Rural Knowledge Clusters: 
Innovation and Vitality in America's Rural Communities

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Executive Summary

Rural communities face tremendous challenges to prosperity and vitality in a knowledge-based global economy. Traditional sources of rural economic competitiveness, such as access to natural resources and relatively lower costs, have been eroded by declining transportation costs and market globalization. Since the early 1980s, the wage gap between urban and rural areas has become increasingly significant.

Rural areas, as a whole, have been less successful than urban areas in growing and attracting clusters of innovative high-technology activity. But innovation is not simply a high-tech phenomenon. Firms across all industries are experiencing heightened competition, and are concluding that innovation is survival. The implication for economic development is that creating a fertile environment for innovation is crucial to economic vitality.

Rural Knowledge Clusters as a Model of Rural Innovation

“Rural knowledge clusters” can be understood as a model for understanding the development of innovative rural economic regions. Rural knowledge clusters are innovative, interrelated groups of firms located outside metropolitan areas, deriving competitive advantages through accumulated, embedded, and imported knowledge among local actors and institutions.

The rural knowledge cluster model builds upon recent work on the concept of industry clusters. In particular, it draws upon the research of Harvard business economist Michael Porter and his “diamond of advantage” framework for analyzing industry clusters, and Stuart Rosenfeld’s efforts to adapt the industry cluster model to rural areas. State and Local Policy Program has used the Porter framework to analyze industry clusters in Minnesota since 1995.

The dynamism of rural knowledge clusters can be explained in terms of three factors:

- competitive advantage: current factors related to supply or demand conditions, related industries, or local rivalry that give local firms a market advantage.

- history: an historical base of knowledge about an industry or technology that has given rise to current sources of competitive advantage.
• institutions: formal and informal institutions that develop around clusters to support the creation, diffusion, and import of knowledge.

Rural Knowledge Clusters: Four Case Studies

Evidence on rural knowledge clusters is presented from four regions in rural (greater) Minnesota. These case studies are intended to identify strengths and weaknesses of the rural knowledge cluster model, and highlight key features distinguishing different types of rural knowledge clusters.

• Mankato: Wireless Technologies

A diverse cluster of companies and institutions exists in the Mankato area (south central Minnesota) around wireless technologies. Historically grounded in the presence of EF Johnson, a manufacturer of two-way radios in Waseca, this cluster presently includes two major wireless service providers, several manufacturers of electronic components for wireless applications, and training service providers based out of the Institute for Wireless Education. Educational institutions, particularly MSU-Mankato and South Central Technical College, have played critical roles for a long time in promoting technology transfer and workforce skill development.

• Alexandria: Automation Technologies

A knowledge cluster relating to automation and motion control technologies has developed around Alexandria in west central Minnesota. Local expertise in this technology can be attributed to the region’s historical strength in the packaging machinery industry, which relies heavily on automation technologies. Alexandria Technical College, which has related closely to the packaging industry over the years, has built on this specialization through its Center for Automation and Motion Control (CAMC). CAMC has become a local broker for automation technologies, aiding their diffusion across a wide range of local manufacturing firms, enhancing productivity and firm competitiveness.

• Northwest Minnesota: Recreational Transportation Equipment

The northwestern Minnesota communities of Thief River Falls and Roseau are home to two of the largest domestic producers of recreational transportation equipment, Arctic Cat and Polaris. Both companies were founded nearly a half-century ago by a single entrepreneur, Edgar Heteen. Today these companies embody a competitive spirit that resembles the snowmobile racing culture off which they thrive. While they were less instrumental role in this cluster’s inception and early development, local institutions like Northland Community
and Technical College are playing a key role today in areas like customized skill training and continuous process improvement.

- **Winona: Advanced Composite Materials**

  The city of Winona, in Minnesota’s southeastern corner, is the center of a knowledge cluster around advanced composite materials technologies. The cluster developed around a company called Fiberite, which was founded by Ben and Rudy Miller after World War II to serve fast-growing defense and aerospace applications. Today the cluster consists of two distinct segments – a small number of companies involved in the production of advanced composite materials, and a larger number of companies engaged in the application of advanced composite technologies to existing products such as electric heaters, stringed instrument bows, canoes, and softball bats. Many of the firms in this latter segment were founded by individuals with experience in local companies producing composite materials. Winona State University enhances this cluster through the country’s only undergraduate composite materials engineering program, and applied research and testing facilities for local firms.

**Rural Knowledge Clusters: Key Findings**

Evidence from these case studies informs and refines the rural knowledge cluster model. Key findings from these examples are:

- History and context are important in the development of rural knowledge clusters.
- A core base of knowledge can be instrumental in driving multiple industries and applications.
- Developing comparable quantitative indicators of knowledge is very difficult.
- The acquisition of local firms by non-local firms can either bolster or threaten the vitality of rural knowledge clusters, depending on the circumstances.
- Two different strategic approaches can boost the vitality of rural knowledge clusters: an “institutional” strategy and an “entrepreneurial” strategy.

**A Rural Knowledge Cluster Approach to Economic Development: Lessons and Strategy Items**

Lesson 1: Understand your local knowledge base.

Related Strategy Items: Knowledge base assessment, including fine-grained analysis of industrial and occupational specializations within your region, types of innovative activity, etc.
Lesson 2: Foster linkages between firms and the local institutions that support them.

*Related Strategy Items: Map linkages and stakeholder relationships between local knowledge clusters and institutions (public, private, non-profit; local and non-local) that relate to them. Identify synergies, redundancies, and gaps between institutions and needs of local knowledge base.*

Lesson 3: Develop strategies for promoting innovation around rural knowledge clusters.

*Related Strategy Items: Support for entrepreneurial programs, risk capital access, technology transfer, etc., especially around knowledge clusters.*

Lesson 4: Don’t try to go it alone – promote a regional vision to guide local strategies.

*Related Strategy Items: Development of a “regional leadership” forum to coordinate and empower local efforts, and to interface with policies and strategies at the state level.*
I. The Challenge of Rural Community Vitality in a Knowledge-Based Global Economy

The implications of globalization for economic development have been dramatic. Firms and industries face a double-edged sword — access to global markets but exposure to global competition. In this new competitive climate, firms and industries producing innovative, high-value products are prospering while those producing standardized, high-volume, low-value products are not. Additionally, industries historically accustomed to insulation from global competition are adjusting less favorably to this new economic context. Globalization creates a market for cheaper imports that easily substitute for domestic goods (Torgerson and Hamrick 1999).

Rural areas face formidable challenges to economic prosperity in an increasingly knowledge-based economy, since they have generally produced goods – agricultural and manufactured – that are vulnerable to changing export conditions. Traditional sources of rural economic competitiveness such as access to natural resources and relatively lower costs are encountering declining transportation costs and market globalization. Disadvantages of both geographic (inability to achieve equivalent economies of scale and specialized division of labor) and structural natures (migration from rural communities) help to explain the underperformance of rural economies relative to urban ones. Since the early 1980s, the wage gap between metro and nonmetro counties has become significant. In 1998, average earnings in nonmetropolitan counties were at a historical low of 69.1 percent of metro earnings (Gale and McGranahan 2001).

Rural areas, as a whole, have been less successful than urban areas in growing and attracting clusters of high-technology activity, where underlying technological changes have increasingly quickened the pace of innovation. There are a number of reasons why rural areas have lagged, including lower concentrations of science and technology workers and fewer sources of research and development (i.e. universities, research laboratories). Furthermore, the technological infrastructure necessary for supporting this type of industry cluster is often not available in rural areas (Drabenstott 2001).
Consequently, high-technology employment in rural areas has generally been limited to production-level jobs in branch plants that show few clustering tendencies (Glasmeier 1991).

But innovation is not simply a high-tech phenomenon. Firms across all industries are experiencing heightened competition, and are concluding that innovation is survival. Advances in transportation technology have made it easier to penetrate global markets, and information technology has shortened the amount of time it takes for low-cost competitors to replicate new product designs. In this environment, successful firms find new ways to do things better, faster, and cheaper. Regardless of whether you are making computer chips or wood chips, innovation requires knowledge about the technologies, processes, and markets that make it work. And quite often that knowledge can be found locally in the people that understand their industry.

The implication for economic development is that creating a fertile environment for innovation is crucial to economic vitality, a fact that applies to both urban and rural communities. For rural areas, however, the primary challenge lies in adapting their historical industrial base, by tapping into the underlying knowledge base for sources of innovation and competitive advantage. This existing knowledge base is important, because innovation rarely occurs out of thin air; rather, it flows from the intersection of existing stocks of knowledge and newly identified market opportunities.

This report proposes a model of “rural knowledge clusters” for understanding how innovative rural economies grow and develop. The theoretical basis and hypothesized features of the rural knowledge cluster model are presented, and evidence from five rural knowledge clusters in greater Minnesota is presented and analyzed. The final section explores conclusions and implications for economic development policy and strategy.
II. Rural Knowledge Clusters as Model of Rural Innovation

Rural Knowledge Clusters: Definition

This report explores the concept of “rural knowledge clusters” as a model for understanding the development of innovative rural economic regions. We define rural knowledge clusters as:

*innovative, interrelated groups of firms located outside metropolitan areas, deriving competitive advantages through accumulated, embedded, and imported knowledge among local actors and institutions.*

The Importance of Models for Economic Development Practice

The economic development profession relies upon conceptual frameworks for understanding successful regions as a means of formulating effective economic development strategies. These stylized models help to identify and articulate important factors driving the success of certain places. They suggest opportunities for learning from these cases, especially in terms of the possibilities and limitations of replicating success factors.

Growing interest in models of innovative and competitive economies resulted from processes of deindustrialization that began in the 1970s and early 1980s. In particular, the resilience and differential performance of successful regions and industries became the center of attention. Silicon Valley and the “Third Italy” were held up by researchers as models of regional development. Silicon Valley, the emerging center of global high-tech development, was lauded for its freewheeling entrepreneurship and dynamic, synergistic relationships between higher education and industry (Saxenian 1994). Meanwhile, the “Third Italy” (portion of northern Italy encompassing the region of Emilia-Romagna) was noted for its “flexibly specialized” networks of small producers in relatively low-tech industrial sectors like shoe production (Piore and Sabel 1984).
Subsequent work by Harvard business economist Michael Porter on “industry clusters” has become the popular paradigm for organizing economic development in recent years. His book *The Competitive Advantage of Nations* drew together re-emergent theories of regional development with elements of business strategy to explain the internal dynamics of successful economies in terms of their key industry clusters (Porter 1990). Since then, countless states, regions, and localities throughout the world have adopted “cluster-based” economic development strategies (Waits 2000).

The most substantial efforts to adapt the industry cluster model to rural areas have come from Stuart Rosenfeld of Regional Technology Strategies Inc., in North Carolina. Influenced by European efforts at organizing small-firm networks in places like Denmark, Rosenfeld became involved in similar organizing efforts throughout the United States in the late 1980s and early 1990s (Rosenfeld 1995a, 1995b). Since then he has become the foremost national expert on rural industry clusters, most recently focusing on the role of community and technical colleges in promoting cluster competitiveness (Rosenfeld 2000). Rosenfeld (2001) notes that the “network” and “cluster” concepts have been used interchangeably in economic development practice despite key underlying conceptual differences.

Since 1995, State and Local Policy Program has utilized Michael Porter’s industry cluster framework to analyze industries and regions throughout Minnesota (see box). This work on rural knowledge clusters represents an attempt to extend the cluster-based framework in ways that make it more relevant to rural economies, and more explicitly addresses the role of economic knowledge.

**Characteristics of Rural Knowledge Clusters**

The rural knowledge cluster definition outlined above incorporates a number of elements that deserve further discussion. Four characteristics, in particular, stand out:
Rural knowledge clusters prosper because they foster innovation on the part of local firms and institutions. Through innovation, firms compete successfully on high value rather than low costs, an increasingly untenable strategy in an integrated global economy. Innovation may take the form of new products and technologies, but also better, more efficient processes, some of which may end up codified into patents.

