

Winnebago County Comprehensive Industry Analysis

Aerospace Industry



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Regional Development Institute
NIU Outreach
Northern Illinois University
DeKalb, IL 60115
www.outreach.niu.edu

NIU Regional
Development Institute
NIU Outreach

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About the Winnebago County Initiative

The *Comprehensive Industry Analysis for the Aerospace Industry in Winnebago County* was commissioned by the County of Winnebago to evaluate the relative strengths and weaknesses of the county's business climate for aerospace product and parts manufacturing. The primary goal of this research is to provide the region with tools and information to develop a targeted marketing campaign to attract and retain the aerospace industry to the region and to build the regional aerospace cluster. It also focuses on identifying and providing recommendations on positioning the region to be a competitive aerospace industry cluster.

The Comprehensive Industry Analysis and the research provided is just one step the region is taking to bolster business attraction efforts. Resources are being provided for technology that will facilitate the collection and dissemination of available industrial space to site selection consultants and companies. This technology uses satellite imagery and data mapping to inventory available sites and buildings. Another significant movement is toward regionalism. Winnebago County is considering participation in a regional economic coalition that will work collectively to access federal grants and other funding sources for special projects.

Under contract with Winnebago County, the Regional Development Institute at Northern Illinois University has prepared the following analysis and recommendations for the aerospace industry in the region.

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Executive Summary

The region's two major aerospace 1st tier supply chain partners generated 34.2% or 91 of the 266 patents issued in Winnebago County from 1999-2003, indicating a high level of innovation. Winnebago County's unique strength in the aerospace industry is the long term presence of major 1st tier suppliers and historical presence of high-skilled machining capabilities. "Due to the engineering center environment, research and development operations, particularly in aerospace and machinery areas, are well suited for Rockford." ¹ However, a critical challenge for the region is to limit the loss of these manufacturing capabilities and to strengthen and grow the region's innovative high-skilled, high-value added, growth industries.

Expand Aerospace Partnerships and Collaborations

Expanding the region's aerospace industry will require evaluation and development along four primary areas of focus. The first area of focus is on partnerships, collaborations, and knowledge development to expand resources and capabilities, develop training cooperatives, and foster increased entrepreneurialism and innovation.

Strategies should include expansion of regional approaches and collaborations to secure funding opportunities at the federal and state levels. An example of funding opportunities includes the recent announcement of a potential \$5 million grant to establish a center for advanced titanium manufacturing center in northern Illinois. These types of initiatives require regional leadership to champion and coordinate collaborative projects in training, skilled machining, and research and development with partners.

Support should also be given to strengthen existing manufacturing collaborations such as EIGERlab which hosts the creative commercial uses of advanced manufacturing technologies, such as micro-machining and MARRV which provides the connection for small, local manufacturers interested in using flexible networks to combine their core competencies. Opportunities also exist in the development and support of aerospace partnerships with state and nation industry associations including the Aerospace Industry Association (AIA) and the Aerospace States Association (ASA).

¹ Carter & Burgess, Inc. Rockford Area, IL Target Industry Analysis, February 2006, Page 33.

Other critical partnerships involve developing the regions' broadband and telecommunication infrastructure which is critical to linkages between the region's local aerospace supply chain and national or international supply chains. Providing leadership and coordination for public-private ventures to secure funding opportunities would be a key strategy for expediting the developing of high-speed fiber optic networks linked to global networks.

Educational collaborations and partnerships focused on workforce development for key aerospace occupations can also strengthen the region's aerospace supply chain. Such partnerships and collaborations involve Northern Illinois University, Rockford College, Rock Valley College, and University of Illinois College of Medicine at Rockford in forming Higher Education Alliance of the Rock River Region (HEARRR).

Improve Manufacturing Quality and Capabilities

The second area of focus includes assisting regional manufacturers to meet the needs of the aerospace supply chain through the expansion of cost cutting strategies and development of quality oriented systems capable of meeting aerospace industry requirements. In order to retain positions in the aerospace supply chain, companies need to expand capabilities for more comprehensive products and lower costs through improved processes or strategic outsourcing. "To reduce costs, aerospace OEMs have increased their outsourcing to suppliers of subassemblies (such as engines, structures, landing gear, and avionics) and are concentrating on their core competencies of design, assembling, and marketing aircraft."²

Aerospace supply chain partners will be expected to provide more in terms of complete assemblies or subassemblies as opposed to piece parts. This presents a challenge for the region's manufacturers as they are generally smaller in size and will have difficulties meeting the demands of completing entire assemblies which often require a high mix of varying products, lower volumes, and highly specialized production.

To work toward this end, the region should develop an aerospace manufacturing network of subject matter experts to build capacity for more comprehensive manufacturing services and competitive manufacturing capabilities. Forming these alliances and joint ventures can require assistance from external organizations to facilitate the process.

² Niosi, Jorge and Zhegu, Majlinda. *Aerospace Clusters: Local or Global Knowledge Spillovers?* Industry and Innovation, The Charlesworth Group, Wakefield, March 2005.

These networks could be formal or informal and involve joint production, resource sharing, joint marketing, and/or knowledge sharing.

Strengthen Workforce Availability

The third area of focus is on workforce availability and development. While there appears to be a good supply of professional, technical, and skilled machining workforce for the existing aerospace industry growth, industry attraction and retention efforts will need to address the ability to expand this workforce for the future. “Skilled workers such as transportation equipment and industrial machinery, particularly welders, CNC machinists and some other equipment operations, are tougher to recruit in this market.”³ Engineers and other professional and technical positions are equally challenging for many companies to attract and retain.

