SME). Utilization of external ideas enables companies to benefit from spillovers of other industry capabilities and ideas. External technologies often influence an industry sector's market as exemplified by the pervasive impact of IT on almost all sectors. Understanding ways to harness the opportunity of adopt R&D from a wider market may result in benefits such as a more effective or flexible development process, faster product launch, or the ability to develop flexible products.

Overlaps also exist between industries. An example is one industry incorporating technology from another industry. This is evident in the automotive industry where IT, polymers and robotics are used extensively. Another way is through informing a new industry direction. An example of this is the robotics' movement toward automation. In addition, an industry may be a driver of other industry innovations. This has been the case with IT's current social networks concept where customer are connected directly to the company's pipeline for new product or process ideas.

The intersection of threads in the tapestry model where innovation moves from R&D through the technological steps of innovation are the interaction points examined in each of the industries. Identifying this point of technology transfer and understanding the proprietary questions surrounding technology transfers, allows for an increase in the understanding of how companies are innovating and barriers to innovation. We sought to identify the nature of the linkages between suppliers, customers, competitors, etc. with industry specific examples of successful collaboration and potential open innovation opportunities.

By allowing opportunities previously inaccessible within the closed innovation model, certain transfer mechanisms may assist with implementing shared processes. Certain challenges exist with implementation of open innovation as the necessity to protect proprietary knowledge and the need to maintain competitive advantage. This can result in a backlash against open innovation where ideas may not be protected between companies (Chesbrough, 2007). Legal agreements discussed in this analysis, such as cross-licensing or mutual transfer agreements, are tools to combat this issue, although they are not a perfect solution.

Our findings suggest that the mechanisms that enable technology transfer for commercialization are similar across industries and for both small and medium enterprises and large companies (SMEs). In addition, large companies utilize mechanisms such as intermediaries and knowledge brokers as one approach for product development, while SME's also contribute new technology to their sectors by support from third parties such as industry alliances and venture capital groups. All industries utilize various collaborative approaches, often including community and university involvement, to accomplish commercialization.

Table 3: Common themes among industries

Theme	Participating Industries
Knowledge Networks	Automotive, Polymer, IT, Robotics, Biotech
SME Strategic Alliances	Robotics, Biotech, Polymers
R&D Cluster Strategies	Robotics, Automotive
Acquisition Strategies	Biotech, Polymer, Automotive

The following sub-sections address each industry sector in the context of the environment for innovation focusing on the size of firms, market trends, and knowledge transfers. This report does not provide a complete understanding of the technical aspects of each industry thrust, but we offer case study examples of current business strategies, mechanisms of technology transfer, and conclude with recommendations for Southside based on our findings.

5.2 Robotic Industry

5.2.1 Overview

Organizations like the Department of Advanced Research Projects Agency (DARPA), SMErobot and the Science Applications International Corporation (SAIC) have a similar interest in advanced robotics for automation, for the automotive industry, for defense purposes as well as many others. The following discussion of DARPA and SAIC outlines their roles in the development or utilization of robotics.

Defense Advanced Research Projects Agency (DARPA)

DARPA is responsible for managing applied and basic research for the Department of Defense and pursues types of technology and research that assists the military's missions and roles. The field of robotics has become especially useful for DARPA's mission with the development of autonomous vehicles. Autonomous vehicles provide many advantages to military personnel, since they provide intelligent and safe means to carry out a mission.

DARPA has found success in Virginia with the DARPA Challenge (Urban and Grand) and the PerceptOR program. These programs encourage research groups to create autonomous vehicles that can win a race quickly while still obeying traffic laws. Victor Tango from Blacksburg, VA won third place and received $500,000 in the 2007 Urban Challenge, and Team Jefferson from Charlottesville competed in the 2004 Grand Challenge. Team Raptor is sponsored by the Science Applications International Corp. (McLean, VA branch) and was awarded $1.5 million in the Perception for Off Road Robots Program (Passive Perception System for Day/night Autonomous Off-road Navigation (Jet Propulsion Laboratory Website, 2008).

An important focus for DARPA is to encourage and facilitate partnerships with new and existing business. More specifically, DARPA assists businesses in the following ways:

- DARPA hires new program managers every 2-6 years in order to promote fresh ideas. Program managers are connected to interested businesses leaders in order to negotiate on the idea's purpose and desired end result for both parties.
- Studies (seedlings) are often funded as initial research.
- Solicitations of business opportunities and financial assistance are available for Small Business Innovation Research and individual technical offices.
- DARPA allows submission of an abstract prior to the proposal to give initial feedback.
- DARPA offers industry days prior to the date of proposal submission to meet industry partners and program managers

DARPA seems to be acting as an Innovation Missionary, which Chesbrough (2003) describes as an effort by firms to create innovation in order to serve a purpose. T Department of Defense as such will benefit through DARPA's promotion.

SAIC- Science Applications International Corp

SAIC solves "mission-critical problems" by utilizing highly skilled workers proficient in robotic technology (SAIC, 2008). SAIC is made up of a family of companies, which is collectively known as the SAIC Venture Capital Corporation. In this corporation minor investments are made in strategic emerging technologies. The SAIC business organizations are responsible for identifying new opportunities within the corporation. The Venture Capital

Corporation is also responsible for making intellectual property available (through licensing, spinouts, and other activities.) SAIC is a Fortune 500 company that provides engineering, technology and scientific applications and works with issues pertinent to national security and the world. "SAIC generates approximately 93% of its business through federal, state and local government contracts. The remaining seven percent is comprised of commercial contracts" (SAIC. 2008).Size of Firm in Robotics

Large firms have a high level of interaction with automotive robotics and small and medium size firms have a lower level connection with automation. However, while comparing companies in the field of robotics to other industries, we found that companies involved in the production of robotics are shifting towards a more open innovation model in order to bring automation robotics into a larger, more diverse market. These players, generally small and medium sized firms, are responding to the current lag in innovation in the automotive market and are shifting focus to developing new types of robotics. This may also indicate that companies are becoming increasingly cooperative and dependent upon out-house R&D as they downsize and become more specialized. In the past, robotics have been heavily used for automotive production. Large companies and federal groups tend to be popular buyers in these markets. It is suspected that the demand for automotive robotics parts will remain high, but automation robots are becoming increasingly popular in the field and thus more popular in small and medium sized firms.

5.2.2 Size of Firms, Market Trends and Knowledge Transfers in Robotics

As mentioned previously, in the past, automotive robotics captured a large portion of the market with large firms being the main innovators. The support from places like DARPA and SAIC ensure that the robotics market continues to develop automotive robotics in large quantities. Recently independent companies like SMErobot are financially and technically encouraging small and medium sized firms to develop robotics focused more on automation. This type of robotics crosses many industry sectors and could potentially infiltrate the market with the continued support of important third parties.

Focus on Partnerships

Team Raptor was made successful through its tight alliance with the Jet Propulsion Laboratory, Carnegie Mellon University, Applied Perception Inc. and Visteon Corporation. The "spinout" companies associated with SAIC make technology commercialization possible through financial investment, licensing of IP and other important support methods. Some of the companies listed are completely self-serving to SAIC and others are partially serving and hold other external responsibilities. Companies include: Bd Systems, Bechtel, Benham, Danet, SAIC Company, LLC, EMA-Egan, McAllister Associates, Medprotect, SAIC-Frederick, Inc, SAIC International Subsidiaries, and Varec.