An environment of continuous innovation can allow companies and clusters in relatively “low tech” industries to compete successfully. Maskell et al (1998) suggest that systems of “low-tech learning and innovation” can explain the ongoing competitiveness of firms in high-cost European countries in traditional industries like furniture and fish processing. This is important for rural economies, which have relied on traditional “low tech” industries – agriculture and other natural-resource-based sectors, and manufacturing – for its export base. The implication is that by fostering innovation around these traditional industries, rural areas may be able to adapt their economic base to compete successfully. For this reason, rural knowledge clusters may potentially exist around a wide variety of industries, products, and technologies.

Firms within rural knowledge clusters are bound together in important ways that make their proximity beneficial. These interrelationships may take a variety of forms – local companies may be making similar and/or competing products or technologies, they may be complementary relationships (buyer-supplier), or they may use analogous technologies to make products for different market segments. These ties may be direct (i.e. use of shared research infrastructure at local university or technical college, membership in trade association or industry group) or indirect (i.e. common history or founding firm(s), shared labor pools for specific skills). Regardless, the interrelationships within rural knowledge clusters are important, because they point to opportunities for firms and their communities to come together around issues and strategies that are critical to their success.
Rural knowledge clusters lack the advantages of urbanization and agglomeration that facilitate cluster activity in metropolitan areas. Research on industry clusters in rural areas has shown that, where they exist, rural clusters contribute positively to economic growth (Henry and Drabenstott 1996) and to average wage levels (Gibbs and Bernat 1997). Rural clusters frequently cited in economic development literature include the carpet industry in Dalton, Georgia, recreational vehicles in northern Indiana, and furniture in Tupelo, Mississippi and North Carolina.

Rural knowledge clusters compensate for disadvantages of scale by developing specializations in particular industries and technologies. Niche “micro-clusters,” such as houseboat production in southern Kentucky (Rosenfeld et al. 2000), rely on a high degree of entrepreneurial activity, spin-offs, and continuous product innovation and differentiation. By comparison, they rely much less on articulated inter-industry linkages than urbanized industry clusters.

There is some research suggesting that industrial specialization on the part of rural areas may make them more vulnerable to cyclical forces. Barkley, Henry, and Kim (1999) find that rural industry agglomerations (clusters) may provide a boost when the industry is growing locally, but at the cost of greater losses when the industry declines. For this reason, rural economic development strategies have traditionally focused more on diversification (usually away from agriculture) rather than specialization.

Locally embedded knowledge

Rural knowledge clusters exhibit a substantial, localized base of knowledge that is embedded within people and institutions in the community. This knowledge accumulates over time, in the form of learning, research and development within companies and institutions like colleges and universities. Not all of the knowledge must be indigenous; it can be also be imported from elsewhere through interfirm collaboration or consultants. The innovation that occurs within rural knowledge clusters can be related back to this knowledge base.
Understanding the nature of knowledge helps to illuminate its importance to cluster activity. Knowledge exists in both codified (formal) and tacit (informal) forms. While information and communications technologies are allowing codified knowledge (information) to travel with increasing speed, tacit knowledge – which some estimate as 80 percent of knowledge – tends to remain localized. This is because tacit knowledge is more complex and uncertain, and thus less readily transferred across space (Botkin and Seeley 2001). The ability to capture innovation from this localized knowledge is fundamental to the ongoing competitiveness of high-cost advanced economies (Audretsch 1998). And because knowledge exhibits increasing returns to scale, and can be reused at almost zero marginal cost, increasing the stock of knowledge, rather than labor or capital, can offer endless opportunities for growth (Cortright 2001).

**Forces Underlying Rural Knowledge Clusters**

The economic performance of rural knowledge clusters can be understood in terms of three major factors that matter to them:

- **Competitive advantage**

  Firms that innovate and succeed in the marketplace draw upon a set of factors that give them a competitive edge. Some of these factors may be purely internal to the firm, while others can be attributed to factors that are external to the firm – that is, are “environmental” in nature. Together these sources of *competitive advantage* are a necessary condition for a firm or an industry to be viable in a given place.

  Michael Porter’s work on industry clusters outlines a “diamond of advantage” that can be used to explain the factors driving innovation and competitiveness. This diamond consists of four main components:

- **factor conditions** – a region’s endowment of factors to production, including human, physical, knowledge, and capital resources, and infrastructure, which make it more conducive to success in a given industry.
• demand conditions – the nature of home demand for a given product or service, which can pressure local firms to innovate faster.

• related and supporting firms – networks of buyers and suppliers transacting in close proximity to foster active information exchange, collective learning, and supply-chain innovation.

• firm strategy, structure, and rivalry – a climate that fosters both intense competition among localized producers, yet cooperation and collective action on shared needs, making it fertile for innovation and regional competitive advantage.

Additionally, Porter conferred a peripheral role to government and chance in affecting the competitive advantage and development path of industry clusters.

This “diamond of advantage” framework has been used by SLPP to analyze industry clusters throughout Minnesota since 1994. The rural knowledge cluster model builds upon Porter’s model, by explicitly incorporating the instrumental role of history and institutions.

• History

Knowledge is incremental and accrues over time – or put differently, the new knowledge you create is directly related to the knowledge you already possess. This fact suggests that places enjoying a history around a certain industry or technology are well positioned to generate new knowledge that results in innovative products and technologies. The phenomenon of “path dependence” and “increasing returns” has been documented as self-reinforcing drivers of specialization in high-tech economies, where new knowledge creation is most intense (Cortright and Meyer 2001). For example, the Twin Cities specialize in medical technology; Portland specializes in semiconductors, Seattle in software, and so on. In rural knowledge clusters, the innovation that occurs today can be traced back to a historical base of knowledge that has evolved and developed.
• **Institutions**

Within rural knowledge clusters, local institutions play an important role as catalysts in promoting and nurturing competitive advantages. They help to create, diffuse, and import knowledge that drives innovation, and also mediate relationships and foster cooperation among highly competitive firms. These institutions are often formally organized, such as educational, civic, and governmental institutions. But they can also be informal in nature, for example, a culture that fosters trust and cooperation, or risk-taking and entrepreneurship. Sometimes these institutions pre-date the development of activity around a rural knowledge cluster, while others form specifically around existing clusters to facilitate their growth (i.e. trade associations, applied research centers). The common element to all of these institutions, formal and informal, is that they represent places where knowledge that is instrumental to the cluster’s success resides external to the firm.
III. Rural Knowledge Clusters: Four Case Studies

Approach and Research Design

This section presents evidence on rural knowledge clusters from four cases in rural (greater) Minnesota. These case studies are intended to identify strengths and weaknesses of the rural knowledge cluster model, and highlight key features distinguishing different types of rural knowledge clusters.

A case study approach offers distinct advantages and disadvantages. Case studies are typically subject to problems of selection bias (e.g. just looking at the winners) and an over reliance on anecdotal over empirical evidence. However, they offer the advantage of obtaining comprehensive, contextual detail that is important for articulating and illustrating broader conceptual frameworks (GAO 1990).

The four cases presented here are:

- **Mankato** area: wireless and radio frequency technologies
- **Alexandria** area: automation and motion control technologies
- **Northwest Minnesota**: recreational transportation equipment
- **Winona** area: advanced composite materials

These cases were chosen in consultation with analysts and researchers familiar with the Minnesota economy. Two of the four cases (Northwest Minnesota and Winona) were examined in 1998 and 1996, respectively, as part of industry cluster studies conducted by SLPP in those regions. Although the intent of documenting four cases is to illustrate the rural knowledge cluster model in multiple contexts, no attempt was made to provide a representative sample of knowledge clusters in greater Minnesota.
The SLPP research team completed these case studies during the 2001-2002 academic term. The research design consisted primarily of focus groups and key informant interviews with individuals working in companies that are part of the cluster, or in institutions that relate to it. For each case, several key research questions were asked:

- What is the history of this particular cluster? What individuals or events have been most important to its development?

- What is the particular “knowledge base” embodied by this cluster? What indicators of this knowledge can be identified?

- What companies and industries comprise this knowledge cluster? What institutions relate to them, and what role have they played?

These focus groups and interviews were supplemented with information collected from a variety of secondary sources, including reports and studies from other organizations, company and institutions’ Internet web sites, and articles from newspapers, business journals, and trade publications.

Quantitative analysis of these knowledge clusters is limited to data on industrial concentration, key socioeconomic and industrial characteristics, and recent growth trends for the places studied. Statistical evidence is provided in the text where relevant. However, as mentioned, the primary purpose of these case studies is to highlight important qualitative features of the rural knowledge cluster model.
Mankato: Wireless Technologies

Sometimes the misfortune of a major employer can actually lead to long-run benefits for a community.

A rural knowledge cluster around wireless technologies exists in south central Minnesota. The cluster, made up of a diverse group of wireless service providers, electronics manufacturers and educators, is concentrated mainly around Mankato (population 32,427), in Blue Earth County. The cluster also extends into the counties of Waseca and Nicollet, a region containing a total of 105,000 people.

Mankato is home to two major wireless service providers, Midwest Wireless and HickoryTech. Midwest Wireless has been operating since 1990, and is privately owned by a group of smaller companies. The company offers a complete host of digital wireless services in the Upper Midwest and employs more than 300 people. HickoryTech, which originated as the local telephone company, is the 25th largest telecommunications company in the nation and provides wireless service as well as many other telecommunications services. The company has more than 500 employees. In addition to the two major service providers, startup companies like Prepaid Systems are also part of the cluster.

The region has also cultivated a substantial base of midsize contract manufacturers of wireless electronics components. These companies, which include Winland Electronics (Mankato), EI Microcircuits (Mankato), and Johnson Components (Waseca), design, engineer, and manufacture high technology components for communications equipment, as well as many other applications. EF Johnson, in Waseca, has been producing two-way radio equipment since 1923. It is currently a division of Nebraska-based Transcript International, and

Mankato

Key Facts

Population (2000): 105,238*
- Major Cities:
  - Mankato: 32,427
  - North Mankato: 11,798
  - Waseca: 8,493

Population Density (pop/sq mi): 65
- (Twin Cities: 601; MN state: 62)

Population Growth (1990-2000): 5%
- (MN non-metro: 4%; US non-metro: 9%)

Source: Census Bureau

Per Capita Income (2000): $26,872
- (MN non-metro: $24,134; US non-metro: 21,847)

Per Cap Inc Change (1990-2000): 64%
- (MN non-metro: 54%; US non-metro: 48%)

Job Growth (1990-2000): 26%
- (MN non-metro: 25%; US non-metro: 18%)

Farm Employment (2000): 5%
- (MN non-metro: 9%; US non-metro: 6%)

Manufacturing Employment (2000): 18%
- (MN non-metro: 15%; US non-metro: 15%)

Source: Bureau of Economic Analysis; income change data in nominal terms, not adjusted for inflation

*Data in table are for region that includes: Blue Earth, Nicollet and Waseca counties.
is a leading supplier of police, fire, and emergency personnel. And Thin Film Technologies (North Mankato), a division of the Japanese corporation Susumu, was initially started in the late 1970s to design and manufacture high-speed electronics components for the Twin Cities computer industry, but presently also serves the telecommunications and automotive industries.

Local institutions represent an important part of the wireless knowledge cluster around Mankato. The most important among these institutions are Minnesota State University-Mankato (MSU) and South Central Technical College (SCTC), both of which are affiliated with the MnSCU. MSU is a four-year university, and its College of Science, Engineering and Technology has been an important stimulus for applied research and education of engineers for wireless companies. MSU also recently embarked on a joint endeavor with Nokia and Midwest Wireless to create one of the first wireless campuses. SCTC offers an intensive two-year degree program for wireless communications technicians and provides customized training for contracting companies.