Regional marketing initiatives need to focus on the combined impact of reasonable wages, low cost of living, and housing affordability. Average annual aerospace wages are lower than many of the comparative regions. However, Winnebago County has the lowest median housing value and fourth lowest cost of living score.

While wages are important, the purchasing power of wages is even more significant to employees. The purchasing power of wages takes into consideration the cost of goods and services in the region. When considering the purchasing power of wages, Winnebago County is the third highest of the comparison regions with a purchasing power equivalent of \$49,900. The two areas in Ohio with a higher purchasing power have a 2 percent or less advantage.

	Average Annual Wages	Median Housing Value	Cost of Living	Purchasing Power	Winnebago Comparison
Winnebago County, IL	\$44,054	\$105,810	88.2	\$51,081	
Essex County, MA	\$48,277	\$319,815	145.3	\$33,257	-35%
Hamilton County, OH	\$42,952	\$131,513	87.8	\$48,920	-6%
Imperial County, CA	\$44,658	\$158,117	188.7	\$23,666	-54%
Jefferson County, CO	\$45,198	\$238,726	110.4	\$40,940	-20%
Lake County, OH	\$43,742	\$127,481	183.0	\$23,902	-53%
Marion County, IN	\$43,077	\$114,240	82.8	\$52,025	2%
Montgomery County, OH	\$43,202	\$109,088	83.6	\$51,677	1%

³ Carter & Burgess, Inc. Rockford Area, IL Target Industry Analysis, February 2006, Page 33.

A tight workforce supply for the aerospace industry is not unique to Winnebago County; rather it is a national trend. According to the Aerospace Industries Association, critical challenges facing the aerospace industry nationally include workforce shortages, longer product lifecycles, declining number of new platforms being developed, and reduced overall spending on research and development.⁴

Regional strategies for developing the aerospace supply chain should focus on workforce training incentives and expansion programs. Many states are incentivizing aerospace relocation or expansion through worker training grants and initiatives strategically designed to address significant workforce issues. Business attraction efforts should place emphasis on development of training grants and incentives in addition to developing relationships and partnerships with AIA, ASA, and other related organizations for access to available resources, potential leads for site selection, as well as increasing and expanding the region's visibility with national aerospace organizations.

Additional Strategies for Strengthening the Aerospace Industry

Finally, business attraction and retention efforts should focus on development of marketing and promotional materials and incentive packages to mitigate higher energy, property tax, and sales tax costs. Efforts should be placed on developing a comprehensive marketing tool that incorporates and communicates information on the region's aerospace cluster, emphasizing manufacturing capabilities, existing collaborations, and potential future developments. Florida and other regions strong in aerospace have developed similar media materials aimed at business attraction and retention, workforce development, and aerospace supply chain development.

Other aerospace regions have programs that provide direct financial assistance to attract customers of the aerospace industries including space, aviation, and defense and to encourage business activities. Similar programs in Winnebago County could foster the development of new aerospace-related investment, operations, and business and assist in the retention and expansion of existing aerospace-related businesses.

Customized business incentive packages for the aerospace industry can be developed to address and mitigate the cost of doing business such as energy, property and sales tax costs. Additionally, workforce development and training grants could be included such as those available through the Aerospace Industries Association. Development of incentive

⁴ Grimson, Matt. *Industry, Government Strategize to Avert Workforce Crisis*. Aerospace Industries Association, P.A. Rel. 2004-42 .

packages addressing energy, property and sales tax costs as well as workforce training grants is essential for further development and growth of the region's aerospace cluster.

According to regional 1st tier aerospace companies supply chain partners, not currently present, that would benefit the supply chain include a distribution center or supply logistics center to facilitate transportation and inventory management. Thus, Winnebago County business attraction efforts should continue focusing on distribution and warehousing with emphasis on high-tech, highly productive firms compatible with the needs of the aerospace industry.

The National Aerospace Industry

*Nature of the Industry*⁵

The aerospace industry comprises companies producing aircraft, guided missiles, space vehicles, aircraft engines, propulsion units, and related parts. Aircraft overhaul, rebuilding, and conversion are also included.

Firms producing transport aircraft make up the largest segment of the civil (nonmilitary) aircraft portion of the industry. Civil transport aircraft are produced for air transportation businesses such as airlines and cargo transportation companies. These aircraft range from small turboprops to wide-body jets and are used to move people and goods all over the world. Another segment of civil aircraft is general aviation aircraft. General aviation aircraft range from the small two-seaters designed for leisure use to corporate jets designed for business transport. Civil helicopters, which make up one of the smallest segments of civil aircraft, are commonly used by police departments, emergency medical services, and businesses such as oil and mining companies that need to transport people to remote worksites.

Aircraft engine manufacturers, usually different than aircraft manufacturers, produce the engines used in civil and military aircraft. These manufacturers design and build engines according to the aircraft design and performance specifications of the aircraft manufacturers. Aircraft manufacturers may use engines designed by different companies on the same type of aircraft.

Military aircraft and helicopters are purchased by governments to meet national defense needs, such as delivering weapons to military targets and transporting troops and equipment around the globe. Some of these aircraft are specifically designed to deliver or guide a powerful array of ordnance to military targets with tremendous maneuverability and low detect ability. Other aircraft, such as unmanned aerial vehicles, are produced to gather defense intelligence such as radio signals or to monitor movement on the ground.

