Rural Knowledge Clusters:

Implications for Minnesota State Colleges and Universities

Prepared for:

NetWORK for Customized Training, Education, and Development,
Minnesota State Colleges and Universities (MnSCU)

March 2002

Lee Munnich
Greg Schrock
Anna Hayes Bonelli

State and Local Policy Program

HUBERT H. HUMPHREY INSTITUTE OF PUBLIC AFFAIRS
UNIVERSITY OF MINNESOTA

301 19th Avenue South
Minneapolis, MN 55455

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Acknowledgements

The authors would like to thank Brian Fazio in Mankato, Kevin Kopischke in Alexandria, and Shari Olson and Chad Coauette in Thief River Falls, for their help and cooperation in organizing the focus groups and site visits, as well as Richard Tvedten from the MnSCU system office, for his interest and guidance in making this project possible.

Executive Summary

Rural communities face tremendous challenges in adapting to a knowledge-based global economy. The "knowledge economy" is characterized by an increasing importance of human capital, and competitiveness is based on the ability to innovate. Traditional rural economic staples are under growing pressure due to globalization of markets, and diseconomies of scale and outmigration hinder adjustment in the rural economy. Consequently a growing gap between urban and rural economic performance has emerged.

Rural Knowledge Clusters as a Model of Rural Innovation

Yet examples of prosperous rural economies can be found in Minnesota and elsewhere. What accounts for these success stories? A model of "rural knowledge clusters" is proposed. 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 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.

This report examines three instances of rural knowledge clusters in greater Minnesota, and their implications for the Minnesota State Colleges and Universities (MnSCU) system. The role of community and technical colleges in supporting the success of clusters in rural areas has been increasingly documented, and was an inspiration for this project.

Case Studies

- **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 techologies. 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 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 founded nearly a half century ago by a single entrepreneur, Edgar Heteen, 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.

Findings About Rural Knowledge Clusters

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

- Innovation does not take place in a vacuum – history and context matter in the emergence of rural knowledge clusters.
- A core base of knowledge can be a driver in diverse industries and applications.
- Developing comparable "knowledge indicators" is very difficult.
- Educational institutions are important feedback mechanisms that foster knowledge development within rural knowledge clusters.

Implications for MnSCU

The cases studied also offer several implications for the MnSCU system in the promotion of rural knowledge clusters:

- Understand your local knowledge base – that is, the specialized expertise that drives innovative and successful firms in the local economy.
- Recognize the importance of "education" in broader sense, particularly as it relates to employers as customers.
- Balance one-on-one customer relationships with opportunities for partnerships that achieve economies of scale and scope, and build sources of regional competitive advantage.
- Develop a "gateway" model for local institutions to collaborate and access specialized knowledge within the MnSCU system.

Context: The Challenge of Rural Community Vitality in a Knowledge-Based Global Economy

The implications of globalization for economic development have been dramatic. Firms are presented with a double-edged sword – they have access to global markets, but this access has come at the price of exposure to global competition. In this new competitive climate, firms producing innovative, high value products have prospered, while those producing standardized, high volume, low value products have not. Additionally, industries historically accustomed to insulation from global competition have also adjusted less favorably to this new economic context.

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As such, rural areas face formidable challenges to economic prosperity in an increasingly knowledge-based economy. Although agriculture has been and remains a key staple of the rural economy, manufacturing has also played an important role. However, the traditional sources of rural competitiveness in manufacturing – access to natural resources and relatively low costs – have been eroded by declining transportation costs and the globalization of markets. 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 relative to urban economies. Since the early 1980s, the wage gap between metro and non-metro counties has grown significantly, with average earnings in non-metropolitan counties at an historical low of 69.1 percent of metro earnings in 1998 (Gale and McGranahan 2001).

A lot of attention has been focused on the shift toward a knowledge-based economy, although comparatively little effort has been placed on understanding what exactly this means. In general, this shift has been associated with the decreasing importance of physical capital assets (such as land, natural resources, and capital equipment), and increasing importance of human capital. The importance of human capital can be understood in terms of individuals' capacity for knowledge accumulation and utilization, which are less transferrable over space than physical capital. Even information – that is, knowledge that has been codified into transferrable form – is less valuable, because the context for its utilization (the "know-how") is typically absent. Knowledge manifests itself economically in innovation, which can take the form of new product and process development. Innovation, then, can be understood as the essence of the knowledge-based economy.

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As a result, discussions about the "knowledge economy" have typically focused on high technology fields, where the pace of innovation is stunning. Consider Moore's Law, which has shown that the capacity of semiconductors doubles approximately every eighteen months. With such short product cycles, the drive for innovation is constant, resulting in a heavy focus on research and development and "knowledge workers," typically in the form of science and technology occupations. Other high-tech industries like software design, medical devices, and electronics face similar pressures, where rapid changes in the underlying technology compel innovation.