SMErobot- SMEEIG

European Small and Medium Enterprises (SMEs) are common organizations in Europe that are just recently becoming consumers of robots. SMErobot has developed an organization with the sole purpose to better acquaint SMEs into the initial technological development phase of the SMErobot, in order to increase the success rate of the future SMErobot. Manufacturers of conventional industrial robots (70% in automotive) are facing an innovation gap. The market has become saturated and therefore it is important for new technologies and players to become involved to further spur innovation. The SMErobot initiative hopes to create new markets for robots since conventional industrial robots do not consist of small batch productions as is typical in SMEs). It takes about 2 to 4 years to implement robot applications, so it is more productive to develop markets at the same time of the technical developments, to makes applications more user-friendly. The basic knowledge network will help to transition the SMEs into the robotics market (therefore expanding it, as well as encouraging innovation) (SMErobot Tools, 2008).

SMErobot offers two groups for interested industry partners to encourage education and collaboration.

- *The European Economic Interest Group (SMEEIG)* was founded to "facilitate the integration and co-operation of both SME End-Users and System Integrators within SMErobot". (SME Involvement, 2008). SME end users will eventually be customers of the SMErobot, so it is to their advantage to take part in active participation in the creation of SMErobot strategies and functions. SMEEIG financially compensates SME participants, but they must be approved in an initial stage for proving that they are adding value to the projects with well thought out idea proposals.
- *The SMEpool* is a similar organization but it is not a legal body and does not financially compensate group members. It acts as a consortium to bring together interested SMEs and party members. The SMEpool offers a helpful contact database that provides previous records with innovative results. The group also acts as a stepping stone into SMEEIG.

SMErobot also offers training and education activities that foster technology development, testing, and skill enhancement, increase cooperation between partners, and improve public relations for SMErobot.

DARPA, SAIC and SMErobot each promote product development and innovation, but in very different ways. As we consider the best strategy for Southside, it is important to remember the recent trends found in this research. While there is going to be a continued demand for automotive robotics between large buyers and manufacturers, the innovative shift recently has moved towards more specific robotics development utilized by smaller firms. Innovation may be fostered in a number of ways, so it is important to encourage the most cooperative partnerships for our particular region.

5.3 Polymer Industry

5.3.1 Overview

Polymers are found in the natural and synthetic environment. Polymers can be manipulated to create advanced materials including fibers, cellulose, organic material, and chemicals. These polymers are utilized in many industrial or consumer applications including plastics, textiles, liquid technology, medical equipment, electronics, and many others. Polymer technology enables the adaptation of products to their ability to meet a market need. Examples include improved function, safety, efficiency or increased productivity. Many industrial sectors use polymer technology including aerospace, defense, automotive, biotech, consumer products, etc.

The industry thread is influenced by the different size of companies and their different strategies approaching innovation and reaction to market trends. Within the polymer industry, large companies use a combination of strategies involving in house R&D, acquisition of smaller companies and collaboration with suppliers, customers and research institutes. The industry is dominated by large firms such as DuPont, BASF, Cargill-Dow and P&G, while future polymer innovations appear to be strong among spin-offs and SME's

5.3.2 Size of Firms in Polymers

The polymer sector's typical research & development model involves integration and collaboration. Organizational structures include alliances, joint development and partnerships, and center of excellence strategies.

Table 4: Strategies Employed by Polymer Companies

Strategy	Examples
Joint Development (i.e. University, Industry & Defense)	In 2006, Virginia Tech's MII and MultiTASC teamed up with ARL to commercialize products for the DOD (Trulove 2006)
Alliances	PolymerOhio (www.polymerohio.org)
Partnerships/Joint Development/Center of Excellence	University of South Carolina Nanocenter; Polymer Nanocomposites Manufacturing Partnership (PNMP); Polymer Nanocomposites

	Research Center of Economic Excellence (http://nano.sc.edu/thrust_polymer.shtml 2002)

Using Malecki's linear model to track the path from R&D to Process Development and Production, some findings suggest that large companies still utilize linear closed R&D approaches. An example is BASFs acquisition strategy. In contrast, small and medium sized companies tend to collaborate with universities, providing technology to larger entities such as the Department of Defense. The evidence of traditional linear R&D in large companies does not preclude the lack of open innovation opportunities in the polymer industry. Facilitating the path of technological development from R&D to market, large companies also solicit for outside ideas and collaborate with universities and research centers. For example, BASF's Research Verbund works through their "Research Cooperations" in bilateral and network arrangements with universities, research centers and other industries (BASF, 2008). Additionally, DuPont's "Knowledge Centers" and "Technology Bank" work with DuPont's customer base to assist with product development or to transfer IP (DuPont, 2008). This suggests the relationships involving polymer commercialization involve a mixture of open and closed approaches for the best fit to a company's marketing strategy.

5.3.3 Market Trends in Polymers

Market research for the polymer sector supports the need to look for innovation in expanding fields like medical and industrial applications and beyond the traditional applications and established markets. This is especially true for products that are at the end of their life cycle and in the advanced stages of maturity (Frost & Sullivan Research Service, 2007). Industry research stresses the need for heightened market attention and the awareness of regulatory requirements:

> "Developing high levels of awareness of the total market will be more important than ever; companies failing to do so will soon find themselves uprooted from their leadership positions and rapidly overtaken by flexible competitors" (Frost & Sullivan Research Service, pg. 2, 2007).

Market trends in the polymer industry are influenced in part by increasing social and economic pressures to create technologies that meet a public good such as biodegradable products that consider environmental concerns (Frost & Sullivan Research Service, 2004). Another growing area is the development of smart fabrics that respond to stimuli or serve a medical purpose such as anti-bacterial (Harvey, 2002). With these emerging trends in the industry and cross sector application of polymers, ample opportunities exist for companies involved in polymer research and manufacturing. Future product applications in industries such as textiles, consumer goods, automotive or the medical sector also may reveal potential crossovers to consider when focusing on matching polymers to new industry in the Southside region.

5.3.4 Mechanisms for Knowledge Transfer in Polymers

The polymer industry is heavily concentrated in research and development. However, there are many examples of product adaptations involving polymers with other industry sectors. This is an example of open innovation where matching new polymer advances with commercial opportunities could be a model for expanding opportunity for existing polymer research and companies already present in the Southside Virginia region.

From our research findings, the following briefly addresses examples of mechanisms for technology transfer. These linkages between R&D and market are examples of tools that can be used to facilitate open innovation in the polymer industry.

- Intermediaries - Models for SME and Large Companies
- Mutual Transfer Agreements – Protein Polymer Technologies and the University of Arizona
- Policy – Enabling Environments for Spin Offs: Akron Polymer Systems

5.3.4.1 Intermediary Strategy

Implementing an intermediary strategy has benefits and challenges, but for this section, the focus is on how differing types and sizes of companies utilize intermediary strategy in the polymer industry. Intermediaries bring together firms or individuals to solve technical problems or to supply a technology to complete a project. Also termed "knowledge brokers", intermediaries connect firms and inventors/researchers by finding matches for uses of their technology. This strategy is essentially IT networking to link R&D to market demand, which provides firms looking to market their intellectual property with a quick and easy way to access other companies who are looking for specific technologies that are already developed and proven (Gwynne, 2007; Babcock, 2007).