Firms producing guided missiles and missile propulsion units sell primarily to military and government organizations. Although missiles are viewed predominantly as offensive

⁵ Excerpts from the U.S. Department of Labor Bureau of Labor Statistics *2005 Career Guide to the Aerospace Industry*.

weapons, improved guidance systems have led to their increased use as defensive systems. This part of the industry also produces space vehicles and the rockets for launching them into space. Consumers of spacecraft include the National Aeronautics and Space Administration (NASA), the U.S. Department of Defense (DOD), telecommunications companies, television networks, and news organizations. Firms producing space satellites are discussed with the computer and electronic product manufacturing industry in this publication because satellites are primarily electronic products.

In 2004, about 2,800 establishments made up the aerospace industry. In the aerospace parts industry, most establishments were subcontractors that manufacture parts and employ fewer than 100 workers. Nevertheless, 63% of the jobs in aerospace manufacturing were in large establishments that employed 1,000 or more workers.

The Federal Government traditionally has been the aerospace industry's biggest customer. The vast majority of government contracts to purchase aerospace equipment are awarded by Department of Defense. NASA is also a major purchaser of the industry's products and services, mainly for space vehicles and launch services.

The aerospace industry is dominated by a few large firms that contract to produce aircraft with government and private businesses, usually airline and cargo transportation companies. These large firms, in turn, subcontract with smaller firms to produce specific systems and parts for their vehicles. Government purchases are largely related to defense. Typically, DOD announces its need for military aircraft or missile systems, specifying a multitude of requirements. Large firms specializing in defense products subsequently submit bids, detailing proposed technical solutions and designs along with cost estimates, hoping to win the contract. Firms also may research and develop materials, electronics, and components relating to their bid, often at their own expense, to improve their chances of winning the contract. Following a negotiation phase, a manufacturer is selected and a prototype is developed and built, then tested and evaluated. If approved by DOD, the craft or system enters production. This process usually takes many years.

Commercial airlines and private businesses typically identify their needs for a particular model of new aircraft based on a number of factors, including the routes they fly. After specifying requirements such as range, size, cargo capacity, type of engine, and seating arrangements, the airlines invite manufacturers of civil aircraft and aircraft engines to submit bids. Selection ultimately is based on a manufacturer's ability to deliver reliable aircraft that best fit the purchaser's stated market needs at the lowest cost and at favorable financing terms.

The way in which commercial and military aircraft are designed, developed, and produced continues to undergo significant change in response to the need to cut costs and deliver products faster. Firms producing commercial aircraft have reduced development time drastically through computer-aided design (CAD), which allows firms to design and to test an entire aircraft, including the individual parts, by computer. The drawings of these parts can be sent electronically to subcontractors who use them to program their machinery. Increasingly, firms bring together teams composed of customers, engineers, and production workers to pool ideas and to make decisions concerning the aircraft at every phase of product development. Additionally, the military has changed its design philosophy, using commercially available, off-the-shelf technology when appropriate, rather than developing new customized components.

Employment

Aerospace manufacturing provided 444,000 wage and salary jobs in 2004. The largest number of aerospace jobs was in Washington and California, although many also were located in Kansas, Texas, Connecticut, and Arizona.

Employment data in this statement do not include aerospace R&D-related workers who work in separate establishments. Under the North American Industry Classification System (NAICS), workers in research and development establishments that are not part of a manufacturing facility are included in a separate industry—research and development in the physical, engineering, and life sciences. Given the importance of R&D work to the aerospace manufacturing industry, aerospace-related R&D occupations and issues are discussed in the following sections, even though much of their employment is not included in the employment data in this statement. Significant points regarding aerospace employment are listed:

- Skilled production, professional and managerial jobs account for the largest share of employment.
- Employment is projected to grow more slowly in this industry than in industries generally.
- During slowdowns in aerospace manufacturing, production workers are vulnerable to layoffs, while professional workers enjoy more job stability.
- Earnings are substantially higher, on average, than in most other manufacturing industries.

Occupations

The design and manufacture of the technologically sophisticated products of the aerospace industry require the input and skills of various workers. Skilled production, professional and related, and managerial jobs make up the bulk of employment. Those employed in managerial and administrative support occupations manage the design process and factory operations, coordinate the hundreds of thousands of parts that are assembled into an aircraft, and ensure compliance with federal recordkeeping regulations. The aerospace industry has a larger proportion of workers with education beyond high school than the average for all industries.

The aerospace industry is on the leading edge of technology, constantly striving to create new products and improve existing ones. The industry invests a great deal of time and money in research and development of aerospace products and much of the work is performed by professional and related workers, who made up 34% of the aerospace workforce in 2004. In addition, as mentioned in the previous section, many more aerospace-related professionals work in the scientific research and development services industry. A bachelor's degree in a specialized field, such as engineering, is required for many of these jobs; a master's or doctoral degree is preferred for a few. For many technician occupations, 2 years of technical training after high school are favored.

Professionals and technicians develop new designs and make improvements to existing designs. *Aerospace engineers* are integral members of the teams that research, design, test, and produce aerospace vehicles. Some specialize in areas such as structural design, guidance, navigation and control, and instrumentation and communication. Electrical and electronics, industrial, and mechanical engineers also contribute to the research for and development and production of aerospace products. For example, *mechanical engineers* help design mechanical components and develop the specific tools and machines needed to produce aircraft, missile, and space vehicle parts, or they may design jet and rocket engines. *Engineering technicians* assist engineers, both in the research and development laboratory and on the manufacturing floor. They may help build prototype versions of newly designed products, run tests and experiments, and perform a variety of other technical tasks. One of the earliest users of computer-aided design, the aerospace industry continues to use the latest computer technology. *Computer scientists and systems analysts, database administrators, computer software engineers, computer programmers, computer support specialists; and network and computer systems administrators* are responsible for the design, testing, evaluation, and setup of computer systems that are used throughout the industry for design and manufacturing purposes.