Firms across all industries are experiencing heightened competition, and are concluding that innovation is survival.

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 rural community vitality. Throughout greater Minnesota, examples of prosperous rural economies can be seen, examples that run counter to aggregate trends indicating rural decline. In many cases this prosperity can be traced back to innovative clusters of firms, the success of which is a generative force that creates good-paying jobs for local residents.

Throughout greater Minnesota, examples of prosperous rural economies can be seen. In many cases this can be traced back to innovative clusters of firms.

What makes these rural communities successful? Are they simply exceptions, or are there factors that can be generalized? What role do community institutions, such as community and technical colleges, play in promoting this success?

We propose that a model of "rural knowledge clusters" can be used to explain the dynamics of such success stories. This report will examine three case studies from greater Minnesota, and discuss the implications for the Minnesota State Colleges and Universities (MnSCU) system and its local affiliates.

Rural Knowledge Clusters: Model of Rural Innovation

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.

This definition contains a number of elements that merit further elaboration. Among these elements are:

- *Innovation:* As mentioned, innovation is critical to surviving and prospering in the current economic climate. Rural knowledge clusters nurture innovation that propels growth among local firms.
- *Interrelationship:* Firms within rural knowledge clusters are bound together in important ways. They may buy and sell to each other, draw upon a common labor pool or skill base, or even originate from the same historical industry base.
- *Rural location:* Rural knowledge clusters lack the advantages of urbanization and agglomeration that facilitate cluster activity in metropolitan areas. They compensate, however, by developing specializations in particular industries and technologies.
- *Locally embedded knowledge:* The knowledge that promotes innovation within rural knowledge clusters is primarily found within actors and institutions that are embedded in the local community. This knowledge accumulates over time, and is augmented by knowledge imported from elsewhere.

Rural knowledge clusters compensate for disadvantages of scale inherent in rural location by developing specializations in particular industries and technologies.

Forces Underlying Rural Knowledge Clusters

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

- **Competitive advantage matters.**

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, in *The Competitive Advantage of Nations* (1990), outlines a "diamond of advantage" that can be used to explain the factors driving innovation and competitiveness in successful industry clusters. 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 industries* – networks of buyers and suppliers transacting in close proximity to foster active information exchange, collective learning, and supply-chain innovation.
- *industry 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.

Previous SLPP Industry Cluster Reports

- Twin Cities (1995)
- Southeast Minnesota (1996)
- Southwest Minnesota (1998)
- Northwest Minnesota (1998)
- Northeast Minnesota (2001)
- *Industry Clusters: An Economic Development Strategy for Minnesota* (1999)

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 matters.**

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" have 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.

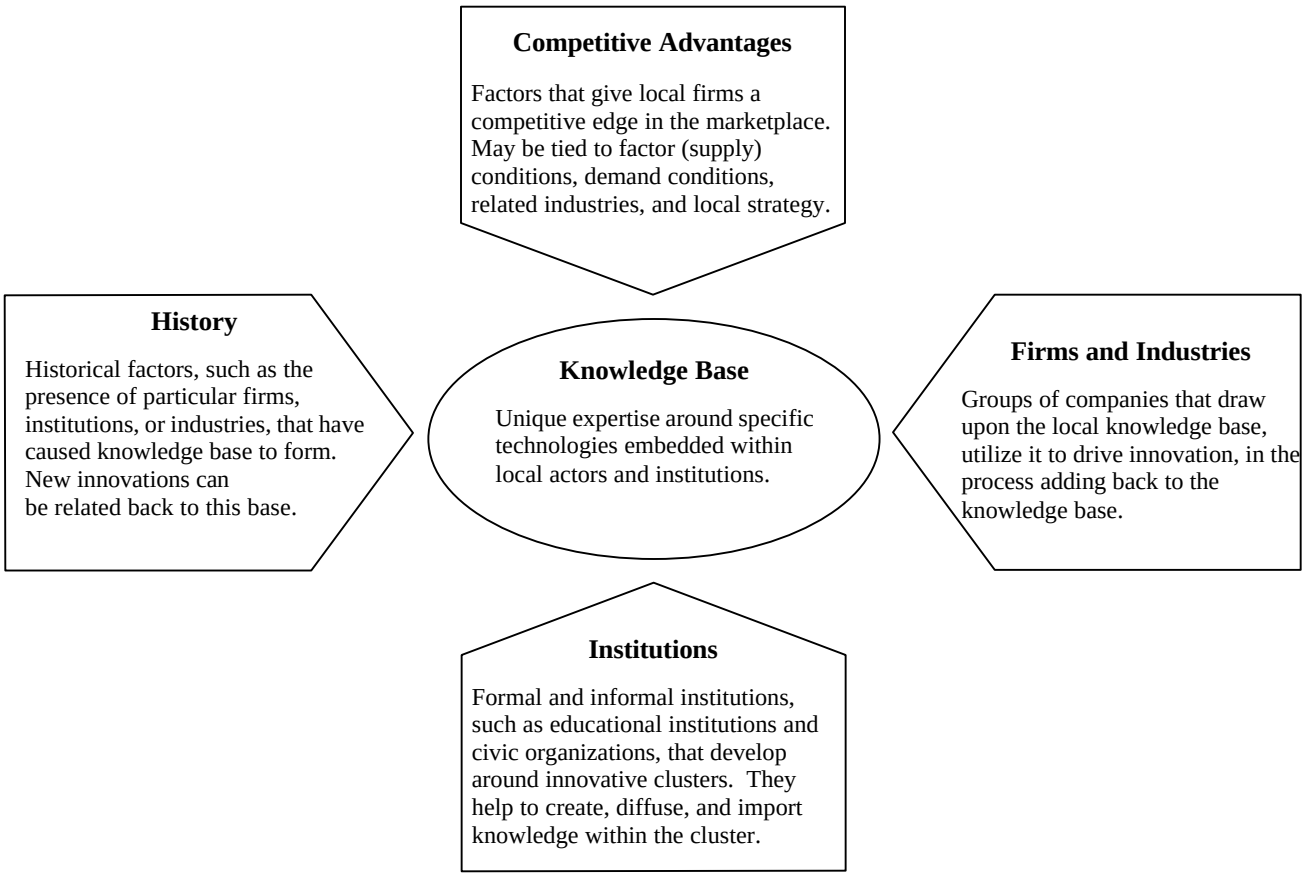
Within rural knowledge clusters, local institutions play an important role in nurturing competitive advantages.