Proprietary concerns can be a roadblock for companies to take part in open innovation, so many intermediaries take various approaches to protect the buyer and seller within the interaction and IP transfer. Some function as agents representing one side of the transaction and have an allegiance to that client, while others operate as brokers or market makers seeking to bring parties together. In some cases intermediaries attempt to assess IP market valuation similar to investment bankers or exchange (Chesbrough, 2007). VTIP (Virginia Tech Intellectual Properties) is an example of an intermediary whose clients are faculty at Virginia Tech.

Examples of intermediaries in the polymer industry include intermediary firms that specialize in assisting with commercialization for many research-based industries through out-licensing. Two specific intermediaries identified that work with advanced materials such as polymers are:

- Pharmalicensing.com – assists with licensing/ commercializing R&D bio-based polymer nanocomposites industry (http://www.pharmalicensing.com).
- Nanowerk.com –a networking site that offers materials database, forums, news – not sure if they have a brokerage/agent capacity (http://www.nanowerk.com).

These intermediary firms may be more instrumental with connecting small and medium enterprises (SME's) with new technology and solutions.Large companies with internal competencies can participate, contribute or create their own intermediary platform. Eli Lily, a large pharmaceutical company, adopted their own open innovation platform and intermediary strategy through InnoCentive. Innocentive's platform connects companies, academic institutions, public sector and non-profit organizations with a global network of "Seekers" and "Solvers" (http://www.innocentive.com). The website allows individuals or companies to view the "Challenges" entered into the intermediary system and can then register to enter their purposed solution in exchange for compensation.

InnoCentive and Eli Lily's ability to utilize their own intermediary strategy reflects the findings of recent research on firm structure and its connection to successful implementation of an intermediary strategy (Lichtenhaler and Ernst, 2008)[3]. The structure of firms and their internal ability to build their own expertise in an industry area strongly correlated with the level of benefit a firm derives from intermediaries. Lichtenhaler and Ernst found that firms that have the ability to align their internal competencies with external knowledge have more success with working through intermediaries.

In comparison, DuPont is a global supplier of technology including polymers. DuPont bridges internal R&D with market demand by linking their customers to polymers and other technologies through their "Knowledge Center" located within the DuPont Engineering Polymers department. This center focuses on helping potential customers carry out a project from "concept to commercialization" (DuPont, 2008). From a brief exploration, the center does not appear to be a formal exchange of external research with DuPont R&D. However, the website offers assistance with a customer's research and design so there may be some spillover effects between ideas from outside customers and DuPont's product innovation. Because companies that use the "Knowledge Center" site may be end users of DuPont polymers or

[3] Lichtenthaler and Ernst found that "structural organizations" that have already devoted substantial resources to developing internal competencies and "institutionalize external technology exploitation"…"can ensure a successful coordination of internal and external activities". (Ulrich Lichtenhaler and Holger Ernst. 2008; *p.1008-1009;1026)*

trademark products, this marketing strategy could create an avenue for DuPont to gain access to new customers for collaboration. Along with their "Knowledge Center" concept, DuPont is also a client with yet2.com, an intermediary broker who assists DuPont with technology transfer. Conversely, the "DuPont Technology Bank" sells DuPont's intellectual property and is an actual open innovation portal that connects research from DuPont to other inventors or companies that would like to purchase DuPont IP for their projects. In this case, it appears that DuPont can still recognize financial gain from IP not utilized within the company.

The intermediary approach could be an additional formalized mechanism to build connections with IALR's research and the community. Revealing new paths in addition to supporting existing technology transfer efforts at IALR; the intermediary function can serve to link research with potential spin-outs or entrepreneurs. Another future consideration for IALR's outreach might involve encouraging the internal "learning effects"[4] for firms in the region by creating a formal system that allows firms to work in a neutral space to solve problems and gain external industry knowledge with the assistance of an intermediary.

5.3.4.2 Mutual Transfer Agreements

Another mechanism utilized in the polymer industry is mutual transfer agreements. These agreements assist small and medium sized companies with accessing research faculties and expertise. This occurs within a safe environment that protects each party's proprietary interests. This collaborative concept is designed to benefit two parties in gaining market share in a technology sector through shared resources[5].

Protein Polymer Technologies, Inc., a biotechnology device business, utilized this arrangement with the University of Arizona in 2007. Specializing in protein design and synthesis, PPTI entered into a Mutual Transfer Agreement to benefit from a collaborative invention in the area of tissue engineering and regenerative medicine (PPTI, 2007). Under the Mutual Transfer Agreement, the private company provides a technology (in this case genetically engineered protein polymers) and if the university develops a new innovation using this technology, the company has the first option to negotiate an exclusive or non-exclusive royalty-bearing license agreement of the university's invention or joint invention enabled by the use of

[4] "...firms are often unable to fully utilize the resources of intermediaries because they f ail to align the external services with their internal activities."..." Moreover, dedicated structures facilitate learning effects and will resulting superior selection of intermediaries." Ulrich Lichtenhaler and Holger Ernst (2008) *p1026*

[5] In Fredberg's "Managing Open Innovation…." he cites Dittrich and Duyster's (2007) analysis of Nokia's business structure. As they developed mobile telephony, Dittrich and Duyster observed that Nokia had once relied on internal product development or long term partnerships, but began to use "explorative collaboration agreements" with organizations that they had "weak ties".

the company's technology (PPTI, 2007). The agreement is similar to a Cooperative Research and Development Agreement (CRADA) in which a private company and a government/institutional agency can work together and share technical expertise in a protected environment (http://www.usgs.gov/tech-transfer/what-crada.html). Such agreements may assist with reconciling the issues that arise between two companies or a university and a company with revealing their proprietary interests and competitive advantages, along with tackling the legalities with IP infringement.

5.3.4.3 Policy: Enabling Environments for Spin-Offs

According to the Ohio Business Development Coalition (OBDC), a nonprofit organization that markets the state for capital investment, the state of Ohio offers several state sponsored programs designed specifically for entrepreneurial business growth and development (PRNewswire.2008). A combination of economic and policy strengths in Ohio, along with strategic alliances, may have contributed to creating the momentum for the spin-offs from the University of Akron. An example of this is Akron Polymer Systems (APS).

APS was established in 2002 by professors Frank Harris and Stephen Cheng. APS is focused on developing high performance polymers, as well as advanced materials commonly used in liquid display (LCD) technologies, for clients in aerospace industries as well as for the medical, optical, photonic and fuel cell industries (PRNewswire.2008). APS is also focused on the commercialization of polymer technology, employing 9 full-time Ph.D. polymer scientists (APS, 2008). APS received two grants through Ohio's Third Frontier Project - a $1.6 billion initiative to help catalyze connections between companies and academic institutions[6]. They also teamed up with PolymerOhio. The company is working toward a long term plan of becoming a supplier to original enterprise manufacturers (OEM) (PRNewswire, 2008).