Mankato’s strength in wireless education is reflected in the Institute for Wireless Education, which was started in 1996 by MSU and SCTC to provide customized training in basic wireless telephony to employees of major telecommunications firms like AT&T and Lucent. Mankato was also the founding location for the Global Wireless Education Consortium, which promotes dialogue between industry and higher education institutions.

These three parts of Mankato’s wireless knowledge cluster – service providers, component manufacturers, and educators – are each represented in the Wireless & Communications Technology Alliance (WCA). WCA is an economic development organization based in the Mankato area that brings together firms and institutions within the cluster, promotes networking between companies, and facilitates outside investment and trade activity with local wireless firms.
History

The history of the wireless technologies knowledge cluster in the Mankato area can be traced back to the early decades of the 20th century, when such technologies were in their infancy. EF Johnson was started in Waseca in 1923 as a mail-order radio parts business and soon expanded into engineering and manufacturing of land mobile two-way radio systems. The company employed a number of engineers and technicians, and fostered interaction among individuals with likeminded interest in ham radio and other wireless communications technology. As the company’s fortunes waned in the late 1970s and early 1980s, it unwittingly facilitated almost two-dozen spin-off companies. Laid-off or dejected employees, including quite a few engineers and technicians with substantial experience in wireless and communications technologies, started their own businesses. Many of these spin-offs operated as contract manufacturers, engineering and manufacturing specialized electronics components for wireless applications. At least half a dozen companies are still in business today in the Mankato area and throughout Minnesota, many of which have become leading firms within the wireless cluster.

The local expertise in wireless and radio frequency (RF) technology developed through EF Johnson and other companies was reflected in MSU, which anchored technology development in the area. In addition to training engineers with state-of-the-art technology, the school provided an excellent opportunity for informal networking. Professors who had formerly worked in the industry often provided important connections between their students and jobs. The school also brought together radio enthusiasts to make contacts among their peers.
Eventually Mankato’s unusual concentration of wireless expertise began to generate national and even international attention. In 1995, an AT&T executive whose brother was an MnSCU regent persuaded AT&T to collaborate with MSU and SCTC to enhance the wireless education curriculum at both schools. This effort culminated in the founding of the Institute for Wireless Education that helped to broker customized training to other companies. The schools trained undergraduate students as well as companies’ technicians, while AT&T and partners provided some equipment as well as mentoring and internship opportunities for students.

Although HickoryTech and Midwest Wireless are today important players in the local cluster, the two companies actually got into wireless services relatively late. HickoryTech did not begin providing services until 1998 when the company saw that wireless communications were rapidly replacing voice. Today, wireless services account for 16% of the company’s operating revenue. Midwest Wireless began in 1990 when several local telephone companies pooled their resources to compete with national wireless providers. Since then the company has experienced rapid growth, and offers an extensive array of digital wireless services in rural Minnesota, Iowa, and Wisconsin.

Competitive Advantages

The rural knowledge cluster around wireless technologies in the Mankato areas enjoys several competitive advantages that have fostered its growth:

Factor Conditions: Skilled and Specialized Labor Force

The Mankato area possesses a strong base of skilled, experienced engineers and technicians, which endows the region with a high capacity for innovation. This has been fueled primarily by the presence of local employers, but has been supplemented by local higher education institutions. It is important to note that individuals educated locally in wireless technologies at MSU and SCTC are also taking jobs outside the region, and that non-local institutions like the University of Minnesota have also been an important source of skilled
workers. But the concentration of highly skilled workers has been important in two respects. It has provided a base of knowledge and “know-how” that has been instrumental to the entrepreneurial spin-offs that have sustained the cluster. And further, the skilled worker base has been an attractive location factor for outside firms to invest in the Mankato area.

**Related Industries: Diverse Market Opportunities**

The growth and performance of Mankato’s wireless technology firms has been aided by their proximity to diverse markets and industries within Minnesota and the Upper Midwest. This is particularly evident for electronics components manufacturers, which are continually diversifying into new industries and applications. For example, many have been developing closer ties with medical device manufacturers in the Twin Cities area, while others supply components to the automotive industry. This diversification is important for insulating local firms from downturns in the communications technology industry, and stimulating innovation and cross-fertilization. Backward, or supply, linkages are also important, and several cluster companies are linked to producers of composites in the Winona area (southeast Minnesota).

**Industry Structure: Cooperative Relationships**

The wireless cluster also benefits from cooperative relationships among local firms. For example, the presence of major wireless service providers like HickoryTech enable the existence of startups like PrePaid Systems, which tap into the infrastructure of the larger firm for research and development and product testing. Similarly, components manufacturers Winland Electronics and Thin Film work together to test out new technologies. In some cases this is because firms are operating in separate niche markets, and thus not in direct competition with each other. However, relationships developed through informal networking, and in other instances through shared experiences at firms like EF Johnson, also help to foster a spirit of cooperation.

**Institutions**

Local institutions play an important role in facilitating the transfer of knowledge between various companies and their
Mankato: Rural Knowledge Cluster Profile

Competitive Advantages
- Skilled, specialized labor force
- Diverse market opportunities
- Cooperative interfirm relations

Wireless and radio frequency technologies

History
- EF Johnson: radio manufacturer, incubator of local talent
- Informal networking through ham radio club

Institutions
- MSU Mankato
- South Central Technical College
- Wireless & Comm. Tech Alliance
- Global Wireless Ed Consortium

Firms and Industries
- Wireless service providers
- Electronic components for wireless applications
- Training in wireless technology

Customers. As discussed above, MSU and SCTC are the two largest institutions, training engineers and technicians for jobs among the high technology companies as well as facilitating formal and informal industry connections. Currently, the SCTC program is training about 15 technicians a year for radio frequency (RF) certification. MSU trains students for a four-year degree in Electrical Engineering and Electronic Engineering Technology. The two schools make academic credits transferable between them to more easily meet the needs of students and build the cooperative relationship between the two institutions to promote the wireless industry.

Also important are the nonprofit organizations that work to coordinate the various companies into a cooperative body in order to pool and attract resources. The Wireless & Communications Technology Alliance was formed in 2000 to share ideas and collectively market the resources of Mankato’s wireless cluster. Many of the companies in the wireless knowledge cluster are also members of the Minnesota High Tech Association, which allows for networking with other high technology firms, economic developers, and venture capitalists,
and promotes cross-fertilization of ideas. Other entities, like the Global Wireless Education Consortium (GWEC), link Mankato to activity in the wireless industry nationally and internationally.

The role of informal institutions has also been important in promoting interaction among firms and workers within the wireless knowledge cluster. Historically, local ham radio clubs have brought together engineers, technicians, and enthusiasts from various backgrounds and companies to exchange and test ideas that can result in recommendations, job offers, or collaboration. These informal institutions are critical to a vibrant and dynamic knowledge cluster.

**Conclusion**

The rural knowledge cluster around wireless technologies in the Mankato area offers fascinating insights about how the historical presence of a single firm – in this case, EF Johnson – can be a catalyst for a dynamic, longer term regional development path. The knowledge and institutional base around wireless technologies that developed in the Mankato area has set the stage for continued innovation and growth, even after the fortunes of the company itself waned. This suggests that local institutions, including higher education institutions, can play a proactive role in promoting the creation and diffusion of knowledge, and facilitating the development of a knowledge cluster that is robust, resilient, and less vulnerable to the success of a single firm or industry.
Alexandria: Automation Technologies

Even as markets for technology become increasingly global, the knowledge and expertise for deploying the technology can still be highly local.

Alexandria is a small city of less than 10,000 people nestled among the lakes of west central Minnesota, and center of a cluster of firms in the region utilizing automation and motion control technologies. The knowledge cluster is distributed across a relatively broad rural area, stretching roughly between Fergus Falls (population 13,471) and Moorhead (population 32,177), near the North Dakota border, toward the Brainerd area in central Minnesota. Overall the region is home to nearly 210,000 people.

The core of this knowledge cluster is located within the packaging equipment industry cluster, which is highly concentrated in the west central Minnesota region. Key firms within this cluster are Douglas Machine and Brenton Engineering, both in Alexandria, Thiele Technologies (Fergus Falls), Minnesota Automation (Crosby), Massman Automation (Villard), and Berg Custom Machine (now Schott Automation, in Garfield). These companies engineer and manufacture industrial packaging and material handling machinery for use by companies in a wide variety of industries, from food products to automotive parts to pharmaceuticals – essentially, any company whose products need to be packaged for shipment.

These packaging equipment firms, which are almost exclusively small and midsized (35 to 500 employees), share common origins within the region, with many having emerged as spin-offs from other firms. Today, however, most of these companies function as specialized divisions within larger, diversified

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**Alexandria**

**Key Facts**

- **Population (2000):** 210,059*
  - Major Cities:
    - Alexandria: 8,820
    - Fergus Falls: 13,471
    - Moorhead: 32,177
  - Population Density (pop/sq mi): 26
    - (Twin Cities: 601; MN state: 62)
  - Population Growth (1990-2000): 6%
    - (MN non-metro: 4%; US non-metro: 9%)
  - Per Capita Income (2000): $23,419
    - (MN non-metro: $24,134; US non-metro: 21,847)
  - Per Cap Inc Change (1990-2000): 57%
    - (MN non-metro: 54%; US non-metro: 48%)
  - Job Growth (1990-2000): 25%
    - (MN non-metro: 21%; US non-metro: 18%)
  - Farm Employment (2000): 9%
    - (MN non-metro: 9%; US non-metro: 6%)
  - Manufacturing Employment (2000): 9%
    - (MN non-metro: 15%; US non-metro: 15%)

*Data in table are for region that includes: Becker, Clay, Douglas, Grant, Otter Tail, Pope, Stevens, Traverse, and Wilkin counties (Region 4).
industry machinery conglomerates based elsewhere. Minnesota Automation and Brenton Engineering, for example, are both divisions of Atlanta-based groups (Riverwood International and Pro-Mach Inc., respectively). However, these establishments remain centers of innovation, and not simply branch plant operations.

Because of the presence of this cluster of packaging firms, a substantial knowledge base in automation technologies has developed in west central Minnesota. This knowledge has spilled over to other local manufacturers, including 3M Corporation’s Alexandria abrasives production facility, and Alexandria Extrusion, a midsize manufacturer of extruded aluminum products for electronics applications, who have experienced substantial productivity growth through the deployment of automation technologies.

Integral to this rural knowledge cluster is Alexandria Technical College (ATC), which acts as a “broker” for automation and motion control technologies through its Center for Automation and Motion Control (CAMC). CAMC serves as a resource for local firms in two respects. It provides an environment for accessing leading-edge automation technologies for research and development purposes. It also serves as a training ground for skilled technicians entering the workforce. ATC also helps to diffuse knowledge about automation technologies through its customized training programs, which serves to upgrade the skills of the incumbent workforce.

History

As in many other parts of rural Minnesota, agriculture has historically been an important part of the economic base in the Alexandria area. This agricultural base supported the existence of numerous small metalworking and machine shops, and farm equipment manufacturers.

A number of factors led to substantial change in the local economy in the 1950s and 1960s. As productivity increases caused employment in agriculture to decline, increasing diversification into manufacturing took place. Taking advantage of improved transportation access to Twin Cities
markets via the newly built Interstate highway system, economic development activities in the Alexandria area focused on expanding the region’s light manufacturing base.

Around this time, increasing consumer demand for packaged goods led to growth in the packaging equipment industry. Alexandria and the surrounding communities were well positioned to take advantage of this growth. Proximity to major Twin Cities producers of food products like Pillsbury and General Mills was a substantial advantage. And the customized nature of the equipment engineering and design lent itself to smaller, craft-like production systems that were suited to the existing base of skilled workers in the area. Soon a cluster of packaging equipment firms began to develop.