- **Institutions matter.**

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.

Rural Knowledge Cluster Framework



Approach and Research Design

This report examines three rural knowledge clusters in greater Minnesota, and their implications for the Minnesota State Colleges and Universities (MnSCU) system. The role of community and technical colleges in promoting economic development in general, and industry clusters in particular, has received increasing attention (Rosenfeld 2000). The belief that MnSCU has a potentially important role to play in the success of rural knowledge clusters was a key inspiration for this project.

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Three case studies were chosen based on consultation with MnSCU representatives at a forum held on October 9, 2001 at the Humphrey Institute, as well as consultation with analysts and researchers familiar with the Minnesota economy. The places selected (Mankato, Alexandria, and Thief River Falls) were not intended to necessarily provide a representative sample of rural knowledge clusters in Minnesota, nor was significant effort placed in identifying all the rural knowledge clusters that exist in the state. Rather, they were chosen for the purposes of exploring the rural knowledge cluster concept further, testing key hypotheses about the dynamics underlying these successful rural economies, and drawing some preliminary findings to inform the efforts of the MnSCU system and its local affiliates.

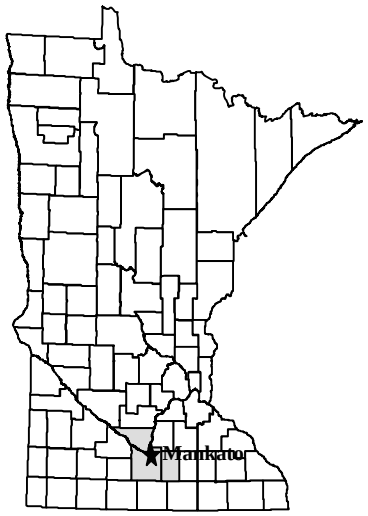
Rural Knowledge Clusters Case Study Sites

The qualitative research design consisted primarily of focus groups and followup interviews, conducted between December 2001 and February 2002 at the three locations. For each case study, several 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" represented by this cluster?
- What companies and industries comprise this knowledge cluster? What institutions relate to them, and what role have they played?
- What indicators of knowledge within this cluster can be identified?

Case Studies

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 then 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 midsized 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 Transcrypt International, and 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

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 (1999): $25,810
(MN non-metro: $23,337;
US non-metro: 21,372)
Per Cap Inc Change (1990-1999): 58%
(MN non-metro: 48%;
US non-metro: 45%)
Job Growth (1990-2000): 30%
(MN non-metro:21%;
US non-metro:17%)
Farm Employment (1999): 5%
(MN non-metro: 9%;
US non-metro: 7%)
Manufacturing Employment (1999): 18%
(MN non-metro: 15%;
US non-metro: 15%)

Source: Bureau of Economic Analysis

*Data in table are for region that includes:
Blue Earth, Nicollet and Waseca counties.

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 a 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.