Support for spin-off polymer companies in Ohio may be due to a large concentration of existing polymer enabled businesses, such as the automotive sector. Although the commercialization and start-up success is evident within Akron Polymer Systems, it is not completely clear what the exact steps were to building their business. The path from R&D to industry for APS seems to have required a combination of technical expertise, governmental policy support, financial resources from state programs such as the Third Frontier Project and networking alliances such as PolymerOhio to bridge the jump from research to spin-off. In addition, Professors Harris and Cheng worked together and gained several US patents from 1994

[6] The Third Frontier Project (one of many programs funded and directed by the state of Ohio and their General Assembly under their Department of Development) is a 10 year $1.6 billion initiative founded in Feb. 2002 and guided by leaders in industry, academia and government as a collaborative effort that provides grants and funding to support formation of companies, transfer of research and the promotion of innovation in Ohio. www.thirdfrontier.org

to 2002 in the polymer field (Cheng, 2008). PolymerOhio contributed to APS' start-up success by supporting them through an industry networking group in Ohio's plastics, rubber and advanced materials industry. The network provides Ohio's polymer industry "value-added programs and services" and also provides resources such as a detailed listing of the state's polymer research universities, industry groups and economic development initiatives (PolymerOhio, 2008). The alliance appears to be based on an open network strategy of shared knowledge.

Judging from the supportive environment that exists in Ohio for polymer research, it appears that commercialization is rather important. One interesting topic for further research in Virginia strategies is the passage of SB286 in 2000 by the Ohio legislature[7], which ushered in a wave of polymer and other technology commercialization for Ohio. This bill basically allows university entrepreneurs to benefit and hold equity ownership in companies which commercialize university-owned inventions denoting the effect of enabling state policy on industry generation and economic development. Other key factors in this example include a network of talented scientists and professionals, strong university/industry commercialization strategy and financial commitment.

Relevant to IALR and the Southside region, using a comparison of the Ohio APS Case Study to assess the policy initiatives in Southside and Virginia, the polymer network in Ohio maintains the advantage of strong support from industry and universities. Southside is connected to Virginia Tech with IALR and is the home to existing polymer businesses (i.e. DanChem, Sartomer, Essel Propack, Intertape Polymer). The polymer industry is linked to many other industrial sectors. Southside Virginia has a historical presence in the manufacturing sector, plus the addition of research strengths through IALR, the strategies discussed here could be assessed for their application for integrating IALR polymer research with other Southside industries. These mechanisms may contribute to the success of spin-offs or attract other companies to the region that could benefit from open innovation.

5.4 Information Technology Industry

5.4.1 Overview

The Information Technology thrust's underlying component is the dissemination of knowledge, whether data, communication, or the storage and implementation of processes. The end product in the IT sector is either hardware or software that is utilized in personal computing, business, research, and large industrial manufacturing. A review of industry articles indicates an over arching theme of the need for flexibility. For example, creating manufacturing software

[7] http://www.lbo.state.oh.us/123ga/fiscalnotes/123ga/SB0286HP.HTM

and smart machinery that adapts for various platform needs. Another theme is the improvement of services or processes through information flow[8]. Recognizing the influence of Web 2.0 in product development and the integration of supplier's or customer's industrial or operational needs is instrumental for the delivery of effective products that span many devices or match with ideas of other company's products. In other words are O'Reilly (2006) states, "trusting users as co-developers".

5.4.2 Size of Firms in IT

Large companies like HP and IBM are starting to embrace open innovation as they realize the need to collaborate with universities and research institutes to share ideas and R&D projects. HP Labs (http://www.hpl.hp.com), for example, is focused on research with other companies, universities and venture capitalists. IBM's "Collaboratories" works with "mostly small, regional joint venture with universities, foreign governments and commercial partners" and is an example of open innovation (Anthes, 2008). Due to the nature of IT, the size of the firm does not seem to have as big of an impact on their participation in open innovation as it does in other sectors.

5.4.3 Market Trends in IT

Large companies and small and medium companies all utilize IT in some fashion, therefore the market trends that concern IT research should be considered for all the industries. Large companies that dominate the IT sector, such as IBM, along with small and medium sized companies, are all subject to the market trends of software and hardware that is easily adaptable to an individual or company's specific business model, operation and/or product. Some of the markets normally dominated by large companies, such as the PC sector, are subject to fluctuations and downturns as products mature and more versatile products become popular[9].

[8] In order to compete, the company is working on this IT/production challenge recognizing that a manufacturer's "prowess" will depend greatly on information technology enhances the machines and how software can assist the company with its awareness of how significant the information that comes from the machine can help with efficiency and business decisions (Factory Automation, 2007).

[9] In mature markets such as the US and Europe, smaller PC makers may be forced out by larger competitors, Shim said (Richard Shim, personal computing research manager for IDC). However, in emerging markets, the smaller PC makers are ripe for acquisition, as larger PC makers are always trying to expand their customer base, he said" (Shah, 2008).

Challenges to IT in SME and Large Companies include:

- Increasing costs
- The need to adapt to a demanding customer base with rapidly changing needs.
- Creating flexible IT technology that is adaptable to many industrial and consumer needs.
- Increasing competitiveness as companies, inventors and entrepreneurs innovate through social networks.

The IT business model is also trending toward the use of web communities (social networking strategies) or networks of intermediaries (innovation bazaars) in order to innovate and create added value (Gwynne, 2007). The use of open network solutions to combat ROI challenges is a main priority for IT firms. By sharing knowledge, IT firms large and small gain insight from their suppliers, competitors and customers. Through social networking, a firm can seek feedback results from their customer base and save money on research, utilizing open innovation by gathering ideas from customers. According to an article based on results from IBM's 2008 Global CEO Survey[10], companies will need to look at networking as a potential avenue for ideas for products and innovation:

> *"The CTO can look at social networking with demanding customers as a way to gain insight for research projects and products. The empowered consumers are no longer a threat, but provide an opportunity to differentiate" (Hennessy, pg.2, 2008)*

In the same article, Hennessy dictates IT strategies for companies to implement in order to become an "Enterprise of the Future" including being able to communicate on business terms the importance of flexible, adaptable IT systems and steering the company's product development toward social responsibility initiatives (i.e. recyclable products, "consolidation and virtualization" of data centers and the continued adaptation to a mobile workforce) (Hennessy, pg.2, 2008).

5.4.4 Mechanisms for Transfer in IT

Information technology is used in practically all sectors, enabling other industrial and personal sectors to conduct daily business, network within and outside the company, and increase the exchange of knowledge. With the increased pace of technological changes and

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[10] This article referred to a survey of 1000 CEO's and was written in Research Technology Management by Mark Hennessy, CIO for IBM, regarding the CIO's vision for their organization's futur

competition, IT is changing the way industry creates and links to other ideas through the use of intermediaries. As discussed in the polymer sector, the intermediary strategy is innately an IT concept utilizing social networks IT platforms are the actual mediums that intermediaries utilize, assisting buyers and sellers of innovative ideas, linking inventors with companies and vice versa. Examples include NineSigma, an agent for proprietary network of scientists, university researchers, and technology providers matching solution providers with network (ninesigma.2008) and yet2.com, a broker that assists with technology evaluation, licensing, tech acquisition, business development and R&D needs (yet2.com, 2008)

Implications for the use of open networks sharing ideas across sectors include the fear of lost proprietary data through IP and copyright infringement. As communities work together in the open source environment, mechanisms such as cross-licensing become important to head off copyright infringement. This has lead to intellectual property rights becoming assets for companies (Fredberg et al, 2008; Chesbrough, 2006). Licensing strategies that are important for software development include cross-licensing. This allows parties involved to share proprietary information. An example of cross-licensing is reflected in the development and application of open source software (a supportive technology of open innovation) between Google and Linux. Google (along with IBM and Oracle) joined the Open Invention Network, a group that cross licenses Linux patents as a means to discourage infringement challenges to Linux (Babcock, 2007).