At the heart of packaging equipment are technologies that automate the packaging process, enabling high volumes of products to be shipped in short periods of time. Early generations of automation and technologies were centered on fluid power technology, a relatively broad classification that includes pneumatics, hydraulics, and electromechanical physics. More recent technologies such as robotics and programmable logic controllers have dramatically increased the flexibility of packaging equipment by permitting companies to do lower volume, more customized packaging to reach increasingly specialized and differentiated markets. The utilization of these automation technologies has been an important aspect of product innovation on the part of packaging machinery firms.

The importance of fluid power and other automation technologies to the local economic base compelled Alexandria Technical College to develop educational curricula around these areas. In 1968, ATC established a separate major in Fluid Power
Technology to better serve the needs of both local businesses and the emerging workforce. Over time, expertise and competency in automation technologies continued to grow, and in 1995 the Center for Automation and Motion Control (CAMC) was formed to integrate new and existing educational programs with applied, industry-driven research and development initiatives related to automation technologies. The “center of excellence” around automation technologies embodied in CAMC has made Alex Tech a critical piece of the knowledge cluster in the Alexandria area. The importance of ATC’s role will be discussed at greater length later in this case study.

This base of localized knowledge has been instrumental in the cross-fertilization of automation technologies across a broad array of manufacturing industries, resulting in process innovation. The deployment of these technologies allows for the automation of wide range of routine manufacturing processes, enhancing product reliability and worker productivity. For example, Alexandria Extrusion is one of the only companies in its field that employs automation technologies. The company credits this process innovation to its proximity to sophisticated users of automation technology in the Alexandria area.

Competitive Advantages

Innovation and knowledge clustering around automation technologies in the Alexandria area have been driven by a couple of important sources of local competitive advantage:

Industry Strategy: Cooperation Around Shared Needs

The capacity to foster collective action and investment around shared needs has been a valuable source of competitive advantage in the Alexandria area. The ability of CAMC to procure leading edge automation technologies for its Manufacturing Automation Research Laboratory (MARL) was enabled by funding from a coalition of local and regional companies, which joined together to form the Minnesota Manufacturing Automation Coalition. Other programs that uniquely benefit the local cluster, such as the Machine Assembly Specialist program at ATC, have been initiated with the technical and equipment support of local firms. The result
is a substantial asset to the local knowledge cluster, and a common resource for promoting innovation and continued industry success.

*Factor Conditions: Shortage of Skilled Labor*

The incentive for manufacturers in west central Minnesota to invest in technologies for process innovation, including automation technologies, has been driven by ongoing shortages of skilled workers throughout the 1990s. Aging of the incumbent workforce combined with slow population growth and youth out migration have forced employers to do more with less labor. The resulting productivity increases from technology adoption have improved company profitability, especially when combined with skill training of incumbent workers relating to the new technologies. At the same time, the cross-fertilization of automation technologies into new industries and applications within the Alexandria area creates greater diffusion of the local knowledge base.

*Institutions*

Local institutions have markedly enhanced the climate for cooperation, innovation, and knowledge development around automation technologies in the Alexandria/west central Minnesota area.

Foremost among these has been Alexandria Technical College. ATC has been a driver of innovation and competitiveness on two fronts – through increased research and development capacity for local companies, and enhanced skill levels among the emerging and incumbent workforce. This has been accomplished through the Center for Automation and Motion Control.

The establishment of the Manufacturing Automation Research Laboratory with state, local, and industry funding in 1998 has been a tremendous boost for the ability of local firms to keep pace with rapidly changing automation technologies. MARL allows Alex Tech to interface effectively between national and international producers of automation technologies like Siemens, Cutler-Hammer, and Rockwell Automation, and consumers of automation technologies within...
Alexandria: Rural Knowledge Cluster Profile

### Competitive Advantages
- Industry collective action around shared needs
- Shortage of skilled labor in related industries

### Institutions
- Alexandria Technical College, Ctr for Automation & Motion Control
- MN Mfg Automation Coalition
- Tri-State Manufacturer’s Assoc.
- Minnesota Technology Inc.
- West Central Initiative

### Automation and motion control technologies

### History
- Ag region, craft-like machine shops and equipment mfg
- Proximity to markets for packaging equipment

### Firms and Industries
- Industry packaging and material handling machinery
- Other light manufacturing industries

The local cluster. MARL offers a centralized, non-proprietary environment for product testing and applied research and development. By doing so, substantial economies of scale are enjoyed by local firms, many of which lack sufficient size to support testing of new technologies.

The other area where ATC is making a major difference is in the area of workforce skills. Through its customized training programs, ATC has developed close and interactive relationships with local companies. These relationships are mutually beneficial – companies become exposed to new technologies (i.e. automation technologies), and can equip their incumbent workers with the skills to use them, while the technical college obtains a better, “real time” source of information about the skills needed by graduates of their programs, many of whom find employment in the cluster. ATC’s customized training department is associated with Minnesota Technology, the state’s Manufacturing Extension Partnership affiliate, allowing it leverage additional resources for manufacturing modernization efforts.
Trade associations and civic institutions have also played a role in relating to the automation knowledge cluster. Many cluster firms and organizations participate in the Tri-State Manufacturers’ Association, a network of small- and mid-sized manufacturing firms in western Minnesota, North Dakota and South Dakota. West Central Initiative, a public foundation based in Fergus Falls, has been an important source of leadership in promoting a vision for integrating economic and workforce development in the region.

Conclusion

The automation technologies knowledge cluster in the Alexandria area offers a couple of useful insights to the rural knowledge cluster model. Like the example of wireless technologies in the Mankato area, Alexandria’s knowledge base has been a generative force that has propelled growth across multiple industries. It also illustrates that local institutions like technical colleges can be a vital resource for firms within a cluster – particularly smaller and mid-sized firms – to access external knowledge, technology, and research and development opportunities that are instrumental to continued innovation and success.
Northwest Minnesota: Recreational Transportation Equipment

It has been said that necessity is the mother of invention. Few axioms could be more insightful for understanding the origins of Northwest Minnesota’s robust cluster of recreational transportation equipment manufacturers.

This region, the most sparsely populated in Minnesota, is the birthplace of the modern snowmobile, and the home of the only two major domestically owned snowmobile manufacturers, Polaris and Arctic Cat. Together the two companies employ over 3,000 workers in the towns of Roseau (pop. 2,750) and Thief River Falls (pop. 8,400), respectively, and are major engines of economic growth for the entire region.

In addition, a host of small and midsize companies exist locally and regionally that function as direct suppliers to, or spin-offs of, Polaris and Arctic Cat. These include Machinewell, a machine shop and direct supplier of Polaris and Arctic Cat based in Grygla; TEAM Industries, a group of companies based in nearby Bagley, which designs and assembles high-performance drivetrains for ATVs, snowmobiles, motorcycles, agricultural and construction equipment; and F.A.S.T. Inc., producer of suspension systems and high-performance racing snowmobiles based on the Iron Range in Eveleth. Overall, nearly 60 percent of Polaris and Arctic Cat’s suppliers are located within Minnesota.

Together these innovative and interrelated firms form the core of a knowledge cluster around high-performance recreational transportation equipment. And while Polaris has moved its corporate headquarters closer to the Twin Cities in recent years, the cluster’s economic impact is evident in the region’s growth and diversity of manufacturing and services.
years, the northwest Minnesota region remains the heart of snowmobile manufacturing, and a hub for recreational transportation equipment in general.

**History**

The history of the recreational transportation equipment cluster can be seen as an outgrowth of the region’s base in farm equipment manufacturing in the early 20th century, which included a number of small engine producers and machine and metalworking shops. In the 1940s, several entrepreneurial producers of farm equipment, led by Edgar Heteen, noted the practical need to get around during the long, snowy winters. They began experimenting with designs for belt-driven snow traveling machines, and soon thereafter founded Polaris Industries in 1945.

Heteen, widely considered the “grandfather” of the modern snowmobile, spun off from Polaris to form Arctic Cat in 1961. Together Polaris and Arctic Cat established themselves as the largest domestic producers of snowmobiles, dominating the North American market along with Canada-based Bombardier. Foreign competition began to increase in the 1970s, however, particularly from Japanese firms like Yamaha, Kawasaki, and Honda, and both firms lost considerable market share. In fact, Arctic Cat went bankrupt for a short period in 1981-1982.

Nevertheless, both firms survived and successfully recovered lost ground in the late 1980s and 1990s. This has been accomplished through a combination of diversification and focus, while emphasizing innovation and quality. Both Polaris and Arctic Cat have diversified their product lines beyond just snowmobiles, into all-terrain vehicles (ATVs), watercraft, and apparel. This has been imperative to reduce the cyclicality inherent in the snowmobile industry. While the market does not fluctuate substantially with the business cycle, it does react to the amount of snow in a given winter, and in any case, does not allow for year-round production. Although not all the expansions have been successful – Arctic Cat recently left the watercraft market – they have managed to achieve greater stability through diversification.
At the same time that they have diversified, they have also placed increasing emphasis on innovation and product differentiation. This strategy can be seen in particular with Arctic Cat, which has focused on the high-performance and snowmobiling racing market to drive innovation, and to establish a market niche and identity. Both Polaris and Arctic Cat, however, are deeply aware of the need to innovate, and develop systems for monitoring and staying one step ahead of their competitors (including each other). For example, both companies have been at the forefront in developing four-stroke engine technology that is quieter and cleaner than traditional two-stroke engines, a response to concerns over negative environmental impacts of snowmobile use, especially in state and national parks.

### Competitive Advantages

The growth and vitality of the recreational transportation equipment cluster in northwest Minnesota can be attributed to several sources of competitive advantage.

**Demand Conditions: Demanding Local Customers**

The region’s primary source of competitive advantage in recreational transportation equipment is home demand – that is, its proximity to a demanding local customer base. And while this factor was certainly important in the cluster’s development, it has been equally important in its recent success. Both Arctic Cat and Polaris responded to increased foreign competition by focusing on innovative, high performance machinery for the most demanding of customers – the snowmobile racing circuit. The ability to satisfy this market, which they credit to their proximity and agility in developing new ideas, has in turn enhanced their ability to compete on high quality within the broader snowmobile market. An instrumental factor allowing them to capitalize upon their proximity to innovation drivers has been the growing utilization of flexible design and

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**Northwest Minnesota Cluster Profile**

**Key Industries**
- Other transportation equipment mfg (NAICS: 3369/SIC: 3799)

2000 Employment: 2,197, 20,500% more concentrated than U.S. overall

Source: County Business Patterns

**Key Employers**
- Arctic Cat ( Thief River Falls) 1,500 employees
- Machinewell (Grygla) 110 employees
- Polaris Industries (Roseau) 2,100 employees
- TEAM Industries (Bagley) 250 employees

Source: MN Dept of Trade and Econ Development
production technologies, which permits them to get from concept to engineering to production in shorter cycles.

**Industry Structure: Intense Interfirm Rivalry**

When Edgar Heteen left to start Arctic Cat in 1961, the rivalry began. Locals note that snowmobile racing began as soon as the second machine was built; similarly, the presence of these two companies a mere 70 miles away from each other has engendered a competitive spirit that exists to this day. The force that drives continual innovation by Arctic Cat and Polaris is the intense rivalry between the two companies. The proximity of the two competitors undoubtedly motivates the racing culture that is reflected in their rapid product cycles. In order to retain brand preference, both companies must constantly update their products and get them to the market ahead of the other. This factor permeates the entire culture of the work environment, encouraging a rivalry even between the workers at the respective firms.