Mankato
Cluster Profile

Key Industries

- Telecommunications Services (NAICS: 5133/SIC: 4812)

  1999 Employment: 217, 52% less concentrated than U.S. overall*

- Semiconductor & other electronic component manufacturing (NAICS: 3344/SIC: 3679)

  1999 Employment: 1,028, 331% more concentrated than U.S. overall

- Communications equipment mfg (NAICS: 3342/SIC: 3661)

  1999 Employment: 334, 191% more concentrated than U.S. overall

Source: County Business Patterns

Key Employers

- EI Microcircuits (Mankato) 162 employees
- EF Johnson Co. (Waseca) 243 employees
- HickoryTech (Mankato) 525 employees
- Johnson Components (Waseca) 210 employees
- Midwest Wireless (Mankato) 356 employees
- PrePaid Systems (Mankato) 5 employees
- Thin Film Technology (North Mankato) 130 employees
- Winland Electronics (Mankato) 107 employees

Source: MN Dept of Trade and Econ Development

* note: figures may not reflect recent growth of Midwest Wireless and HickoryTech

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 innovaion. 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.

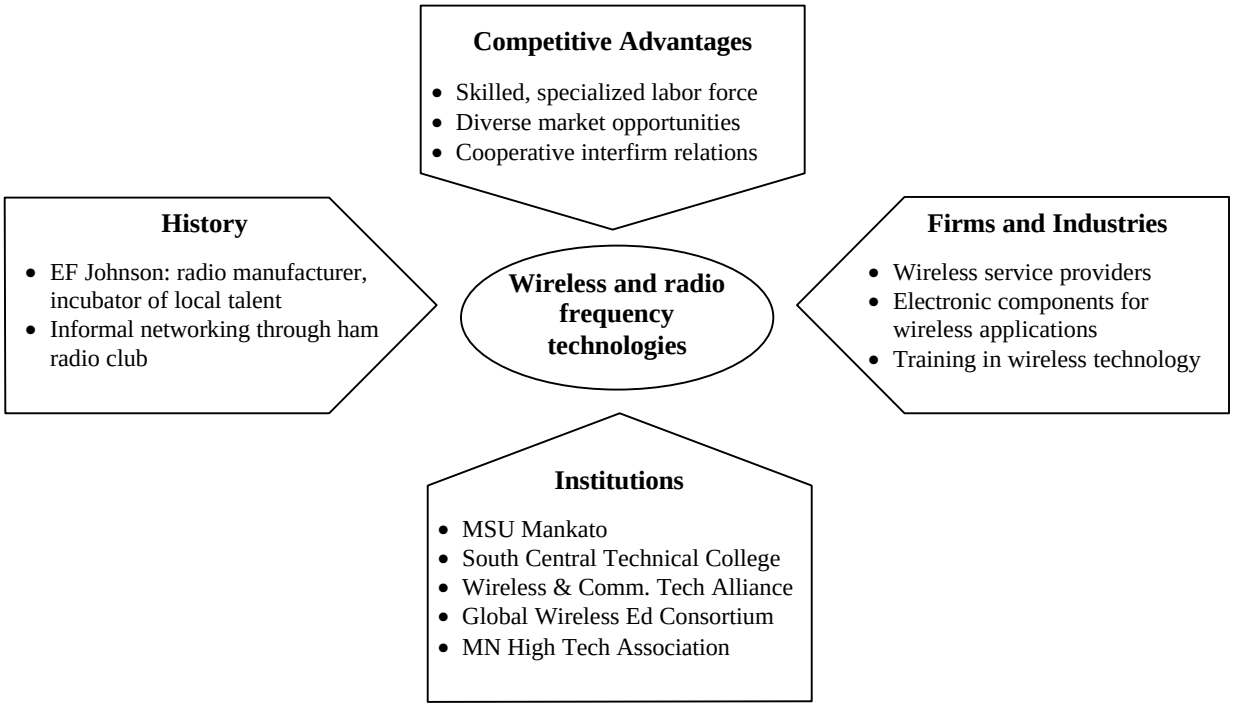
Related Industries: Diverse Market Opportunities

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.

Mankato: Rural Knowledge Cluster Profile



Institutions

Local institutions play an important role in facilitating the transfer of knowledge between various companies and their 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,

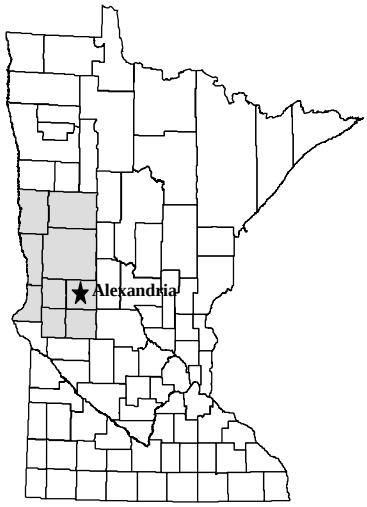
like the Global Wireless Education Consortium (GWEC), link Mankato to activity in the wireless industry nationally and internationally.