In the context of Southside, perhaps IT intermediary strategies could formalize a network that could connect the research thrusts to outside business opportunities. In addition, tools like intermediaries and cross-licensing may address gaps such as IP valuation and transfer, locating appropriate ventures and new companies or matching market demand between research and process development, production and diffusion.

5.5 Agriculture Biotech Industry

5.5.1 Overview

The biotechnology industry began in 1973, and focused on the idea of gene splicing or Recombinant DNA. The industry of biotechnology today studies and makes products that utilize gene splicing and is a global industry worth over $500,000 billion. The study of recombinant DNA was patented by Stanford University (Cohen-Boyer Patent) with research funding and royalties from two major pharmaceutical companies, Genentech and Amgen. The licensing strategy used by Stanford’s laboratory emphasized that biotechnology would be commercialized for public benefit, and that it would be consistent with the public service ideals of the university. The resulting industry of biotechnology frequently follows a production model that is rooted in university based innovation.

Monsanto and DuPont are two large entities in the biotech industry. The agriculture biotech industry is involved in pharmaceutical and transgenic crops. Pharmaceuticals are designed to meet ailment needs of mammals, while transgenic crop enhancement is designed to protect or increase the value or yield of plant life. Transgenic crop traits focus on seed production, which is genetically altered so that crops yield a greater harvest which could be based on herbicide tolerance or virus resistant gene enhancement. In the late nineties Monsanto was able to improve its holdings on transgenic crops while other large companies like DuPont focused on pharmaceuticals (David Wheat, the Bowditch Group).

5.5.2 Size of Firms in Biotech

Some biotech companies recruit skilled scientists to create new technology in a vertical integration model. However, this method is not that common as it is costly and is not focused on results. This sort of strategy is considered a luxury of large companies. Large biotech companies also have the ability to hire specialized laboratory work, or in the case of companies like DuPont, buy companies that are working in desirable fields such as pharmaceuticals or agriculture/transgenic crop enhancement. This acquisition strategy is only accessible to large companies. There are several barriers that inhibit small companies from entry into the market. Initial start-up costs are too large for some companies, government regulations and inability to find funding are also problems. Small biotech companies are more likely to be purchased by the larger companies before much innovation is able to occur. Open innovation is breaking down some of the barriers for small and medium companies, but obstacles still remain.

The stages of development for biotech firms is an involved process. These stages points to how small and medium firms can take advantage of the principles of open innovation. The porous nature of the boundaries in open innovation lend themselves to providing small and medium companies without

Biotech Industry Model

Successful stages for building should consider the following to streamline production design.

1. **No unplanned downtime upon startup**. Must not allow competitors to get to the market first.
2. **No factory losses upon startup**. Understanding costs to best assess business risk should be considered when focusing resources.
3. **Well-organized documents for FDA inspection.**
4. **Well-organized documents for future reference by operations staff.** An example would be developing properly organized engineering calculations as part of the design qualification (DQ).
5. **Project Anatomy for Biotech project delivery:** (again each phase has various inputs such as CAD/and other engineering scientific designs based on type of Biotech)

Biotech Industry Model

large R&D to compete with the larger companies like Monsanto and DuPont. The stages for development are as follows:

1. **Conceptual Design**: definition stage of types of criteria essential for successful design solution.
2. **Schematic Design**: the engineering department is responsible for developing the design solution, while the manufacturing support personnel only review the design solution and not try to develop it themselves.
3. **Detailed Design:** engineers have worked with the process designers to develop control strategies and size control valves and other instrumentation in schematic design in this phase. Constructability considerations are also now included in the final design.
4. **Procurement**: many manufacturers have corporate engineering departments that have specifications for common process and utility equipment, instrumentation, and piping, which can be checked by pharma/biotech industry references such as ASME bioprocessing standards. The specifications and design information are sent to the vendor(s) for bidding or estimation.
5. **Construction:** can either be contracted out or in house, laborers, especially on larger projects may not have the experience so training and necessary industry compliance are focused on.
6. **Commissioning and Qualification**: field testing stage.
7. **Process Validation:** quality unit representative and FDA are aware of the challenges inherent with the specific product.

5.5.3 Market Trends and Knowledge Transfers in Biotech

Strategic alliances and other collaborative agreements among universities, biotechnology firms, and larger industrial companies are widely used methods of achieving innovation (Mohannok 2007). Regional clustering is likely to incorporate institutions engaged with R&D and training in areas relevant to the business activities of the firms in the network. Biotechnology is a constant process of updating and refining gene splicing to fit a desired need, which can be quite costly and labor/research intensive. To offset this problem, firms have to combine different sources of capital, including public funds, venture capital, national research contracts and debt financing to sustain operations (Greis et al., 1995) These can be politically initiated regional economic incentives, or facilities for the sharing of knowledge and merging of SME's.

The benefit for a region is increased "economic activity based on new knowledge which generates higher wages and greater employment opportunities reflecting the exploding demand for innovative products in high-technology" (Rhodes, 2002). Biotech as an industry has its roots in transferable 'know how'. This continues into these new strategies with patenting of innovative ideas being a key component for relationship in clusters and collaborative efforts.

Patents illustrate the collaborative, incremental nature of the industry, and the key role that research-tool technologies and broad licensing have played in promoting further innovation. A fear of stealing innovation increases the importance of interpersonal networks where relationships function on a different operational logic than other models of innovation development. Within network arrangements the existence of mutual trust is identified as a necessary mechanism to bring organizations together (Grandori and Soda, 1995). Mutual trust fosters a willingness to overcome organizational differences, to work through difficulties, and encourage openness in exchanging ideas and information. Relationship based networks have a better potential to reduce the cost of innovation and the level of uncertainty. (Cohen and Prusak, 2002)

5.6 Automotive Industry

5.6.1 Overview

In Southside Virginia, the focus of infrastructure development has been on auto parts enhancement, not the creation or enticement of a primary automobile manufacturer. In the beginning of the auto industry, vehicles were made by combining parts from various developers (late 1800's). With the introduction of primary manufacturers such as Ford, GM, and Chrysler, a new model was introduced in the early 1900's. The model of 'vertical innovation' was characterized by manufacturers creating their own parts which were designed and manufactured on site. This philosophy resulted in massive auto plants and development/research facilities around Detroit. Liability suits in the 1970's, and the advent of Japanese competition created a change in the 'vertical innovation' model. Parts innovation has evolved into a model similar to the late 1800's involving independent entities, with heightened input from manufacturers.