**Related Industries: Knowledge Diffusion to New Products and Firms**

The base of knowledge and engineering “know-how” that developed around snowmobile manufacturing has supported innovation in new product areas. A classic example is ASV, a firm started by Heteen and snowmobile dealer Gary Lemke in 1983. ASV, based in Grand Rapids and a partially owned by industrial equipment giant Caterpillar, produces rubber-tracked, all-purpose construction and landscaping machinery that borrow heavily from the founders’ snowmobiling origins. Similarly, ATVs developed by Polaris incorporate elements of belt-driven snowmobile design, unlike most ATV producers, which started out making motorcycles and dirt bikes.

Additionally, the presence of Polaris and Arctic Cat supports the growth and development of smaller “niche” producers within the region. For example, F.A.S.T. has used its cooperative, supplier relationship with Polaris to leverage the bigger firm’s capacity for product safety testing and certification. This has been instrumental for the smaller F.A.S.T. in its expansion into production of high-performance racing snowmobiles.
Institutions

In contrast to the previous two cases, formal institutions have played a less central role in the historical development of the recreational transportation equipment knowledge cluster. More important in this regard, perhaps, have been informal institutions – the “racing culture” – that permeate the local communities. The racing metaphor is a rich one for understanding the forces promoting competition and innovation within the cluster.

But formal institutions, in particular educational institutions, have taken on growing importance for promoting the cluster’s competitiveness. This has come primarily in the areas of workforce training and continuous quality improvement.

Workforce issues have become a major concern for both Polaris and Arctic Cat. This concern is grounded in two separate but interrelated issues. The first is the inability to access a sufficient supply of highly skilled workers, and in particular, trained and certified engineers. Both companies recruit throughout the Midwest region and nationally, but the region’s remote location and harsh winters make this process difficult. Consequently, efforts have focused on upgrading the skills of existing workers by bringing postsecondary education and training directly to them. NCTC works directly with Polaris to provide on-site, credit-based instruction for basic skills relevant to the workplace. More specialized educational needs, however, have necessitated the use of non-local providers. For example, Polaris has contracted with Purdue University for the online delivery of engineering training to its workers.

The other facet of workforce issues within the cluster has been the growing skill intensity of production jobs, and the resulting need for training programs to take full advantage of the new, flexible technologies in use on the shop floor. Arctic Cat, Polaris, and Machinewell have all established customized job-training relationships with NCTC, which have been supported through grants from the Minnesota Jobs Skills Partnership program, which provides matching grants for such
NW Minnesota: Rural Knowledge Cluster Profile

**History**
- Farm equipment mfg base
- Need for transportation in snow
- Heteen et al develop first modern snowmobile, start Polaris
- Spins off, starts Arctic Cat

**Institutions**
- Northland Community & Technical College
- Minnesota Job Skills Partnership
- “Racing culture” – snowmobile racing circuit

**Competitive Advantages**
- Demanding local customers
- Intense interfirm rivalry
- Diffusion to new products and industries

**Firms and Industries**
- Snowmobile manufacturing
- All-terrain vehicles
- Equipment suppliers and machine shops

**Recreational transportation equipment**

Education-industry partnerships. While many of the skill needs and applications addressed through customized training are firm-specific, areas of common need across firms have given rise to certificate-based programs like inventory management. As production technology continues to change and evolve, the need for worker cross-training – and importance of such training relationships – can be expected to increase.

The other area where local institutions have been playing an instrumental role in promoting the competitiveness of the recreational transportation cluster is continuous quality improvement. NCTC works individually with Arctic Cat and Polaris to promote “lean manufacturing” principles, which add to each company’s bottom line by reducing waste and emphasizing quality. This also has had the effect of promoting quality improvement throughout each firm’s supply chain. For example, NCTC is preparing to work with Arctic Cat to promote continuous improvement among its local and non-local vendors.

**Conclusion**

The recreational transportation equipment cluster in Northwest Minnesota possesses a number of important
characteristics of the “rural knowledge cluster” model. Its key companies, Polaris and Arctic Cat, as well as an array of smaller, interrelated firms, display a strong propensity for innovation, which is driven by sources of competitive advantage like home demand and interfirm rivalry. The region’s knowledge base in snowmobile engineering has deep historical roots that have manifested themselves in a variety of innovative and successful products. And finally, local institutions are playing an increasing role in fostering the creation and diffusion of knowledge within the cluster, and finding ways to engage highly competitive companies around common needs.
Winona: Advanced Composites Materials

Winona, Minnesota is a small city of approximately 25,000 residents nestled tightly along the bluffs lining the Mississippi River in the state’s southeastern corner. It is the center of a vibrant knowledge cluster around advanced composites manufacturing, hosting approximately a dozen firms within the region, as well as local educational institutions with specialized knowledge of the field.\(^2\)

Composite materials consist of “a matrix of one material that has been reinforced by the fibers and/or particles of another material.”\(^3\) This changes the physical, thermal, electric, or aesthetic characteristics of the base material, which can have the effect of making it stronger, more conductive, flame retardant, and water resistant, etc. The properties of the new composite material are determined primarily by the length and orientation of the reinforcing fibers, as well as the flow characteristics of the base material. Materials that are commonly used for composites include polymers (plastics), metal, ceramic, and carbon. Glass, carbon, Kevlar and other polymeric fibers, and natural fibers are typically used for reinforcement of composite materials.

Companies within the Winona composites cluster range from firms pioneering new raw composite materials, to those using composite materials to develop innovative products for a wide range of applications. Products made by Winona-area composites firms are often lighter weight, more durable improvements to products already in existence on the market.

Key local firms producing raw composites materials include Cytec Engineering (formerly Fiberite), RTP...
Company, and Ticona Celstran (formerly Polymer Composites Inc.). RTP, which stands for “reinforced thermalplastics,” is the only one of these three companies that remains locally owned, as well as privately held (e.g. not publicly traded). Both Cytec and Ticona Celstran, which are currently subsidiaries of New Jersey-based chemicals firms, nonetheless have their origins in Winona. This portion of the composites industry is marked by higher degrees of capital intensity and economies of scale.

Firms in the product side of the composites cluster, on the other hand, tend to be smaller and more craft-like in nature, and are more likely to be locally owned. Key firms include Weno-nah Canoe, which makes lightweight canoes from composite materials; Watlow Polymer Technologies, a start-up division of the St. Louis-based Watlow Electric Manufacturing Company, which makes heated plastic products for aerospace energy and life sciences; Strongwell, which produces a variety of composite products, such as fiberglass grating; Composite Products Inc. (CPI), producer of molded composite products for the automotive industry; CodaBow, which makes high-quality graphic fiber bows for stringed instruments; Miken Composites, which makes composite softball bats; and Geotek, which produces fiberglass pultrusion elements for electric utility and animal containment markets.

The majority of these composites firms are located in the city of Winona or neighboring Goodview. However, a few companies, including Strongwell (in Chatfield), Miken Composites (Caledonia), and Geotek (Stewartville, near Rochester), are located in smaller towns in counties adjacent to Winona. The Winona cluster also relates to activity around advanced materials engineering in the Twin Cities metro area at companies like 3M (which recently sold its composites division to Cytec). While the markets for most Winona companies are national and international in nature, the companies also relate to downstream local users of composite materials, such as Andersen Windows in Bayport, and Cirrus Design of Duluth, an innovative designer and producer of personal aircraft using advanced composite materials.

The diversity of activities within the Winona composites cluster makes it difficult to track using traditional industry-based employment statistics. While most of the composites
Rural Knowledge Clusters

materials producers can be found within “miscellaneous plastics products” (SIC 308), other firms tend to be classified elsewhere, according to the product they make (canoes, softball bats, electrical equipment). This poses challenges for measuring the exact scope of the composites cluster, both on a point-in-time basis and especially on an ongoing basis.4

History

Like many other rural knowledge clusters, the Winona composites knowledge cluster can be traced back to the entrepreneurial efforts of two men – brothers in this case – in the early years following the Second World War. Ben and Rudy Miller, whose father Joseph had formed Miller Waste Mills in Winona in the 1920s to collect cotton waste and other fabric materials for reprocessing, launched a manufacturing company called Fiberite in 1948. The Miller brothers began experimenting with phenolic and melamine resins, using them to coat cotton fiber waste, producing products for the emerging markets in military and civilian aerospace.

As Fiberite began to grow during the 1960s and 1970s, it fueled a series of spin-off ventures, including several of the companies that are at the core of the composites cluster today, such as RTP and PCI (now Ticona). The source of many of these entrepreneurial ventures were engineers from local composites firms, such as Ron Hawley and Stan Prosen, both of whom struck out on their own to explore new applications for composites technologies. This spin-off activity was facilitated by local banks, which were attuned to the needs of this industry.

Winona
Cluster Profile

Key Industries
• Custom compounding of purchased resin
  (NAICS: 325991/SIC: 3087)
  2000 Employment: 517, 537% more concentrated than U.S. overall
• All other plastics products mfg
  (NAICS: 326199/SIC: 3089)
  2000 Employment: 241, 30% more concentrated than U.S. overall

Source: County Business Patterns

Key Employers
• RTP Company (Winona) 407 employees
• Cytec Engineering (Winona) 175 employees
• Ticona Celstran (Goodview) 69 employees
• We-no-nah Canoe (Winona) 75 employees
• Watlow Polymer Technologies (Winona) 24 employees
• AFC Strongwell (Chatfield) 200 employees
• Composite Products Inc. (Winona) 50 employees
• CodaBow Composites (Winona) 15 employees
• Miken Composites (Caledonia) 15 employees
• Geotek (Stewartville) 35 employees

Source: MN Dept of Trade and Econ Development
The composites knowledge cluster around Winona has grown and developed since its early days, but remains marked by its historical origins. The engineering school at Winona State University has been named after the Miller Brothers, for both their financial contributions to the university’s engineering programs, and their role in promoting opportunities for engineers in the composites industry. And the ongoing presence of “founding fathers” like Ben Miller, Hawley, and Prosen helps to form the cluster’s collective identity around its historical basis in the Winona area.

Competitive Advantages

Related and Supporting Industries – Diverse Local Industry Base

The Winona area has benefited from a remarkably diverse set of manufacturing enterprises for a city of its size. In addition to its cluster of composites companies, the area is home to manufacturers of automotive equipment, knitted goods, circuit boards, food products, and electrical equipment. Some of these companies have direct ties to the composites industry. Watlow Controls, an electronic process controls firm that specializes in heaters for the plastics industry, was originally founded as Waynco by Rudy Miller, and purchased by the St. Louis-based firm in 1976.

This diversity has benefited the composites cluster by providing new opportunities to cross-fertilize knowledge from one industry to another. For example, when Watlow Polymer Technologies began experimenting with integrating heating elements into composite materials, it relied upon specialized machinery used by local knitting mills to develop an innovative technique for holding the electrical wires into place during the composite molding process.

Factor Conditions – Specialized Knowledge Base

Over the years Winona has accrued a substantial base of talent with extensive knowledge about the field of composite materials engineering – a common phenomenon in localized knowledge clusters. These talented individuals, many of whom moved to Winona from around the country to work for key
companies like Fiberite, have stayed in the local area and carried their knowledge to other local composites firms, or into new startup enterprises. The formation of an undergraduate composite materials engineering program at Winona State University in 1990 has offered the region a unique local source of young workers with specialized skills in the composites field, a substantial competitive advantage for local companies.

Firm Structure, Strategy, and Rivalry – Cooperative Relations

The Winona composites cluster enjoys several characteristics that promote collegial and collaborative relationships between firms. First of all, the cluster’s presence in a smaller city like Winona gives it higher visibility and importance within the community, which identifies with this key source of local jobs and income. Also, the common history of local firms around Fiberite, and presence and high profile of the cluster’s “founding fathers” promotes cohesion and communication within the cluster. And finally, the relatively low degree of direct competition among firms, especially composite product manufacturers, is also conducive to collaboration.