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 bought 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 spinoffs from other firms. Today, however, most of these companies function as specialized divisions within larger, diversified 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
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%)

Source: Census Bureau

Per Capita Income (1999): $22,469
(MN non-metro: $23,337;
US non-metro: 21,372)
Per Cap Inc Change (1990-1999): 51%
(MN non-metro: 48%;
US non-metro: 45%)
Job Growth (1990-2000): 29%
(MN non-metro: 21%;
US non-metro: 17%)
Farm Employment (1999): 10%
(MN non-metro: 9%;
US non-metro: 7%)
Manufacturing Employment (1999): 9%
(MN non-metro: 15%;
US non-metro: 15%)

Source: Bureau of Economic Analysis

* Data in table are for region that includes: Becker, Clay, Douglas, Grant, Otter Tail, Pope, Stevens, Traverse, and Wilkin counties (Region 4).

Alexandria abrasives production facility, and Alexandria Extrusion, a midsized 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.

Alexandria
Cluster Profile

Key Industries

- Packaging Machinery (NAICS: 3339/SIC: 3565)

1999 Employment: 1,262, 463% more concentrated than U.S. overall

Source: County Business Patterns

Key Employers

- 3M (Alexandria) 317 employees
- Alexandria Extrusion (Alexandria) 274 employees
- Brenton Engineering (Alexandria) 127 employees
- Douglas Machine (Alexandria) 492 employees
- Minnesota Automation (Crosby) 120 employees
- Massman Automation (Villard) 100 employees
- Schott Automation (Garfield) 35 employees
- Thiele Engineering (Fergus Falls) 93 employees

Source: MN Dept of Trade and Econ Development

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.

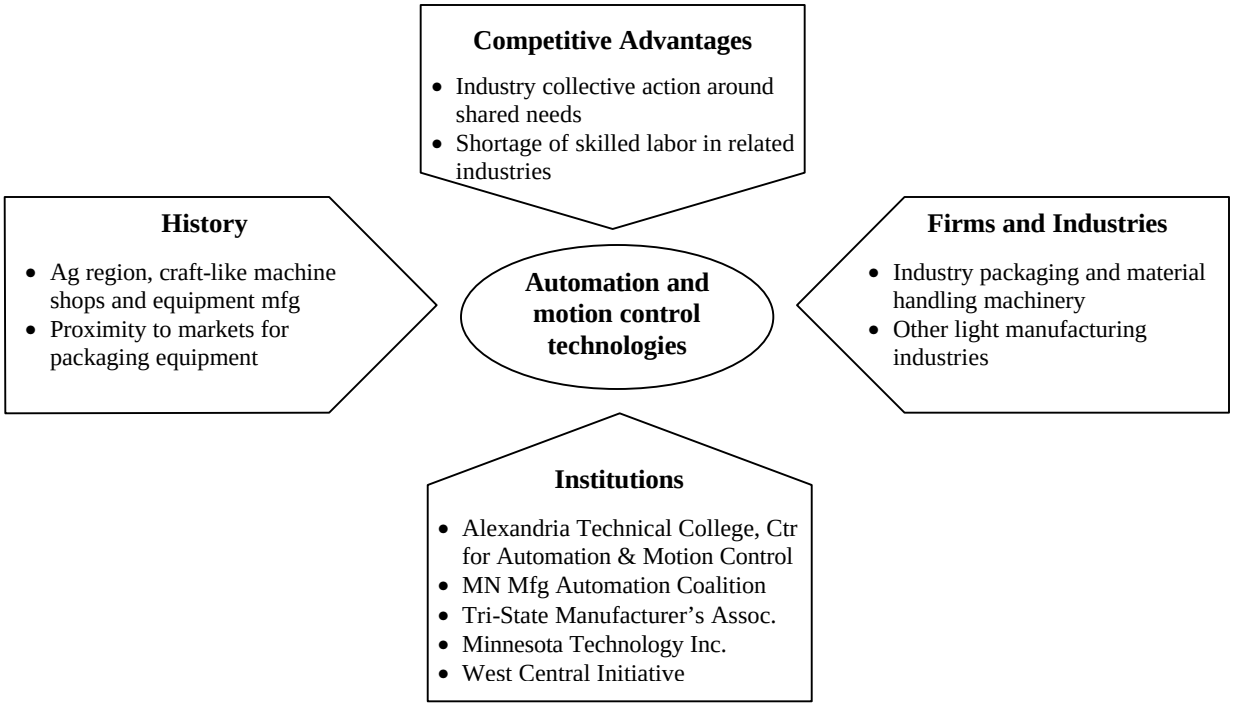
Institutions

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

Alexandria: Rural Knowledge Cluster Profile



to interface effectively between national and international producers of automation technologies like Siemens, Cutler-Hammer, and Rockwell Automation, and consumers of automation technologies within 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 midsized companies exist locally and regionally that function as direct suppliers to, or spinoffs 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 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