5.6.2 Size of Firms, Market Trends and Knowledge Transfers in Automotive

Two different types of independent production models exist for high performance parts production and manufacturing. The parts can be created in one area and transported to the auto manufacturing/assembly sites, or the parts can be created through manufacturer supported 'supplier park'. Since Southside VA does not have a major auto manufacturer, creation of a specific manufacturer supplier park is not viable. Supplier parks have the benefit of being on the doorstep of a major manufacturer. This allows them direct access to the manufacturer, lower inventory costs, and lower shipping costs. Parks also increase efficiency and reduce environmental impact. Toyota created a supply park in San Antonio when it began manufacturing Tundra there. Toyota built a supplier park for support that was 1.5 million square feet. These parks function as small and medium enterprise (SME) clusters that are not directly owned by the manufacturer.

The alternative method of parts production and distribution is similar to the situation in Danville. Companies located in Southside Virginia would most likely be transporting the product or technology to a manufacturing center, or introducing the technology through an exhibition. Currently the parts engineering focus in Southside follows dynamic systems model of drive train and suspension. The method of production/distribution of a similar parts industry is found in Germany's ZF Friedrichshafen AG (ZFFAG).

ZFFAG creates advanced chassis and drivetrain systems. In 2005 it introduced a concept that linked active suspension, steering and power-transfer systems for optimal driving control. To market its product, the company had attended a technology clinic at Michelin SA's proving grounds in Laurens, SC. Michelin created a proving ground for parts that could be used by the BMW manufacturing plant located near Laurens (Michelin located on its own/not part of a BMW park). BMW was interested in the technology and wanted to insert the system into its BMW 5-series AWD. A problem existed in that such a system would not fit within the engineered body. BMW found the system to be so valuable that it reengineered the car to fit the chassis. This example points out that while large automotive clusters exist around primary manufacturers, it is not necessary if the technology can be transported.

5.7 Industry Findings

We found that the industry sectors incorporate aspects of open innovation in their commercialization strategies in various ways across industry thrusts; Small, Medium, and Large enterprises select technology that correlates with the appropriate placement in their overall product mix. Companies' response to market trends and demand relating to resources, competition, marketability, and policy parameters is dependent on their internal ability to absorb new information and their position in the market. Larger companies may have more resources, whereas SME's may rely on networks or alliances for support. The following summary underlines our research findings, reflecting the pattern we discovered correlating to transfer mechanisms across industry thrusts:

Table 5: Summary of Industry Thread and Technology Transfer

	Size of Firm	Market Trends	Knowledge Transfer
Robotics	Small/Medium	Demand Exists- Gap in Financing	Financing and Education
	Large	Major Consumers	Robotics Fairs

Polymers	Small/Medium	Specialized/Supplement	Policy; Mutual Agreements
	Large	Smart Products	Knowledge Brokers
Automotive	Small/Medium	Specialized Engineering	Clusters in Parks, export to test sights
	Large	Outsourcing	Park creation
Biotech	Small/Medium	Pool for Resources	Cluster
	Large	Diversify Portfolio	Acquisition
IT	Small/Medium	Flexible Platforms	Web Community
	Large	Data Management	Cross-Licensing

We found that large companies still rely on traditional strategies such as acquisition (i.e. polymer and biotech sectors), however evidence of various open innovation network strategies are reflected with their use of intermediaries. Large companies such as Eli Lily and DuPont took the idea and created their own intermediaries. Mature industries, such as the automotive sector, encourage clustering partnerships to either specialize in product innovation supplying to automotive manufacturers or develop technology that can be utilized in many automotive platforms.

The implications for Southside and IALR as they consider open innovation strategies to improve local commerce differ among industry thrusts due to the region's assets and resources. We found that certain policy and supportive environments must be present. Also methods to resolve conflicts such as IP infringement and proprietary knowledge protection must exist for organizations to be comfortable with participating in sharing internal research with external sources or vice versa.

We have concluded with recommendations that are reflective of similar regional industry initiatives and models that may prove to be informative to IALR for future economic development in the Southside region.

The following recommendations include:

- **Automotive:** The Southside VA thrust of parts engineering follows dynamic systems models of drive train, and suspension focuses. The region must consider whether or not to attract/create its own 'park', or create an environment suitable for easy exportation of goods to markets/parks.

- **Biotech:** Regional clustering is likely to incorporate institutions engaged with R&D. Firms have to combine different sources of capital, including public funds, venture capital, nation research contracts and debt financing to sustain operations.

- **Polymers:** The Polymer community is strong in skilled research – To successfully connect to end users of applications, possibly refer to existing intermediary or cooperative agreement examples as a model to create an enhanced IALR Technology Transfer strategy (i.e. Intermediaries -"Knowledge Brokers" & Mutual Transfer Agreements)

- **Information Technology:** Across the industry community, the prevalent market trends influencing the IT sector have an impact on operations. The ability to compete in the manufacturing sector will depend on flexible platforms such as smart software in machine re-tooling. In addition, industry will need to develop an IT strategy for managing data and security. The potential to connect to community for IALR may lie in the social networking qualities of the IT sector, whereas an interactive link to activities or classes with the institute may be helpful to skill development in the region.

- **Robotics:** The Robotics community seems to be encouraging financing and education for small and medium sized companies because the next wave of innovation lies in the diversification of these products. Until now, only large manufacturers such as automotive producers and government entities have been able to afford research for major technological advancements in robotics. As the market expands to include these smaller enterprises, robotics will become a more valuable industry to the average US city. Therefore, any opportunities for increased financing and education should be fully taken advantage of (such as through third party entities like SMErobot, DARPA and SAIC).

6 COMMUNITY THREAD

6.1 Roles of Community in Open Innovation

Within the literature review and the analysis completed with regard to the Institute for Advanced Learning and Research, we found that communities most often participate in open innovation through its interactions with universities. Community involvement in an open innovation strategy is increasingly important as communities are faced with pressures of the changing economy. Lester (2005) brings up the issue of globalization and the challenges that many local communities are now facing as they compete in a global market. These challenges can be met with an open innovation model that forges the relationship between communities and universities. There are several ways in which the involvement of a university can be advantageous for a community. One of the primary advantages of the involvement of a university is the fact that universities are stationary (Lester, 2005). While companies may move in and out of an area based upon the financial situation before them, universities do not move. Universities can also attract other economic resources such as firms and individuals that want be nearby (Lester, 2005). Malecki (1997) also points out that spin-offs or licensing from universities can encourage the location of production in the same area to take advantage of the synergies from being close to the originator of the intellectual property. Researchers who head up spin-offs are also more likely to locate production in the same area. It is important to recognize, however, that some communities, particularly those that are underdeveloped or struggling, still face challenges in recruiting production firms or keeping spin-off companies in the region. This challenge may hint to locational factors as a primary determinant in deciding how licensing IP can be part of a region's strategy for using open innovation as an economic development tool.

Cooke (2005) further addresses locational factors with his discussion on regional knowledge monopolies. Firms gain an economic advantage by locating near these research monopolies and taking advantage of being spatially close to other firms in the same industry. Silicon Valley is an example of firms moving to an area because of other firms. Cooke further points out that these regional clusters of knowledge allow for returns to these spatial knowledge monopolies. Table 4 provides a few examples of regional knowledge monopolies in the United States. There are different ways in which these regions became monopolies of a certain technology: through indigenous creation, through transplantation, or through diversification of a technology that was already present, or through upgrading (Lester, 2005). Communities who have struggled economically or lost industry market share can use one of these four strategies to again compete in a globalized market place.