Institutions

Institutions have played an important role in facilitating the growth and vitality of the composites cluster in Winona. Among the most important institutions historically has been the Society for the Advancement of Material and Processing Engineering, or SAMPE, which offers professional networking for engineers in the composites fields, both locally through the local chapter, and also on a national basis. This networking function was especially important in the 1970s and 1980s when advanced composite technologies were in their infancy, and national markets in the defense and aerospace industries were growing rapidly.

The decline of the local SAMPE chapter in the mid-1990s created a need for informal networking opportunities among Winona composites firms, which has been addressed recently by the establishment of the Winona Composites Consortium. The Consortium has met on a quarterly basis for over a year, and features presentations by local composites companies and
Winona: Rural Knowledge Cluster Profile

**Competitive Advantages**
- Diverse local industry base
- Skilled worker base around composite engineering
- Cooperative relationships

**History**
- Miller Brothers – formed Fiberite after WWII
- Initial growth in aerospace, military applications
- Spin-off/startup activity to new firms

**Institutions**
- SAMPE – professional society
- Winona St – composite eng.
- COMTEC – applied R&D/testing
- Winona Composites Consortium
- Technical college – custom training, technical education

**Advanced composite materials mfg**

**Firms and Industries**
- Composite materials producers
- Existing products improved through use of composite materials (i.e. canoes, heated plastics, automotive products, violin bows)

Winona’s local technical college, Minnesota State College – Southeast Technical (MSC-ST), has also been active in working with companies in the composites industry. The college has traditionally been involved in the area of technical education, and established a two-year composites technician program in the early 1990s to better serve this industry. This program was eventually discontinued for a variety of reasons, particularly
insufficient student demand. However, the college’s recent efforts in the area of employer-based customized training have been more successful. Their efforts have focused primarily on process and quality improvement, and initiatives with companies like Composite Products Inc. and Cytec have been supported through Minnesota Job Skills Partnership grants.

Conclusion

The Winona knowledge cluster around advanced composite material technologies shares many features of the wireless technologies cluster around Mankato. The cluster was seeded with the presence of a key firm, Fiberite, which served as a generative force in the cluster’s development, breeding substantial spin-off activity. Over time, the vitality of the knowledge cluster has been supported by the emergence of new applications for composite materials. This has allowed Winona entrepreneurs with experience in the composites industry to carry their knowledge into the development of new and innovative products for the marketplace. Meanwhile, key interventions on behalf of the knowledge cluster, most recently the establishment of baccalaureate and applied research programs in composites engineering at Winona State University, have been instrumental in bolstering the cluster’s competitiveness relative to other hotbeds of composite materials technology (particularly out West, closer to important customers in the aerospace industry).
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<th>Rural Knowledge Cluster Case Studies:</th>
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<td><strong>Mankato</strong> (wireless technologies)</td>
<td>EF Johnson, producer of two-way radios in Waseca, cultivated base of talent in radio frequency engineering; decline of company in 1970s and 1980s led to entrepreneurial spin-off activity among former EF Johnson employees; cluster currently encompasses electronic component mfg, wireless telephone service provision, and wireless education.</td>
<td>Strong base of engineers and technicians with experience and expertise in wireless technologies; proximity to market opportunities in related industry clusters, like medical devices in Twin Cities; cooperative relationships between companies for R&amp;D and product testing.</td>
<td>Local university (MSU-Mankato) and technical college (South Central Technical College); Wireless and Communications Technology Alliance; Global Wireless Education Consortium; local ham radio club</td>
</tr>
<tr>
<td><strong>Alexandria</strong> (automation technologies)</td>
<td>Strong local cluster of packaging equipment manufacturers; automation technology essential to product innovation in packaging equipment; local competency developed in automation technologies among workforce and local institutions.</td>
<td>Robust local demand for automation technology local base of midsize manufacturers in diverse industries looking for process innovations to enhance productivity; industry cooperation around need for shared R&amp;D resource at Alexandria Technical College.</td>
<td>Center for Automation and Motion Control, customized training programs, Alexandria Technical College; manufacturing extension program (Minnesota Technology); Tri-State Manufacturer’s Association; West Central Initiative</td>
</tr>
<tr>
<td><strong>Northwest Minnesota</strong> (recreational transportation equipment)</td>
<td>Snowmobile first developed in 1950s by Edgar Heteen, local producer of farm equipment; founded only two current domestically-owned snowmobile producers, Polaris and Arctic Cat, which employ over 3,200 locally; expanded recently into ATV production.</td>
<td>Close connection to demanding local customer base (snowmobile racers); fierce competition between Polaris and Arctic Cat; opportunities to transfer knowledge base to new products and industries.</td>
<td>Informal “racing culture”; local technical colleges (Northland Community and Technical College), customized training programs, continuous improvement programs.</td>
</tr>
<tr>
<td><strong>Winona</strong> (advanced composite materials)</td>
<td>Cluster developed around Fiberite, local composite materials firm that served fast-growing military and aerospace markets after WWII. Substantial spin-off activity, particularly into applications of composite materials technology for existing products.</td>
<td>Diverse local industry base to support cross-fertilization of knowledge; highly specialized knowledge base around composite materials engineering; cooperative relationships and cohesion, particularly around cluster’s “founding fathers.”</td>
<td>SAMPE (materials engineering society); Winona State University, composite engineering program; Composite Materials Technology Center; Southeast Technical College; Winona Composites Consortium.</td>
</tr>
</tbody>
</table>
IV. Rural Knowledge Clusters: Key Findings

Based on the four case studies presented here, several key findings can be identified about how rural knowledge clusters develop and function.

- **History and context are important in the development of rural knowledge clusters.**
  
  In each of the cases examined, entrepreneurial behavior on the part of key individuals has been a driving force behind the growth and development of their respective knowledge clusters. Without the vision of Edgar Heteen and his colleagues, for example, it is uncertain whether northwest Minnesota would have developed into the robust, innovative center of snowmobile manufacturing that it is today. At the same time, though, each cluster has been fostered by a host of environmental factors, which interact to form a climate conducive to innovation and entrepreneurship. The importance of these “place” characteristics lies at the heart of the rural knowledge cluster model, and is reinforced by the evidence from these three cases.

- **A core knowledge base can be instrumental in driving multiple industries and applications.**
  
  One of the more surprising findings of this work has been the degree to which a core base of knowledge within a local economy can be the driver of innovation and dynamism in a broad range of economic contexts. For example, the knowledge and “know-how” accrued in the Alexandria area around automation technologies for the packaging equipment industry has been instrumental in its innovative application locally to a variety of manufacturing contexts. This fact poses challenges for delineating and measuring a particular cluster around a simple, homogenous set of firms and industries, but is perhaps more representative of the complex interrelationships that bind together innovative companies within a given place.

  The entrepreneurial cross-fertilization of accrued knowledge into new technologies, products, and markets should be viewed as an important feature of rural knowledge
clusters. Finding new applications for a local knowledge base could mitigate the potential for firms within a knowledge cluster to become too specialized or “locked in” on a particular set of products, as in the case of the precision agricultural sprayer equipment cluster in southwest Minnesota (see box below). Overspecialization from a product or industry standpoint can make a knowledge cluster vulnerable to ongoing forces of industry consolidation or downturn.

- Developing comparable quantitative indicators of knowledge is extremely difficult.

Among the goals of the project was to explore whether the knowledge bases in the four cases studied could be measured or quantified in a manner that was comparable. The findings of these cases suggest that this is an extremely difficult task to accomplish, due to the heterogeneous and typically application-specific nature of knowledge. For example, representatives of the wireless technology cluster in Mankato suggested that product certifications from the Federal Communications Commission (FCC) were a potential indicator of local knowledge related to these technologies. Patent activity, a more commonly used indicator of knowledge intensity, was not viewed as relevant to all industries and firms studied. The development of “knowledge indicators” represents an area of future research on rural knowledge clusters.

Appendix B presents a variety of knowledge indicators, mapping their presence throughout greater Minnesota. These indicators, including patent activity, technology-driven companies, college-educated workers, knowledge-intensive producer service industry employment, and manufacturing start-up activity, represent crude proxies for the presence of knowledge-based activity, with different strengths and weaknesses.

- The acquisition of local firms by non-local firms can either bolster or threaten the vitality of rural knowledge clusters, depending on the circumstances.

Most, if not all, rural knowledge clusters develop from one or two local firms that prosper and grow, eventually
generating spin-off and related activity that causes a cluster to form. These local firms are an important factor for the communities in which they are located, both economically and socially. Economically, they employ substantial amounts of highly skilled workers engaged in innovative research and development activities, and are a stable source of good jobs for many local workers. And socially they often represent key “corporate citizens,” endowing local foundations and supporting diverse local activities.

Mergers and acquisitions are certainly not a new phenomenon; however, it has become commonplace in recent years as corporations move to expand, diversify, or consolidate within increasingly global markets. For rural knowledge clusters, the net effect of having previously locally owned companies purchased by non-local companies differs from case to case. On one hand, the company being acquired often enjoys enhanced access to new technologies, management and marketing expertise, global presence, and financial resources. These resources can be particularly important for small- and mid-sized companies as they look to develop or acquire innovative technologies that can help them compete successfully. On the other hand, non-local decision makers within a firm may be more likely to deal with adverse market conditions with plant closings and layoffs, especially if the parent firm is publicly held rather than a private company.

In the end it is probably less important where the ownership is of companies in rural knowledge clusters than where their innovative activity takes place. Most threatening to rural knowledge clusters are acquisitions that move or reduce research and development functions, leaving production-only facilities. These functions are essential to the local production and deployment of new knowledge and innovation.

- **Two different strategic approaches can boost the vitality of rural knowledge clusters: an “institutional” strategy and an “entrepreneurial” strategy.**

Rural knowledge clusters necessitate ongoing attention and strategic focus in order to provide for continued vitality. This requires constant attention to the cluster’s strengths and liabilities, opportunities for growth, and potential near- and
Precision agricultural sprayer equipment in southwestern Minnesota: Rural knowledge cluster in turmoil

Having a successful cluster of homegrown companies making innovative and differentiated products does not guarantee ongoing growth and success. The recent case of southwestern Minnesota’s cluster of precision agricultural sprayer equipment manufacturers illustrates that rural knowledge clusters can also be vulnerable to processes of industry consolidation.

The communities of Jackson, Benson, and Willmar in western and southwestern Minnesota have been home to a handful of companies on the cutting edge of technologies for self-propelled, precision application of agricultural fertilizers. These companies, including Ag-Chem, Willmar Manufacturing, Lor’Al, (Team) Tyler Industries, and Custom Ag Products, were founded primarily in the 1960s and 1970s by key entrepreneurs like Al McQuinn (Ag-Chem) and Loren Tyler (Team Tyler and Lor’al). Together they produced a variety of truck, tractor, and trailer-mounted sprayer models, and into the 1990s controlled roughly 80 percent of North American production of precision agricultural chemical application equipment. Their presence also supported a number of smaller local machine shops and other related supplier companies.

Despite their origins producing relatively low-tech mechanical devices for fertilizer application, several of these companies became deeply involved in the development of new, high-tech products for “site specific” or “precision agriculture” application techniques. These technologies, which were first developed in the late 1970s and early 1980s, used increasing sophisticated computer technologies to manage information about crop and soil conditions, resulting in more effective fertilizer application. Ventures like SoilTeq in Waconia, MN and CENEX in Renville developed some of the first commercially viable variable rate technology (VRT) applicators and spatial geographic information systems (SGIS). These technologies became embedded in the sprayer products sold by companies like Ag-Chem, Lor’Al, and Tyler, and eventually SoilTeq was incorporated as a division within Ag-Chem in 1996, and CENEX became part of Land O’Lakes.