Management, business, and financial occupations accounted for 18% of industry employment in 2004. Many managers in the aerospace industry have a technical or engineering background and supervise teams of engineers in activities such as testing and research and development. *Industrial production managers* oversee all workers and lower level managers in a factory. They also coordinate all activities related to production. In addition to technical and production managers, *financial managers; purchasing managers, buyers, and purchasing agents; cost estimators; and accountants and auditors* are needed to negotiate with customers and subcontractors and to track costs.

Of all aerospace workers, 37% are employed in production; installation, maintenance, and repair; and transportation and material-moving occupations. Many of these jobs are not specific to aerospace and can be found in other manufacturing industries. Many production jobs are open to persons with only a high school education; however, special vocational training after high school is preferred for some of the more highly skilled jobs.

Aircraft structure, surfaces, rigging, and systems assemblers usually specialize in one assembly task; hundreds of different assemblers may work at various times on producing a single aircraft. Assemblers may put together parts of airplanes, such as wings or landing gear, or install parts and equipment into the airplane itself. Those involved in assembling aircraft or systems must be skilled in reading and interpreting engineering specifications and instructions.

Machinists make parts that are needed in numbers too small to mass-produce. Machinists follow blueprints and specifications and are highly skilled with machine tools and metalworking. *Tool and die makers* are responsible for constructing precision tools and metal forms, called dies, which are used to shape metal. Increasingly, as individual components are designed electronically, these highly skilled workers must be able to read electronic blueprints and set up and operate computer-controlled machines. *Inspectors, testers, sorters, samplers, and weighers* perform numerous quality-control and safety checks on aerospace parts throughout the production cycle. Their work is vital to ensure the safety of the aircraft.

The remaining jobs in the industry are in office and administrative support, service, and sales occupations. Most of these jobs can be entered without education beyond high school. Those in service occupations are employed mostly as guards and janitors and other cleaning and maintenance workers. Sales workers are mostly wholesale and manufacturing sales representatives and sales workers' supervisors.

**Employment of wage and salary workers in aerospace manufacturing by occupation
2004 and projected change 2004-2014 (Employment in thousands)**

Occupation	Employment, 2004		Percent change, 2004-2014
	Number	Percent	
Total, all occupations	444	100.0	8.2
Management, business, and financial occupations	78	17.6	9.6
Industrial production managers	5	1.1	7.8
Engineering managers	9	2.0	9.0
Purchasing agents, except wholesale, retail, and farm products	9	2.0	7.8
Management analysts	10	2.3	7.8
Business operation specialists, all other	9	2.0	18.6
Accountants and auditors	4	1.0	7.8
Professional and related occupations	150	33.8	11.2
Computer software engineers	13	2.9	29.1
Computer systems analysts	6	1.3	18.6
Aerospace engineers	45	10.2	5.6
Industrial engineers	12	2.7	19.9
Mechanical engineers	13	3.0	9.0
Engineers, all other	7	1.6	9.1
Drafters, engineering, and mapping technicians	23	5.3	8.5
Aerospace engineering and operations technicians	5	1.2	7.8
Engineering technicians, except drafters, all other	7	1.6	9.0
Sales and related occupations	5	1.2	8.6
Office and administrative support occupations	36	8.0	-3.0
Material recording, scheduling, dispatching, and distributing occupations	14	3.1	-1.9
Secretaries and administrative assistants	7	1.6	-0.3
Office clerks, general	6	1.3	-4.0
Installation, maintenance, and repair occupations	35	8.0	19.7
Avionics technicians	5	1.0	20.8
Aircraft mechanics and service technicians	15	3.5	30.9
Maintenance and repair workers, general	5	1.1	7.8
Production occupations	121	27.2	4.1
First-line supervisors/managers of production and operating workers	9	2.0	7.8
Aircraft structure, surfaces, rigging, and systems assemblers	16	3.6	7.8
Team assemblers	8	1.8	7.8
Computer-controlled machine tool operators, metal and plastic	5	1.2	7.8
Machine tool cutting setters, operators, and tenders, metal and plastic	11	2.5	-4.4
Machinists	16	3.6	7.8
Miscellaneous metalworkers and plastic workers	5	1.2	-5.9
Inspectors, testers, sorters, samplers, and weighers	14	3.1	-1.9

NOTE: May not add to totals due to omission of occupations with small employment.

Training and Advancement

Because employers need well-informed, knowledgeable employees who can keep up with the rapid technological advancements in aerospace manufacturing, the industry provides substantial support for the education and training of its workers. Firms provide onsite, job-related training to upgrade the skills of technicians, production workers, and engineers. Classes teaching computer skills and blueprint reading are common. Some firms reimburse employees for educational expenses at colleges and universities, emphasizing four-year degrees and postgraduate studies.

Professionals, such as engineers and scientists, require a bachelor's degree in a specialized field. For some jobs, particularly in research and development, a master's or doctoral degree may be preferred.

Production workers may enter the aerospace industry with minimal skills. Mechanical aptitude and good hand-eye coordination usually are necessary. A high school diploma or equivalent is required, and some vocational training in electronics or mechanics also is favored.