Table 4: U.S. Regional Knowledge Monopolies (Lester, 2005)

Location	Industry/technology
Rochester, NY	Opto-electronics
Akron, OH	Advanced polymers
Allentown, PA	Opto-electronics/Steel
Boston, MA	Bioinformatics
New Haven, CT	Biotechnology
Charlotte, NC	Motor sports (NASCAR)
Greenville-Spartanburg, SC	Autos
Alfred-Corning, NY	Ceramics
Youngstown, OH	Steel/Autos

As mentioned in the University Thread section of this report, the creation of educational pathways and the commitment to the local workforce may help to incentivize firms looking to relocate to the community. The potential economic benefits that may come from encouraging an educational continuum, as well as supporting a culture of entrepreneurialism within the community, are significant. Communities must continue to support a wide range of educational programs, including programs that support secondary school completion, programs connecting high school graduates with community college or other undergraduate programs, programs focusing on entrepreneurial training and gaining access to venture capital, and workforce training programs specific to local industries. Communities must begin to recognize the links between education, economic, and workforce development systems since the interplay between these systems is vital to regional economic success.

The role of the university and community in open innovation is an important one and how they perform that role can determine the success or failure of regional competitiveness. SRI International (2008) lists four necessary components to "catalyze innovation". Table 5 below lists these four factors and describes how the university and community can help those needs be met.

Table 5: Role of Universities and Communities in Facilitating Open Innovation

Catalyzing Factors	University	Community
Increasing Collaboration Across Sectors and Disciplines	Recent focus on collaboration among faculty will facilitate this principle at the basic and applied research level. Grants are beginning to provide the necessary financial	Social networks can provide an interface for university and industry to interact. Other social networks such as Bar Camps, further facilitate collaboration.

	incentives for collaboration.	
Making Smart Technology Choices	The use of incubators or accelerators such as VT Knowledgeworks.	Feedback from the community through the above mentioned social networks could help facilitate this need.
Nurturing Entrepreneurship & Access to Capital	Again, the purpose of incubators and accelerators is to provide a place for entrepreneurial start-ups to thrive.	Policies and accommodations for companies. For example, the CRC provides some of the needed infrastructure for small companies wishing to compete in a global market. Attraction of Venture Capitalists to region.
Enhancing Research Excellence at Universities	Competition for in-house funding as well as budget cuts forcing researchers to compete for funds can raise the level of research.	N/A

6.2 Southside Virginia and IALR

Referring back to our vision of open innovation as a woven tapestry, the community thread is influenced primarily by the infrastructure that is available within a particular community. Adequate built infrastructure, such as affordable and desirable housing, is important when appealing to companies looking to relocate or when trying to lure top-notch researchers or graduate students to an area. Similar to the built infrastructure available, the civic infrastructure such as quality public school system and other public services is important when attracting potential companies and residents. Technology infrastructure, including Broadband access, is a particularly important consideration for small start-up companies. Political infrastructure such as "buy-in" from local officials is also important in building a successful innovation enterprise. This is particularly true in the Southside region since IALR's service area encompasses seven jurisdictions. There must be a political investment from the region as a whole and a recognition that the innovative work being done at the Institute has the potential to generate region-wide economic benefits, not only for Danville. Finally, the geographic location of an area plays an important part in either supporting or hindering the success of the innovation structure. Factors such as proximity to major airports and highways are vital for issues such as access to venture capital, ability to host networking events, and overall livability of a region.

The primary factor influencing the Southside community's role in open innovation is its interaction with programs at IALR. Currently, most of this interaction is initiated by the Institute, not the community. IALR's academic programs are designed to prepare the local workforce for the future knowledge-based economy, meet local employer needs, and expand access to higher education opportunities for area citizens. The Institute is committed to creating an educational continuum for local students so that they can move directly from associates to bachelors to graduate degree programs associated with IALR's research centers. In fact, at least one research center provides scholarship awards for local seniors so that they may go on to an undergraduate program in the field of the research thrust, with the intention of providing research opportunities within the center at IALR. IALR also benefits from its proximity to Danville Community College's Regional Center for Advanced Technology and Training (RCATT), which is adjacent to IALR in the same 330-acre cyber park. The co-location of IALR and RCATT provides the community with a visible commitment to workforce development in the region. RCATT offers credit and non-credit programs designed to meet occupational and professional needs of local residents. RCATT hosts Danville Community College's (DCC) Workforce Services programs, including Associate of Applied Science degree programs focusing on Polymers Manufacturing Technology and Manufacturing Engineering Technology. The high-tech facilities located at RCATT and the proximity to IALR's research labs, particularly the Advanced and Applied Polymer Processing Institute, help to encourage DCC students to not only complete their Associates degree, but to move on to Bachelors and graduate programs, as well. There may be additional opportunities, however, to strengthen the relationship between these institutions by creating formalized admission agreements, shared equipment and hands-on learning opportunities, or open house opportunities for DCC students to learn about further training. By creating defined educational pathways in the research areas, IALR hopes to create a critical mass of highly trained workers in areas that will attract core industries to the area, which will ultimately bring economic gains to the region.

IALR also offers educational programs *not affiliated* with the research thrusts. Undergraduate programs offered online or on-site range from Bachelors in Nursing from Old Dominion University (online) to a Bachelors in Computer Science and Technology from Radford University (on-site). Graduate programs range from those affiliated with the research centers (MS in Mechanical Engineering) to a Master of Dental Hygiene from the University of Tennessee. Having a central educational facility with a variety of programmatic options available allows the community to identify IALR as a conduit for higher education in the Southside region.

IALR's outreach initiatives are designed to facilitate a cultural shift that emphasizes the importance of science, math, and computer literacy for both youth and adults in the Southside region. IALR currently facilitates internship partnerships for undergraduate students at local businesses, offers a summer camp for children in first through eighth grade in science, technology, engineering, and mathematics, and provides professional development opportunities for the region's K-12 teachers in the area of science, math, and technology. The Institute also offers a public computer lab with Internet access and Microsoft software and computer skills training and certification through the International Computer Drivers License (ICDL) program, which teaches students the basic computer skills needed to succeed in today's workplace. Through its academic programs, particularly the educational pathways affiliated with IALR's research centers, and broader outreach initiatives, IALR provides workforce development opportunities and crucial interaction points with the community that are critical to the open innovation model.

7 RECOMMENDATIONS

Opportunities and challenges facing open innovation as a tool for economic development have been discussed throughout this report. There are two challenges and five opportunities that are believed to be the most relevant for Southside. The overall challenges that we believe may hinder open innovation's success as an economic tool include: 1) open innovation and its economic development benefits are not regionally bound, and 2) adequate built infrastructure is needed to attract companies to locate near this center of knowledge.

For Southside, the first challenge leads to importance of the second challenge. The openness of the boundaries in the open innovation model means that an area does not automatically capture every step in the technological change. The porous boundaries lead to a region needing a unique benefit in order for companies to locate in the area and the infrastructure discussed in the community section is a part of that.

The opportunities that exist within open innovation provide a way for Southside and each of the three threads in our woven tapestry to become actively involved in allowing open innovation to work as a tool for economic development. These opportunities are suggestions for IALR and economic developers in Southside for helping to facilitate open innovation in the region.