A wave of recent corporate consolidations, however, has taken a toll on this cluster. In 1998 Team Tyler was purchased by Racine, WI-based Case Corporation, and Willmar Manufacturing by Duluth, GA-based AGCO Corporation, both as part of efforts to expand into the precision ag-sprayer market. Two years later AGCO acquired Ag-Chem, which had purchased Lor’Al almost a decade earlier. Continued weakness in the farm economy, combined with excess production capacity between its three facilities in the region, caused AGCO to shutter its plants in Willmar and Benson, laying off 200 workers and consolidating its remaining workforce of 900 in Jackson. Some of the capacity in Benson has been picked up by Redball (formerly Custom Ag Products), a fast-growing local producer of related, “non-precision” sprayer technologies. To date, start-up activity by displaced workers from this cluster has been minimal, with many workers moving into other local industries. Most people familiar with this industry consider both the strength and innovative capacity of this knowledge cluster to have been negatively impacted by this process.

Could this fate have been avoided? Any answer to this question would be purely speculative. It is worth considering, however, whether strategies to identify new products or industries for the region’s core knowledge base around precision sprayer technology would have insulated it more effectively from processes of consolidation. Either way, this case reinforces the understanding that rural knowledge clusters are not infallible, and must constantly look for ways to maintain their competitiveness and vitality.

long-term threats to competitiveness. This assessment should lead directly to strategy development. Strategies for promoting existing rural knowledge clusters can be characterized in two general categories: “institutional” strategies and “entrepreneurial” strategies.

“Institutional” strategies develop consensus around the need for new or enhanced local institutions – typically organizations or programs – to address key competitiveness issues facing the cluster. These institutions can be associational in nature, as in the case of the Winona Composites Consortium and the Mankato Wireless and Communications Technology Alliance, bringing cluster firms and related organizations (education, economic development) together to foster dialogue and market them jointly. Or alternatively, the institutions can be focused on addressing needs shared among local firms, for example, in workforce training or technology development (i.e. Alexandria Center for Automation and Motion Control).

Where they are developed effectively, institutions can represent key competitive advantages for a cluster – or help them overcome competitive disadvantages, such as a lack of agglomeration economies enjoyed by urban competitors. Wherever possible, institutions should be focused on providing benefits to firms throughout the cluster, and not just individual firms. But most importantly, institutions must be demand-driven, especially for publicly sponsored programs. Programs developed for rural knowledge clusters without their direct involvement and input are less likely to be effective than those developed by the cluster, based on their identified needs and preferred solutions.

An “entrepreneurial” strategy, on the other hand, focuses on creating an environment that is supportive for start-up and spin-off firms. This is important because new ventures often extend the region’s knowledge base into new products and technologies. And perhaps more importantly, they reduce a cluster’s reliance on the success of a small number of larger firms. Components of an entrepreneurial strategy would include technical assistance for startup firms (i.e. management advice), incubators and technology transfer programs (especially around sources of research and development, like
higher education institutions), and enhanced access to risk capital (i.e. low-interest loans, “angel” investor networks).

None of the four cases presented here have adopted an explicit entrepreneurial strategy. However, entrepreneurship and spin-off activity have been important to all of them throughout their development. Sometimes this has come from adverse conditions like economic downturns or layoffs (as in the case of EF Johnson for the Mankato wireless cluster), others simply from the emergence of new, technology-related market opportunities (i.e. use of composite materials in place of traditional metals or plastics).
V. Conclusion: A Rural Knowledge Cluster Approach to Economic Development – Lessons and Strategy Items

Based on the evidence presented, several components of a rural knowledge cluster approach to economic development can be identified.

Lesson 1: Understand your local knowledge base.

Assessment is always the first step to developing a plan for action. Look to your economic base and identify the specialized knowledge that propels your most innovative and successful enterprises. Where patterns exist, either clusters of firms in a similar industry or product line, or diverse firms that share a common history or underlying technology, they should be noted. Formal assessment tools, such as business visitation programs (Morse 1990) or knowledge management approaches (Jarboe 2001), may be useful in this regard. Understanding what makes your community and its economy different (Cortright 2002) may help in discovering its current and potential sources of competitive advantage.

**Strategy Items:**
Knowledge base assessment, including fine-grained analysis of industrial and occupational specialization within region, types of innovative activity, etc.

Lesson 2: Foster linkages between firms and the local institutions that support them.

Active feedback loops between industry and local institutions, particularly educational institutions, are an important mechanism for promoting economic competitiveness. For rural knowledge clusters this is especially critical, given the centrality of human capital and workforce skills, to their success. Strategies to engage local firms should focus on both the emerging workforce, through school-to-work and apprenticeship programs, and the incumbent workforce, through customized job training, continuing education, and training partnerships. The result is a win-win situation, where lines of “real time” communication from the demand to the supply side benefit both local businesses and the workforce.
Rural Knowledge Clusters

Other, noneducational institutions are also important. For example, cluster-based economic development consortia can be instrumental in bridging the public and private sectors, and focusing public investments around rural knowledge clusters.

**Strategy Items:**

*Map linkages and stakeholder relationships between local knowledge clusters and institutions (public, private, non-profit; local and non-local) that relate to them. Identify synergies, redundancies, and gaps between institutions and needs of local knowledge base.*

**Lesson 3: Develop strategies for promoting innovation around rural knowledge clusters.**

Innovation is the most important element of rural knowledge clusters. Consequently, strategies should focus on promoting innovation and new product development. These strategies include stimulating research and development and technology transfer activity among existing firms, which can be accomplished through manufacturing extension programs and applied research centers at local universities and technical colleges. Equally important, however, are policies that support new business start-ups and spin-offs. These include technical assistance to entrepreneurs, as well as access to risk capital (venture capital, “angel” investors, revolving loan funds). Relying on the success of larger firms alone will not assure ongoing dynamism and vitality. Rural knowledge clusters must encourage generative activity that builds on and sustains sources of competitive advantage.

**Strategy Items:**

*Support for entrepreneurship programs, risk capital access, technology transfer, etc., especially around knowledge clusters.*

**Lesson 4: Don’t try to go it alone – promote a regional vision to guide local strategies.**

Economic development strategies remain notoriously local in nature, even as there is an increasing awareness that regions must work together to be effective. A rural knowledge cluster approach must recognize the need to develop a regional
vision to guide local activities. This is important on a practical level, since the firms that comprise a rural knowledge cluster may be scattered throughout a given region (especially in sparsely populated areas) and draw from a specialized labor pool that is regional in nature. All levels of government have a role in promoting regional visions. In addition, institutions that may be most instrumental to promoting rural knowledge clusters are typically regional in scope. This does not mean that local initiatives cannot play an important role in promoting rural knowledge clusters. It does suggest, however, that the regional interdependencies inherent in successful rural knowledge clusters make the region the most appropriate scale undertaking action.

**Strategy Items:**
Development of a “regional leadership” forum to coordinate and empower local efforts, and to interface with policies and strategies at state level.
Endnotes

1 The case studies for Mankato, Alexandria, and Northwest Minnesota were completed in conjunction with the NetWORK for Customized Training, Education, and Development, Minnesota State College and Universities (MnSCU), and appear in similar form in a document published in March 2002.

2 This case study draws substantially from the analysis of the composites cluster in The Southeastern Minnesota Industry Cluster Study, completed by State and Local Policy Program in 1996 for The Initiative Fund of Southeastern and South Central Minnesota.

3 Definition taken from Winona State University, Composite Material Engineering Program, online presentation at: http://www.winona.edu/engineering/LinksComposites/Presentation/


5 It should be noted that the presence of a cluster in a smaller (rural) community does not automatically guarantee congenial relations among companies. For example, in their analysis of houseboat manufacturers in south central Kentucky, Rosenfeld et al (2000) find that the relationships between many of these firms are highly competitive and not entirely amicable. This fact is likely exacerbated by the small town setting, which allows for more direct observation of competitors’ activities.
VI. Bibliography


VII. Appendices

Appendix A: Acknowledgements

Appendix B: Knowledge Indicators for Greater Minnesota

Appendix C: About the Project, “Globalization and Knowledge Clusters for Rural America”

Appendix D: About the State and Local Policy Program

Appendix E: About the USDA Fund for Rural America
Appendix A
Acknowledgements

This report was completed as part of the project “Globalization and Knowledge Clusters for Rural America,” which was funded in 2001 by the U.S. Department of Agriculture, Cooperative State Research, Education, and Extension Service, through its Fund for Rural America initiative. We wish to thank Phillip Schwab and Elizabeth Tuckermanly from USDA for their assistance with this grant. A more complete description of the project’s goals and activities in provided in Appendix C.

We also wish to acknowledge the role of a number of other individuals and organizations that have been instrumental to the completion of our research on rural knowledge clusters. The University of Minnesota Extension Service provided early financial support for the rural knowledge cluster initiative, in addition to its support for industry cluster projects in recent years. Minnesota State Colleges and Universities (MnSCU), NetWORK for Customized, Training, Education, and Development, provided partial support for the case studies in Mankato, Alexandria, and Thief River Falls, and a related report outlining the implications for the MnSCU system was published in March 2002. And the Economic Development Administration, U.S. Department of Commerce, provided funding support for a literature review on the topic, published August 2002, as part of its Review of Economic Development Literature and Practice series. We would like to thank Barbara Warren and Richard Senese from U of M Extension Service, Richard Tvedten from MnSCU, and John Fieser from EDA for their support and guidance.

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Appendix B
Knowledge Indicators for Greater Minnesota

Among the goals of this project was the development of quantitative knowledge indicators. Such indicators could be used to identify the existence of knowledge clusters in rural areas. Knowledge indicators could also help to distinguish the presence of knowledge clusters from traditional industry clusters, which are typically identified in terms of employment agglomerations and positive employment shifts.

Because knowledge tends to be heterogeneous in nature, there are no perfect indicators for it. Instead one must rely upon proxies that may point to presence of knowledge or knowledge-based activity. This appendix presents a set of indicators that, when used in tandem, may point to an area with a knowledge cluster. None of the following indicators are likely to single handedly confirm the existence or location of a knowledge cluster. What these indicators can do, however, is help direct or warrant continued research.

County-level data for six indicators are mapped for non-metropolitan counties in greater Minnesota:

- **College-educated workforce**: percentage of adults 25 years and older with at least a bachelor’s degree, 2000
- **Science and technology workers**: percentage of workforce in scientific and engineering occupations, 2000
- **Technology-driven companies**: share of establishments involved in the creation or application of technology, 2001
- **Patent activity**: utility patents granted, per capita, 1990-99
- **Manufacturing start-ups**: formation rate of new manufacturing establishments, 1992-2000
- **Knowledge-intensive producer services**: employment concentration in professional, technical, and scientific service firms, 2000

Mapping data at the county level poses a number of challenges, especially for rural areas. Lower population levels relative to urban areas often precludes the availability of timely, reliable socioeconomic data for rural areas. Data from survey-based sources (such as Census long-form data) tend to suffer from lack of statistical reliability, while data from administrative sources (such as ES-202 covered employment data) are limited due to confidentiality guidelines. But perhaps more importantly, knowledge clusters rarely conform neatly to county boundaries. However, for the purposes of this analysis, county-level data are the best available for identifying and mapping indicators of knowledge.
For each indicator, this section describes:

- Source of the data, time period presented, and basis on which counties are compared;
- Reasons why the indicator may proxy for knowledge or knowledge-based activity, and what its limitations are; and
- Patterns that can be identified in greater Minnesota.
College-Educated Workforce

Data Source:
U.S. Census Bureau, Census 2000. Percentage of adults ages 25 and older with a bachelor’s degree or higher.

Why might this be indicative of knowledge? What are the limitations of this measure?