Northwest Minnesota
Key Facts

Population (2000): 88,472*
Major Cities:
Crookston: 8,192
East Grand Forks: 7,501
Roseau: 2,756
Thief River Falls: 8,410
Population Density (pop/sq mi): 11
(Twin Cities: 601; MN state: 62)
Population Growth (1990-2000): -2%
(MN non-metro: 4%;
US non-metro: 9%)

Source: Census Bureau

Per Capita Income (1999): $22,929
(MN non-metro: $23,337;
US non-metro: 21,372)
Per Cap Inc Change (1990-1999): 42%
(MN non-metro: 48%;
US non-metro: 45%)
Job Growth (1990-2000): 20%
(MN non-metro: 21%;
US non-metro: 17%)
Farm Employment (1999): 16%
(MN non-metro: 9%;
US non-metro: 7%)
Manufacturing Employment (1999)
18% (MN non-metro: 15%;
US non-metro: 15%)

Source: Bureau of Economic Analysis

* Data in table are for region that includes: Kittson, Marshall, Norman, Pennington, Polk, Red Lake, Roseau counties (Region 1).

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 cylicality 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 production technologies, which permits them to get from concept to engineering to production in shorter cycles.

Northwestern Minnesota
Cluster Profile

Key Industries

- Transportation equipment manufacturing (NAICS: 336/SIC: 3799)

  1999 Employment: 2,632, 421% more concentrated than U.S. overall

- Industrial Machinery Wholesale (NAICS: 4218/SIC: 5088)

  1999 Employment: 368, 73% 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

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 dirtbikes.

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

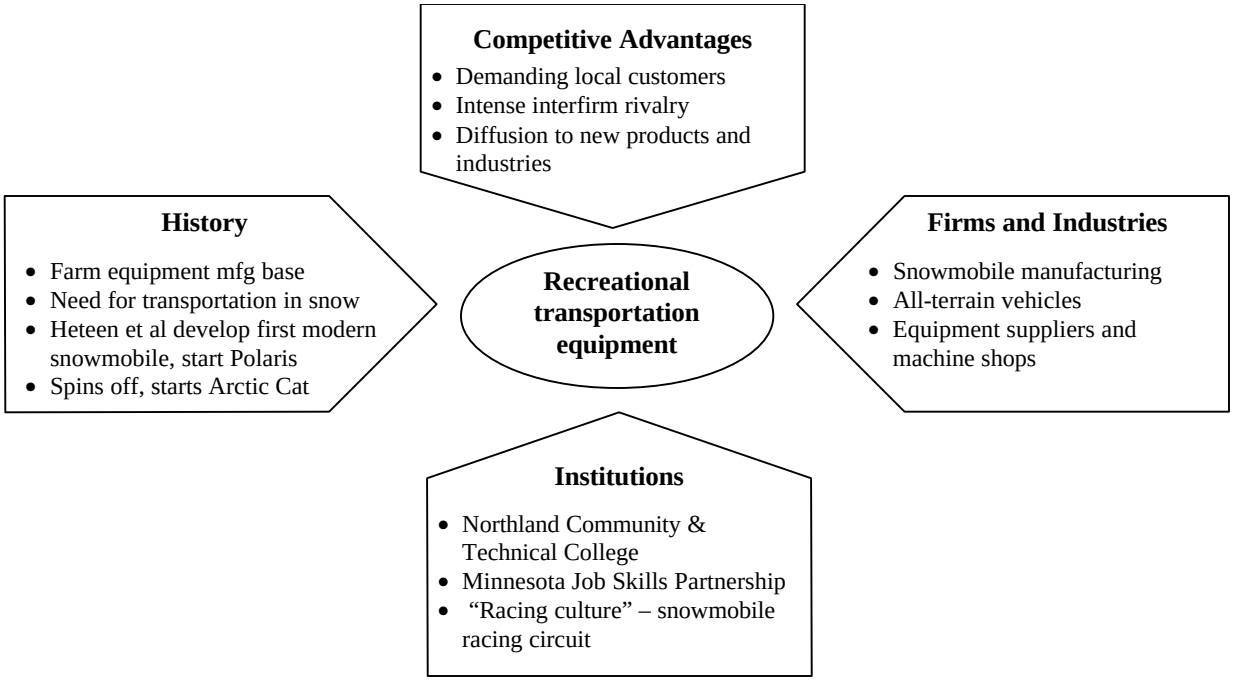
In contrast to the previous two cases, formal institutions have played a less central role in the historical development of the recreational transportation equipment knowledge cluster. More important in this regard, perhaps, have been informal institutions – the "racing culture" – that permeate the local 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 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.

NW Minnesota: Rural Knowledge Cluster Profile



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.