- Tapping into human and knowledge capital at IALR.
- Providing greater networking opportunities between the threads.
- Advertise and market state-of-the-art facilities.
- Take advantage of Southside as one region with many parts.
- Determine how cost and time savings by tapping into existing research can benefit each industry thrust.

1. Tapping into human and knowledge capital at IALR

The seven laboratories at IALR and the people involved in research at IALR, from research directors down to graduate students, are a unique source of knowledge and skill. IALR may want to consider a knowledge broker or intermediary that works specifically and alongside research directors and each respective industry. The knowledge broker would provide a link between solution seekers and solution solvers.

The human and knowledge capital also benefits the community of Southside. Examining the programs offered by OneKC and placing additional focus on investing in the education and investing in the people of Southside will have long-term payoffs for IALR and the community.

Funding programs that similar to PREPKC (discussed in the University Thread section of this report) should be a component of IALR and of state leaders.

2. Provide greater networking opportunities between the three threads.

Networking allows for direct and indirect knowledge transfers to occur. In addition to a knowledge broker helping to identify specific companies for the laboratories, providing industry specific interaction for research directories and for the industries could enhance companies' awareness of Southside and the unique opportunities that exist in the area. For example, targeting suppliers to customers of VIPER and providing interaction for VIPER, its customers and suppliers to its customers could allow for greater knowledge transfers.

Interaction with local government officials, local business leaders and IALR strengthens the relationships and opportunities among these groups. A monthly seminar that allowed speakers from any of the three groups is a way to start this formal interaction.

3. Advertise and market state-of-the-art facilities.

Identify companies that could take advantage of the facilities offered at IALR and market the opportunities to interested companies focusing the presentation of IALR's central location to companies in Virginia, North Carolina, and other surrounding states. Possibly, these same companies could offer their past learning experiences of how to partner technologies and create cross-sector applications. Identify industrial trade groups that could mentor spin-off activity from their previous experience (Ohio). Also consider ways that the facilities can be used to re-train the current workforce. The WIRED regions provide multiple examples for workforce re-training programs.

4. Take advantage of Southside as one region with many parts.

Providing and working toward a regional identity is important for outlying jurisdictions to feel a part of IALR and to work with neighboring communities in bringing economic opportunities to the region. The interaction and investment in the community allows IALR to facilitate openness among the various jurisdictions and may help to create this unified identity. Involved and actively engaged political leaders can also help facilitate a regional identity. Identifying public and private funding streams that could market a grassroots entrepreneurial campaign highlighting how the individual strengths of each jurisdiction and importance of pride in heritage may serve to develop this regional identity of Southside.

In addition to a regional identity, exploiting the diversity of the region is beneficial to economic development in the region. The leftover infrastructure from the tobacco industry, the network of racetracks in the area, and the numerous nurseries are examples of some of the diversity that exists. Linking a grassroots campaign to the geography a new local asset, IALR, along with the educational connection to Virginia Tech, could signal a transition for Southside toward a renewal of economic prosperity.

5. Determine how cost and time savings, by tapping into existing research, can benefit each industry thrust.

Rapid scale-up is one of the primary advantages of open innovation. Identifying ways that Southside and IALR can help companies be in position to take advantage of technology could lead to economic development. The five industry thrusts being courted by IALR have many overlapping uses and market trends that can be recognized by the Southside Virginia community.

- The robotics industry has shown great improvements in research and development through third-party support. These external actors spur robotics innovation by providing opportunities for companies, especially small and medium sized enterprises, to expand their technology through education and financing. Examples include a technology consortium for companies to exchange research ideas and a grant program that provides financial rewards for potentially successful proposals. These resources may be provided through large public entities as well as private consulting type companies.

- For the automotive industry, it may be valuable to court small and medium sized industries with the idea of exporting innovation and ideas to markets where test sites exist. The proximity to markets/test sites in D.C. and the centrality of location on the east coast may contribute to the viability of this marketing method.

- Biotech industries might be appealing to all industry sizes (DuPont's headquarters are not far removed, which may allow for subsidiary location). Creation of a market niche by focusing on specific regional resources such as corn, switchgrass, tobacco, or forestry options might be the specialized fields for pursuing biotech engineering.

- Polymer industries are already present in the Southside region and with the continued development of AAPPI research strengths the existence of these two factors may already save costs for initiating new companies or new product development. The cross-sector application of polymer technology may offer an opportunity to spin-off IP for expansion to not only traditional applications such as plastics, but in the emerging socially sustainable markets or in applications with the existing automotive thrust. In addition, as found in the Biotech sector, large companies such as Dupont may offer an opportunity for joint development.

- Information Technology applications are embedded in all industries. IALR and Virginia Tech have access to strong IT research through the university which may be attractive to companies demanding sophisticated data management and flexible platform research. Across business sectors, the potential operational and communication needs in industry IT departments could be identified and matched to current research at IALR and Virginia Tech.

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Appendix

The Institute for Advanced Learning and Research (IALR) has been awarded a total of $7,438,704 since 2004 through sponsored research contracts from a variety of sources (see the table below). A majority of this funding, a total of $6,623,756, has gone to support the development of the JOUSTER site.

Sponsored Research Programs at IALR, 2005-2008

Year	Project Title	Funding	Sponsor
2004	Develop the joint unmanned systems experimentation and research (JOUSTER) site	$1,750,000	Naval Air Systems Command
2005	Develop the joint unmanned systems experimentation and research (JOUSTER) site	$4,700,000	Naval Air Systems Command
2005	Structure bonding improvements in the production of cured-in-place pipe liners	$71,996	VPMEP
2006	Develop the joint unmanned systems experimentation and research (JOUSTER) site	$37,757	Naval Air Systems Command
2006	Embedded passive radio frequency-based sensors for radial aircraft tire structural health monitoring	$27,770	NASA, Langley Research Center
2006	Embedded passive radio frequency-based sensors for radial aircraft tire structural health monitoring	$38,191	NASA, Langley Research Center
2006	Embedded passive radio frequency-based sensors for radial aircraft tire structural health monitoring	$9,039	NASA, Langley Research Center
2006	Structure bonding improvements in the production of cured-in-place pipe liners	$855	VPMEP
2007	Develop the joint unmanned systems experimentation and research (JOUSTER) site	$135,999	Naval Air Systems Command
2007	A counter rotating mandrel die for the study of superimposed shear flows in polymer processing	$126,989	US Army Research Office
2008	Foamed polyurethane engineered growth medium for root x-ray imaging	$40,000	Phenotype Screening Corporation
2008	Counter Rotating Mandrel Die	$37,095	Virginia Tech Foundation Inc
2008	Counter Rotating Mandrel Die	$12,000	Virginia Tech Foundation Inc
2008	Glass Estrusion process analysis and optimization research	$204,976	VA Center for Innovative Technology
2008	Glass Estrusion process analysis and optimization research	$129,905	VA Center for Innovative Technology
2008	Glass Estrusion process analysis and optimization research	$116,132	VA Center for Innovative Technology
Total		**$7,438,704**	

Source: Virginia Tech Office of Sponsored Programs

A majority of the sponsored research funding was awarded at IALR's inception, which likely helped to establish the research labs. Funding has since decreased, yet has more than doubled from 2007 to 2008 (see graph below).