Educational attainment can be understood as representing how much codified knowledge a person has obtained. Individuals with a bachelors, masters, professional, or doctoral degree are more likely to be engaged in jobs that require specific technological knowledge and expertise. Within knowledge clusters, specific types of formalized postsecondary training may be necessary to access the base of localized knowledge that underlies the cluster. However, this indicator misses the less formalized types of knowledge that are important to knowledge clusters – in particular, tacit knowledge learned on the job.

What does this show for greater Minnesota?

The map below shows clusters of college-educated individuals around Bemidji in the northwest, Mankato in the south central region, and Winona in the southeast. Additionally, Cook County, in the extreme northeast corner of the state, has a high concentration of college-educated individuals, which may relate to the presence of “lone eagles” and retired professionals along Lake Superior. In general, the south central and southeast region, and portions of west central Minnesota, have higher concentrations of college-educated individuals, while the central and southwest regions have lower concentrations. Relatively high concentrations around communities such as Morris (Stevens County) likely represent the influence of local higher education institutions.

Overall, a substantial gap exists between the educational attainment levels for the state overall, and those for rural (non-metropolitan) areas, with the college attainment rate for rural areas (16.8%) over ten points lower than the statewide rate (27.4%).
Science and Technology Workers

Data Source:
U.S. Census Bureau, Census 2000. Share of workforce in the following occupational groups: computer and mathematics; engineering and architecture; and life, physical, and social sciences.

Why might this be indicative of knowledge? What are the limitations of this measure?

Like the college attainment indicator, the share of science and technology workers in the workforce is indicative of the types of jobs that people hold in the local economy. Because these jobs are more reliant on intellectual rather than physical skills, people in these occupations are often considered “knowledge workers.” Science and technology workers are more likely to be involved in research and development activities, and in the creation of new, economically valuable knowledge in the workplace. These data, however, are based on place of residence, rather than place of work, meaning that areas where knowledge workers commute into will be understated (similar establishment-based data are not available at the county level).

What does this show for greater Minnesota?

The patterns for science and technology workers are generally similar to those of college-educated individuals. Counties with higher concentrations tend to be found in the south central region, including Winona, Steele, Dodge, Nicollet, and McLeod Counties. Roseau County in the far northwest region, home to Polaris Industries and Marvin Windows, also shows up in the highest group among nonmetro counties. The far western counties tended to have lower concentrations, with exceptions around university centers like Morris and Marshall.

Again, greater Minnesota lagged the statewide average for science and technology workers substantially. Its share (2.9%) was less than half the average for the state (6.0%), and no non-metro counties exceeded that average.
Technology-Driven Companies

Data Source:

Why might this be indicative of knowledge? What are the limitations of this measure?

Companies that are involved in the development, application, or commercialization of technology rely heavily on a base of knowledge about existing technologies that relate to their business. This directory identifies “technology-driven companies,” a broad definition that encompasses more than traditional, narrow definition of “high-tech” as being electronics, computers, and software. It also includes companies that apply advanced process technologies to improve productivity, a common feature of knowledge clusters. But this indicator, as it is presented here in aggregate form, does not necessarily offer evidence about whether a high concentration of technology-driven companies in an area is related to a particular knowledge cluster. More detailed analysis of this database would be required for this purpose. And also, the listings of companies in this database may be skewed toward regions where Minnesota Technology, Inc., is most active.

What does this show for greater Minnesota?

Among nonmetropolitan areas, the highest concentrations of technology-driven companies appear to be found in southeast and south central Minnesota, as well as west central Minnesota. Counties with concentrations at or above the state average include Winona, Meeker, Renville, Traverse, Red Lake, and Kittson. For small counties like Kittson and Red Lake it may reflect the presence of one or two companies. In bigger counties like Winona, it is more likely to represent a cluster of related activity.

The overall gap between metro and non-metro areas is somewhat lower for the presence of technology-driven companies than for other knowledge indicators.
Patent Activity

Data Source:

Why might this be indicative of knowledge? What are the limitations of this measure?

Patents are granted by the government for product and process designs that are new and innovative, and/or improve upon an existing product. Companies and institutions seek patent protection to allow exclusive marketing rights to these new products and designs, representing the codification of proprietary knowledge. Areas with high levels of patent activity indicate a concentration of research and development activity, typically within corporations and research organizations like universities. Thus the location where a patent is registered represents its point of design, and not necessarily where production takes place. However, the importance of patent protection varies substantially from industry to industry, and innovation that occurs within larger firms tends get patented more than for smaller firms, which usually have less resources to navigate the lengthy patenting process. The length of the patent process also means that patent data are not necessarily a current indicator of innovative activity.

What does this show for greater Minnesota?

The data indicate that nonmetropolitan patent activity is strongest in the south central, southeast, and west central Minnesota regions. In particular, a cluster of counties directly south of the Twin Cities metro, including Goodhue, Dodge, Steele, Waseca, and La Suer counties, and McLeod County (just west of the Twin Cities), have the highest rates of patent activity.

However, the overall gap in non-metro patent activity is quite substantial, with the non-metro rate (11.3 patents per 10,000 people) less than one-third the statewide average (36.0 patents).
Manufacturing Start-up Rate

*Data Source:*

*Why might this be indicative of knowledge? What are the limitations of this measure?*

New business formation can occur for a variety of reasons. For service or retail establishments, start-ups are generally associated with new or growing markets within the local population. For new manufacturing firms, however, it is more likely to relate to the development of new products. The entrepreneurs who start these ventures are likely to build upon their existing base of knowledge and “know-how,” often accrued at other related firms in the area. While larger firms tend to offer higher-paying, more stable jobs, small and start-up businesses are a critical piece of a dynamic local economy. Some start-ups remain perpetually small, while other fast-growing “gazelles” may quickly become key employers within the region. It should be noted that new manufacturing firm formations could also result from the establishment of operations on the part of non-local companies. And also, small manufacturing firms such as machine shops are often not involved in the production of their own products, but rather as contract suppliers to larger companies.

*What does this show for greater Minnesota?*

The north central region of Minnesota appears to have the highest overall rates of manufacturing startup activity, while lower rates were found in the south central and southwest regions. However, a number of isolated counties around the state registered substantially above average startup rates.

Overall, the rate of manufacturing startup activity in rural areas (19.3 existing manufacturing establishments per startup) was only slightly lower than the statewide average (18.3).
Knowledge-Intensive Producer Services

Data Source:
U.S. Census Bureau, County Business Patterns. Employment concentration for NAICS 54 (professional, scientific, and technical services) industry, 2000.

Why might this be indicative of knowledge? What are the limitations of this measure?

Producer service industries have grown substantially over the past several decades, owing directly to the growing need for specialized expertise on the part of businesses. This expertise may relate to management issues (legal, financial, marketing), but also to technical issues (product design, engineering, and testing). Firms in these industries, which range from large multinational consulting firms to small sole proprietorships, sell their knowledge base, which they have often built from years of experience within industry. Within knowledge clusters, producer service firms often export locally generated knowledge to clients throughout the country, and sometimes the world. One limitation of this indicator is that it does not distinguish between “generalist” and “specialist” producer service firms. Generalist firms are more likely to sell relatively routine services to local clients, while specialist firms tend to offer more unique expertise to clients on a broader scale. Also, these data do not include self-employed individuals, which represent a substantial share of technical consultants.

What does this show for greater Minnesota?

Only two counties in Minnesota – Pipestone in the southwest, and Le Sueur in south central, have a higher concentration of these services than in the rest of the nation. Other than these two counties, there is no clear pattern to the presence of knowledge-intensive producer service firms.

Overall, these service activities are not very concentrated in greater Minnesota. The location quotient for non-metro areas (0.41, meaning almost 60 percent less concentrated than the nation overall) was less than half the rate for the state overall (0.85).
Appendix C
About the Project, “Globalization and Knowledge Clusters for Rural America”

Source: USDA Fund for Rural America
Length: Three years (Fall 2001-Spring 2004)

Project Partners:
State and Local Policy Program, and
Freeman Center for International Economic Policy:
Humphrey Institute of Public Affairs, University of Minnesota

Co-Principal Investigators:
Lee W. Munnich, Jr., Senior Fellow and Director, State and Local Policy Program
G. Edward Schuh, University Regents Professor of International Economic Policy
and Orville and Jane Freeman Chair in International Trade and Investment Policy

This 36-month research and outreach project will examine the implications of globalization and the shift to a knowledge-based economy for America’s rural communities.

The project consists of four distinct elements:

1. Research examining the consequences of globalization for local government and local development policy and activities;
2. Research examining the phenomenon of “rural knowledge clusters” – innovative, globally competitive groups of firms based in rural communities – through a series of case studies and related empirical research;
3. A national conference on globalization and rural knowledge clusters to be held in the Twin Cities, featuring results from elements (1) and (2), in addition to analogous and relevant research produced by partners from throughout the United States.
4. A two-year outreach effort to translate research findings into strategies for communities of rural Minnesota. Activities would integrate regional- and community-level strategic planning and applied research efforts, in partnership with University Extension Service, Center for Urban and Regional Affairs, Global Resource Associates Inc., University of Minnesota Regional Partnerships, and regional Initiative Funds. National outreach efforts would communicate and disseminate project findings to a national rural development audience.
Goals of the project include:

- An enhanced understanding among rural, economic, and community development practitioners about the dynamics of globalization for rural economies;
- Contribution toward a model of rural innovation that emphasizes the role of community institutions as catalysts of knowledge creation; and
- Effective outreach to rural communities, consistent with the University’s land grant mission.
Appendix D
About the State and Local Policy Program
http://www.hhh.umn.edu/centers/slp/

The State and Local Policy Program (SLPP) works as a highly visible regional policy resource. It works with individuals and institutions from government, business, academia, labor and nonprofits to develop improved public policy, particularly in the Upper Midwest. The program provides a forum for discussion of issues and for coming up with new information and ideas on policy issues. The program draws heavily on University faculty from a variety of specialties.

SLPP undertakes projects in four major policy areas:

- **Transportation and the Community**
  - Understanding the social, economic and environmental impacts of advanced transportation technology and exploring how new policy models can benefit communities.

- **Economic Development and Human Capital**
  - Understanding how changes in the global economy affect the economies of regions and communities, including economic and income disparities, and examining how industry clusters relate to knowledge and workforce strategies.

- **Telecommunications and Information Technology Policy**
  - Examining how investments in telecommunications and information infrastructure can enhance community development and sustainability and evaluating public policies related to information technology.

- **Government Finance and Productivity**
  - Exploring the potential for state and local fiscal redesign and productivity improvement and evaluating the effectiveness of alternative strategies.
Appendix E
About the USDA Fund for Rural America

The Fund for Rural America competitive grant program supports competitively awarded research; extension and education grants addressing key issues that contribute to economic diversification and sustainable development in rural areas.

Preservation of the economic viability of rural communities will be the focus of the Fund for Rural America 2001. The program focuses attention on rural communities' twin challenges of rural community innovation and demographic change. Challenges of an aging population, the arrival of new immigrant populations, and youth retention and workforce development all are critical issues that impact the rural economy. Rural communities may propose research, education and extension/outreach projects that will create an understanding of these demographic forces and develop capacity to turn these challenges into economic promise. Projects should facilitate the development of the capacity to translate on- and off-farm innovations into economic growth and community revitalization. The Fund seeks to stimulate innovations in value-added processing; e-commerce, distance learning, niche markets and new industries that can help rural communities share more fully in economic opportunities.

**Rural Community Innovation**

This program area seeks research, education, and extension proposals that will help rural Americans address existing and new problems in innovative ways. In a period of rapid change in both the agriculture and non-agricultural sectors of the rural economy, this program will emphasize projects that result in robust economies and vital and effective communities in rural areas. The goals of this program area are to generate new knowledge and transfer that knowledge to assist rural communities to diversify their economies, to develop and maintain profitable farms, firms, and businesses, to build community capacity, to aid smart growth, to protect natural resources, and to increase family economic security.