Unskilled production workers typically start by being shown how to perform a simple assembly task. Through experience, on-the-job instruction provided by other workers, and brief formal training sessions, they expand their skills. Their pay increases as they advance into more highly skilled or responsible jobs. For example, machinists may take additional training to become numerical tool and process control programmers or tool and die makers. Inspectors usually are promoted from assembly, machine operation, and mechanical occupations.

Because of the reliance on computers and computer-operated equipment, classes in computer skills are common. With training, production workers may be able to advance to supervisory or technician jobs.

To enter some of the more highly skilled production occupations, workers must go through a formal apprenticeship. Machinists and electricians complete apprenticeships that can last as long as four years. Apprenticeships usually include classroom instruction and shop training.

Entry-level positions for technicians usually require a degree from a technical school or junior college. Companies sometimes retrain technicians to upgrade their skills or to teach different specialties. They are taught traditional as well as new production

technology skills, such as computer-aided design and manufacturing, and statistical process control methods.

Outlook

Wage and salary employment in the aerospace product and parts manufacturing industry is expected to grow by 8% over the 2004-2014 period, slower than the 14% growth projected for all industries combined. Employment in the aerospace industry has declined in recent years as a result of a drastic reduction in commercial transport aircraft orders, but a modest increase in orders is expected over the projection period. The decline in orders was caused by the reduction in air travel that resulted from the terrorist attacks on the United States and severe financial problems that many of the nation's airlines have experienced. However, an increase in air traffic and the improving financial health of the nation's airlines are beginning to reverse the trend.

The outlook for the military aircraft and missiles portion of the industry is better. Concern for the nation's security has increased the need for military aircraft and military aerospace equipment. Although new employment opportunities in the defense-related sector of the aerospace industry may not reach levels previously attained during the Cold War, employment in this sector is expected to rise.

Because of past reductions in defense expenditures and competition in the commercial aircraft sector, there have been and may continue to be mergers in the industry, resulting in layoffs. Even though the number of large firms performing final assembly of aircraft has been reduced, hundreds of smaller manufacturers and subcontractors will remain in this industry.

In addition to some growth in employment opportunities for professional workers in the industry, there should be job openings arising from replacement needs, especially for aerospace engineers. Many engineers who entered the industry in the 1960s are approaching retirement. Among those in the aerospace manufacturing industry, professionals typically enjoy more job stability than do other workers. During slowdowns in production, companies prefer to keep technical teams intact to continue research and development activities, in anticipation of new business. Production workers, on the other hand, are particularly vulnerable to layoffs during downturns in the economy, when aircraft orders decline.

Earnings

Production workers in the aerospace industry earn higher pay than the average for all industries. Weekly earnings for production workers averaged \$1,019 in aerospace product parts manufacturing in 2004, compared with \$659 in all manufacturing and \$529 in all private industry. Above-average earnings reflect, in part, the high levels of skill required by the industry and the need to motivate workers to concentrate on maintaining high-quality standards in their work. Nonproduction workers, such as engineering managers, engineers, and computer specialists, generally command higher pay because of their advanced education and training.

Median hourly earnings of the largest occupations in aerospace product and parts manufacturing, May 2004

Occupation	Aerospace product and parts manufacturing	All industries
Engineering managers	\$49.79	\$46.94
Aerospace engineers	36.43	38.03
Mechanical engineers	33.84	31.88
Industrial engineers	31.85	31.26
Management analysts	30.78	30.51
First-line supervisors/managers of production and operating workers	27.78	21.51
Aircraft mechanics and service technicians	20.60	21.77
Inspectors, testers, sorters, samplers, and weighers	18.58	13.66
Aircraft structure, surfaces, rigging, and systems assemblers	18.29	17.79
Machinists	17.78	16.33

In 2004, 17% of all workers in the aerospace industry were union members or covered by union contracts, compared with about 14% of all workers throughout private industry. Some of the major aerospace unions include the International Association of Machinists and Aerospace Workers; the United Automobile, Aerospace, and Agricultural Implement Workers of America; the Society of Professional Engineering Employees in Aerospace (SPEEA); and the International Union of Allied Industrial Workers of America.

Industry Clusters

Industry clusters are defined by Professor Michael Porter of Harvard University as “geographic concentrations of interconnected companies and institutes in a particular field that encompass not just the industry itself, but key components of that industry’s supply chain.”⁶ Industry clusters are not a new phenomenon and can be found throughout the U.S. Common examples include information technology in the Silicon Valley, textiles in the Carolinas, and the California wine industry. Clusters are also evident in retail, tourism, manufacturing, insurance, and finance.

Industry clusters reflect a change in the role of competition away from a focus on the costs of input, cheap labor, and location toward more productive use of inputs which requires continuous improvement and innovation. “The enduring competitive advantages in a global economy lie increasingly in local things – knowledge, relationships, motivation – that distant rivals cannot match.”⁷ An important advantage of clusters rests not only in a more highly specialized workforce, but also in motivation driven by local competitive forces, a community of specialized information, and industry innovation. Clusters can have a significant impact on competition by increasing productivity, driving the pace of innovation, and stimulating the formation of new businesses in a region.

The aerospace industry is uniquely structured with just a few, well established aerospace original equipment manufacturers (OEMs) and 1st tier suppliers but many 2nd and 3rd tier suppliers. Given the low numbers of OEMs and 1st tier supplier, business attraction efforts would be very challenging. A more feasible alternative is to focus on 2nd and 3rd tier supply chain partners including manufacturing distribution and professional organizations such as engineering. Understanding the aerospace supply chain structure is important for evaluating business attraction efforts focused on 2nd and 3rd tier suppliers.