Rural Knowledge Cluster Case Studies:
History, Competitive Advantages, and Institutional Drivers

	History	Competitive Advantages	Institutional Drivers
Mankato (wireless technologies)	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.	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&D and product testing.	Local university (MSU-Mankato) and technical college (South Central Technical College); Wireless and Communications Technology Alliance; Global Wireless Education Consortium; local ham radio club
Alexandria (automation technologies)	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.	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&D resource at Alexandria Technical College.	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
Northwest Minnesota (recreational transportation equipment)	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.	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.	Informal "racing culture"; local technical colleges (Northland Community and Technical College), customized training programs, continuous improvement programs.

Findings About Rural Knowledge Clusters

An important goal of this project was to learn more about "rural knowledge clusters" as a model of rural economic dynamism. In that regard, the three case studies presented here serve to inform and refine the model. Several relevant findings can be drawn from these examples:

- **Innovation does not take place in a vacuum – history and context matter in the emergence of rural knowledge clusters.**

In each of the three 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 base of knowledge can be a driver in diverse 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. It suggests that the entrepreneurial cross-fertilization of accrued knowledge into new technologies, products, and markets should be viewed as an important feature of rural knowledge clusters.

- **Developing comparable "knowledge indicators" is very difficult.**

Among the goals of the project was to explore whether the knowledge bases in the three 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.

- **Educational institutions are important feedback mechanisms that foster knowledge development within rural knowledge clusters.**

The rural knowledge cluster framework suggests that local institutions, both formal and informal, play an important role in catalyzing knowledge creation and diffusion within local economies. The perceived importance of higher education institutions in this regard served as an impetus for this project. The findings from these three cases, in which local educational institutions have played differing but important roles, reinforce this idea. Educational institutions, when engaging and working proactively with local firms, provide them with an interactive, real-time learning environment that encourages them to innovate and remain competitive. Customized training programs offer substantial promise, by allowing educators to develop a greater sense of firms' skill needs, so that curricula geared toward the emerging workforce can be more responsive and meaningful. "Centers of excellence," which promote applied research and technology development relating to clusters of local firms, such as the Center for Automation and Motion Control in Alexandria, are also promising, albeit very resource intensive to organize. This finding suggests that local institutions, including educational institutions, can play a key role in facilitating (but not necessarily leading) the formation and success of rural knowledge clusters.

Implications for MnSCU Institutions

The findings from these case studies present a number of implications for promoting a rural knowledge cluster approach among community and technical colleges in the Minnesota State College and Universities (MnSCU) system.

- **Understand your local knowledge base.**

The first step in promoting a rural knowledge cluster approach is to develop an understanding of the local knowledge base. The most logical place to start is with the innovative and successful companies in the local economy. What characteristics do they share, especially in terms of specialized skills, expertise, and "know-how" needed and technologies used? How do the current knowledge specializations relate to the region's historical economic and industrial base? What role have community and technical colleges played in developing this knowledge base? A greater awareness of the distinctive knowledge base that exists in the local and regional economy will help to inform strategies for nurturing and promoting rural knowledge clusters.

- **Recognize the importance of "education" in broader sense, particularly as it relates to employers as customers.**

A mission of community and technical colleges has traditionally been to build and develop the skills of individuals that meet the needs of the workplace. However, community and technical colleges also play an important role in providing "education" to local employers, by working with them to develop better, more efficient processes that help them achieve higher levels of productivity and competitiveness. These efforts, in turn, shape the skills needed by the emerging and incumbent workforce. Opportunities should be pursued to maintain and strengthen coordination with related providers of employer-focused services, such as Minnesota Technology.

- **Balance one-on-one customer relationships with opportunities for partnerships that achieve economies of scale and scope.**

Businesses' skill and training needs are like snowflakes – no two are exactly alike. Consequently, programs like customized job training are often highly effective because they are designed to reflect the customer's particular needs, rather than some standardized, "off the shelf" commodity. At the same time, though, these one-on-one relationships need to be balanced with opportunities for leveraging economies of scale and scope. This should be pursued where shared needs and incentives for firms to collaborate can be identified. Skill- (or knowledge-) based training partnerships or cooperatives represent a potential approach. This model of "cooperative competition"

promotes not only a more efficient use of scarce public resources, but also the development of shared sources of regional competitive advantage.

- **Develop a "gateway" model for accessing specialized knowledge within the MnSCU system.**

Local relationships form the building blocks of effective strategies for community and technical colleges to promote rural knowledge clusters. This will continue to be the case, even as sources of specialized centers of excellence grow within the MnSCU system. A "gateway" approach should be considered for linking local businesses to specialized sources of knowledge at MnSCU institutions, such as those highlighted in this report. Again, this promotes more effective deployment of public resources, by avoiding duplication and "watering down" of existing strengths, and improving the viability of major investments in new centers of excellence. Incentives should be considered for encouraging such collaboration among local MnSCU institutions.