Much research has been done to evaluate the unique nature of aerospace supply chains. The industry is “dependent on rapid technological progress with government support for corporate research and development...with demand that is not necessarily geographically bounded.”⁸ Supply chain management which includes components such as development of technical specifications, concurrent engineering, quality control and product co-

⁶ Porter, Michael E. *Clusters and the New Economics of Competition*. Harvard Business Review; Boston; Nov/Dec 1998.

⁷ Ibid.

⁸ Niosi, Jorge and Zhegu, Majlinda. *Aerospace Clusters: Local or Global Knowledge Spillovers?* Industry and Innovation, The Charlesworth Group, Wakefield, March 2005, page 6.

development, becomes in the source for knowledge sharing, expertise and expansion of intellectual capital.

“Clustering is about proximity; the underlying rationale is that businesses that are closer to one another have advantages that are unavailable to businesses that are farther away”.⁹ One of the key advantages of clusters is labor market pooling, supplier specialization, knowledge spillovers, and entrepreneurship.

Anchor firms such as the Woodward and Hamilton Sundstrand, become the center of the cluster surrounded by scores of small to medium sized manufacturers. The following observations and conclusions can be drawn regarding the nature of aerospace supply chains.¹⁰

- Large firms dominate aerospace clusters and represent a magnet for suppliers.
- Michael Porter’s model which emphasizes local competition and local demand does not fit an industry dominated by global supply and demand chains.
- Aerospace production clusters and innovation clusters do not necessarily overlap; products may be designed in one location and produced in another
- In the aerospace industry, the role of universities and government laboratories is secondary in nature, operating independent rather than cooperatively.
- The large infrastructure costs required for major manufacturing plants can lead to long-term clustering.
- Clusters and regional innovation systems tend to be formed by one or two large 1st tier OEMs and or 2nd tier producers surrounded by hundreds of small- and medium-sized parts and components producers.

⁹ Cortright, Joseph. Making Sense of Clusters: Regional Competitiveness and Economic Development. Impresa, Inc., March 2006.

¹⁰ Ibid, page 22

Aerospace Industry Supply Chain Analysis

The aerospace supply chain analysis is a method to identify industry strengths and weaknesses for the purpose strengthening the region's aerospace cluster. Winnebago County and other regions are required to make investment decisions about which industries to focus attraction and retention efforts. A detailed supply chain analysis provides useful insight into the strength and weakness within a region's industry cluster and is used as a tool for strategic investment in business attraction and retention efforts. Even in an economy where suppliers and buyers are in a global marketplace, strategic location of complementary industries can give a firm a competitive advantage.

The analysis was completed using the IMPLANPro input/output model developed by Implan group which is based on county specific patterns and data from 2003. The model provides information on what industries the aerospace industry buys inputs from. Once the top 20 impacted industries for Winnebago County are identified, measures are selected to gauge which industries in the region are performing well and are competitive in terms of employment and productivity. The top 20 Aerospace industries include the following measures:

- Supply Chain Industry Presence
- Employment Location Quotient
- Short-Term Employment Growth/Declines
- Productivity
- Overall Supply Chain Analysis

The analysis to follow examines the aerospace industries for Winnebago County, comparing the attributes of Winnebago County to the United States industry averages. Details on the method for calculating each indicator is followed with an explanation of the Winnebago County results. A summary of strength and weaknesses as well as recommendations follow the detailed analysis.

Supply Chain Industry Presence

The analysis of an impact on an aerospace project is based on a supply-chain analysis using Implan Professional 2003. This analysis is intended to give insight into which industries within the supply chain have higher than normal presence in the county and to

identify potential gaps in the supply chain. No regional economy can be as diverse as the U.S. economy. However, using the United States as a basis for comparison can give a view into which industry Winnebago County currently specializes within the supply chain, and which industry are lacking in presence. Three of the five aerospace industries are not present Winnebago County. They include guided missile and space vehicle manufacturing, propulsion units and parts for space vehicles and guided missiles, and aircraft manufacturing.

The following table identifies the top 20 industries most directly impacted, in terms of output, by an aerospace project. For example, on a national level 6.9% of non-labor expenditures of aerospace companies go to management of companies and enterprises. For Winnebago County the comparable figure is 1.8%. The top 20 industry represent 65.8% of the total direct output impact for the United States and 61.2% of the total direct output impact for Winnebago County.

Top 20 Industries Impacted by an Aerospace Project - Ouput Impact Percent			
Description	United States - Ouput Impact Percent	Winnebago - Ouput Impact Percent	Impact Coefficient
Aircraft engine and engine parts manufacturing	11.7%	22.8%	1.951
Management of companies and enterprises	6.9%	1.8%	0.267
Wholesale trade	5.6%	7.0%	1.246
Guided missile and space vehicle manufacturing	4.5%	0.0%	NA
Propulsion units and parts for space vehicles and guided missiles	4.4%	0.0%	NA
Search, detection, and navigation instruments	4.0%	0.6%	0.137
Scientific research and development services	3.7%	0.3%	0.091
Semiconductors and related device manufacturing	3.6%	0.0%	NA
Other aircraft parts and equipment	2.9%	10.4%	3.545
All other miscellaneous professional and technical services	2.6%	2.8%	1.106
Aircraft manufacturing	2.2%	0.0%	NA
Architectural and engineering services	1.9%	2.3%	1.188
Machine shops	1.8%	2.8%	1.520
Metal valve manufacturing	1.8%	1.0%	0.580
Monetary authorities and depository credit intermediation	1.8%	2.2%	1.207
Warehousing and storage	1.7%	2.3%	1.328
Truck transportation	1.2%	2.1%	1.721
Custom computer programming services	1.2%	0.7%	0.649
Power generation and supply	1.1%	1.9%	1.688
Data processing services	1.0%	0.1%	0.101

Winnebago County has some clear strengths and weaknesses within the supply chain. Aircraft engine and engine parts and manufacturing will absorb the greatest amount of the impact in the United States and Winnebago County. Because of Winnebago County's high presence of this industry compared to other industries in the supply chain, this industry is expected to absorb approximately double that of the U.S. Ten of the top 20

industries are estimated to absorb greater amounts of the impact than the U.S., six are estimated to absorb less, and four industries are not present in the county.

Employment Location Quotient

The employment location quotient (LQ) is a way to view Winnebago’s aerospace industry employment base compared to the typical distribution of the United States. The LQs were calculated using 2003 county and national Implan data. A higher LQ, over 1.2, is an indicator of specialization of an industry within Winnebago County. Other the other hand, a low LQ, .8 or lower, is an indicator of a weakness within the supply chain.

Top 20 Industries Impacted by an Aerospace Project - United States Location Quotient			
Description	United States - Employment Percent	Winnebago - Employment Percent	United States - Employment Location Quotient
Aircraft engine and engine parts manufacturing	0.02%	0.09%	3.580
Management of companies and enterprises	0.52%	0.08%	0.151
Wholesale trade	1.76%	1.71%	0.970
Guided missile and space vehicle manufacturing	0.01%	0.00%	NA
Propulsion units and parts for space vehicles and guided missiles	0.01%	0.00%	NA
Search, detection, and navigation instruments	0.04%	0.00%	0.029
Scientific research and development services	0.26%	0.01%	0.052
Semiconductors and related device manufacturing	0.07%	0.00%	NA
Other aircraft parts and equipment	0.02%	0.13%	5.597
All other miscellaneous professional and technical services	0.07%	0.16%	2.138
Aircraft manufacturing	0.06%	0.00%	NA
Architectural and engineering services	0.57%	0.24%	0.421
Machine shops	0.07%	0.31%	4.791
Metal valve manufacturing	0.03%	0.11%	3.772
Monetary authorities and depository credit intermediation	0.54%	0.58%	1.060
Warehousing and storage	0.17%	0.19%	1.093
Truck transportation	0.57%	0.50%	0.878
Custom computer programming services	0.48%	0.10%	0.208
Power generation and supply	0.12%	0.30%	2.549
Data processing services	0.09%	0.01%	0.076

Winnebago has a smaller presence of Management of Companies and Enterprises than the national average. The very high level of relative output impact absorption can at least partly be explained by the very high employment LQ in the two present aerospace industries: aircraft engine and engine parts manufacturing and other aircraft parts and equipment. The LQ indicates a high degree of specialization in these two aerospace industries sectors. Although the area is not expected to absorb relatively high amount of the output impact in the metal value manufacturing industry, the LQ indicates a high level of specialization in the industry. This is likely due to the lack of presence in three of the five Aerospace industries, which could potentially act as buyers to the metal value manufacturing industry. This is an example of a region having assets that are critical to

an industry not current present in the county and therefore presents an opportunity to do some targeted industry attraction.

Short-term Employment Growth/Declines

The short-term growth and declines are a way to understand the direction the county is moving in terms industry employment. The aerospace industry is an industry dependent on manufacturing and high technology, making it extremely volatile to economic conditions. For this reason, the change in industry employment in Winnebago County is compared to the national change in the industry employment. Employment was analyzed for the years 2001 to 2003.

Top 20 Industries Impacted by an Aerospace Project - Short-term Employment Growth/Declines			
Description	United States Employment Change	Winnebago Employment Change	Real Employment Change
Aircraft engine and engine parts manufacturing	-14.8%	-30.2%	-15.4%
Management of companies and enterprises	-0.4%	-28.0%	-27.5%
Wholesale trade	-4.0%	-12.4%	-8.4%
Guided missile and space vehicle manufacturing	-5.2%	0.0%	NA
Propulsion units and parts for space vehicles and guided missiles	-16.7%	0.0%	NA
Search, detection, and navigation instruments	-3.0%	-20.0%	-17.0%
Scientific research and development services	3.8%	-38.6%	-42.4%
Semiconductors and related device manufacturing	-23.3%	0.0%	NA
Other aircraft parts and equipment	-18.1%	75.8%	94.0%
All other miscellaneous professional and technical services	4.5%	-41.1%	-45.5%
Aircraft manufacturing	-13.2%	0.0%	NA
Architectural and engineering services	-0.1%	-11.4%	-11.3%
Machine shops	-9.3%	0.7%	10.0%
Metal valve manufacturing	-14.1%	46.9%	61.0%
Monetary authorities and depository credit intermediation	2.4%	1.2%	-1.2%
Warehousing and storage	2.5%	46.7%	44.2%
Truck transportation	16.6%	27.5%	11.0%
Custom computer programming services	-9.2%	-45.4%	-36.2%
Power generation and supply	-7.2%	-32.9%	-25.7%
Data processing services	-13.1%	-90.1%	-77.0%

Eleven of the 16 industry sectors that are present in the region are declining faster than the United States. One of the present aerospace industries, other aircraft parts and equipment, has seen employment growth during the period. The other, aircraft engine and engine parts manufacturing, has seen a decline in employment for the period. Management of companies and enterprises, an industry that is important in the aerospace supply chain, has seen heavy relative declines in Winnebago County during the period. Metal value manufacturing again appears to be strong supplier industry in Winnebago County, growing 61% faster than the nation, which declined by 14.1%. These top 20 industries accounted for a total of 14,352 Winnebago County employees in the year 2003. This figure is down 9.7% since 2001. Nationally, the same set of industries saw a decline of 1.6% during the period. One concern related to these data is the relatively higher

decline in employment in Winnebago County in sectors of strength, such as aircraft engine and engine parts manufacturing. This may be due in part to Winnebago County recovering from the 2001 economic downturn slower than the economy in general.