Bibliography

Works Cited

Cortright, Joseph, and Heike Meyer. 2001. *High Tech Specialization: A Comparison of High Technology Centers*, Washington, D.C.: The Brookings Institution, Center on Urban and Metropolitan Policy.

Gale, Fred, and David McGranahan. 2001. "Nonmetro Areas Fall Behind in the 'New Economy'." *Rural America*, Vol. 16, No. 1, pp. 44-52.

Porter, Michael. 1990. *The Competitive Advantage of Nations*, New York: The Free Press.

Rosenfeld, Stuart A. 2000. "Community College/Cluster Connections: Specialization and Competitiveness in the United States and Europe," *Economic Development Quarterly*, Vol. 14, No. 1, pp. 51-62.

Recent Publications Relevant to Rural Knowledge Clusters

Barkley, David L., and Mark S. Henry. 1997. "Rural Industrial Development: To Cluster or Not to Cluster?" *Review of Agricultural Economics*, Vol. 19, No. 2, pp. 308-325.

Henry, Mark, and Mark Drabenstott. 1996. "A New Micro View of the U.S. Rural Economy." *Economic Review*, 2nd Quarter, pp. 53-70.

Jarboe, Kenan Patrick. 2001. "Knowledge Management as an Economic Development Strategy," *Reviews of Economic Development Literature and Practice*, Washington, D.C.: Economic Development Administration, No. 7.

Rosenfeld, Stuart A., Cynthia D. Liston, Marcia E. Kingslow, and Eric R. Forman. 2000. *Clusters in Rural Areas: Auto Supply Chains in Tennessee and Houseboat Manufacturers in Kentucky*. Carrboro, NC: Regional Technology Strategies, Inc.

Project Participants

Rural Knowledge Clusters Workshop: October 9, 2001

A seminar and discussion on rural knowledge clusters, sponsored by MnSCU, was held at the Humphrey Institute on October 9, 2001. Stuart Rosenfeld, Principal of Regional Technology Strategies in Carrboro, NC, gave a presentation on "Colleges as Instruments of Regional Development." A subsequent discussion focused on areas where research on rural knowledge clusters could benefit local MnSCU institutions. The following individuals from the MnSCU system attended:

Ron Dreyer, MnSCU System Office
Kathy Friedrich, St. Cloud Technical College
Tom Gausman, Fergus Falls Community College
Ken Howe, NW Technical College, Bemidji
Jim Johnson, Southeast Technical, Winona
Warren Kemplin, Rochester Community & Technical College
Curt Kephart, Rochester Community & Technical College
Kevin Kopischke, Alexandria Technical College
Pradeep Kotamraju, Dakota Community and Technical College
Barb Lee, NW Technical College, Bemidji
Larry Lundblad, South Central Technical College, Mankato
Mary Jean Lush, Lake Superior College, Duluth
Michelle Pyfferoen, Rochester Community & Technical College
Ellen Nelson, Rochester Community & Technical College
Richard Tvedten, NetWORK for Customized Training

Site Visits

The following individuals participated in focus groups and interviews that provided information for this report:

Mankato

John Baldwin, South Central Technical College
Brian Fazio, Wireless & Communications Technology Alliance
John Frey, Minnesota State University Mankato
Connie Ireland, Minnesota Technology Inc.
Lorin Krueger, Winland Electronics
Larry Lundblad, South Central Technical College
Peter Wendt, PrePaid Systems, Inc.
Jerry Wilke, HickoryTech

Alexandria

Robert Auel, Center for Automation and Motion Control
Jan Doebbert, Alexandria Technical College
Kevin Kopischke, Alexandria Technical College
Rick Kvasager, Minnesota Technology Inc.

James Newenhouse, Brenton Engineering
Ken Ryan, Center for Automation and Motion Control
Tom Schabel, Alexandria Extrusion Company
John Seim, Center for Automation and Motion Control
Todd Zarbok, Center for Automation and Motion Control

Thief River Falls

Dennis Buckley, Arctic Cat
Chad Coauette, Northland Community and Technical College
Shari Olson, Northland Community and Technical College
Steve Pavek, Polaris Industries
Rhonda Stene, Polaris Industries
David Swedberg, Polaris Industries

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.

About the NetWORK for Customized Training, Education & Development, Minnesota State Colleges & Universities (MnSCU)

http://www.thenetwork.mnscu.edu/

The NetWORK for Customized Training, Education & Development is a confederation of 33 service units within the Minnesota State Colleges and Universities. Located in 60 cities throughout the state, they operate to serve the performance improvement needs of Minnesota's employers.

Each local service unit is staffed by program coordinators who work directly with employers to assess needs, identify education and training resources, coordinate the delivery of services and ensure client satisfaction. These coordinators depend on qualified college and university faculty members and business/industry experts to deliver exactly what the employer needs — at the organization, team or individual level.