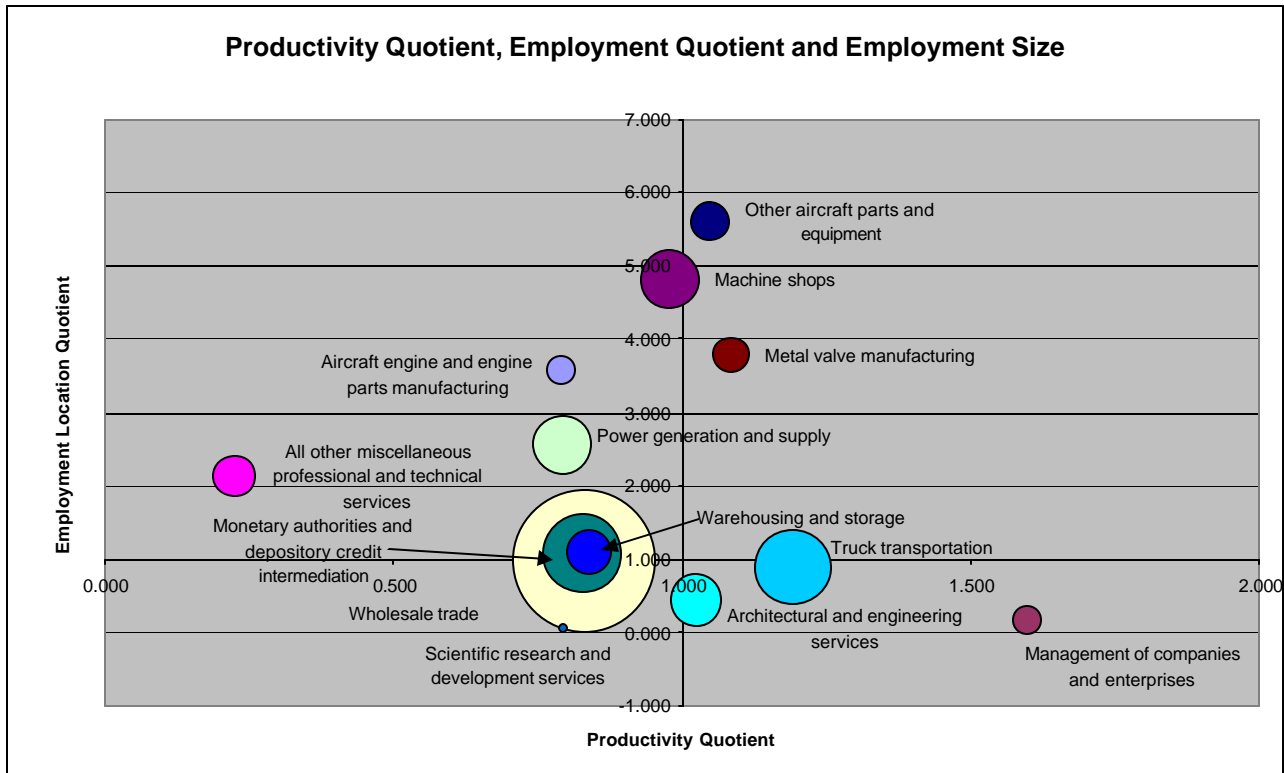
Productivity – Industry Value Added per Employee

The industry productivity for aerospace supply chain is determined by calculating the industry value added-per-employee. A productivity quotient is calculated by simple taking the Winnebago industry productivity over the United States Productivity. The United States and Winnebago measurements are based Implan 2003 data.

Top 20 Industries Impacted by an Aerospace Project - Industry Value Added per Employee			
Description	United States Value Added Per Worker	Winnebago Value Added Per Worker	Productivity Quotient
Aircraft engine and engine parts manufacturing	\$ 161,561	\$ 127,648	0.790
Management of companies and enterprises	\$ 106,713	\$ 170,664	1.599
Wholesale trade	\$ 108,338	\$ 90,086	0.832
Guided missile and space vehicle manufacturing	\$ 182,794		NA
Propulsion units and parts for space vehicles and guided missiles	\$ 104,306		NA
Search, detection, and navigation instruments	\$ 107,881	\$ 26,750	0.248
Scientific research and development services	\$ 73,784	\$ 58,465	0.792
Semiconductors and related device manufacturing	\$ 173,290		NA
Other aircraft parts and equipment	\$ 90,103	\$ 94,462	1.048
All other miscellaneous professional and technical services	\$ 231,909	\$ 52,141	0.225
Aircraft manufacturing	\$ 103,509		NA
Architectural and engineering services	\$ 63,193	\$ 64,768	1.025
Machine shops	\$ 54,781	\$ 53,577	0.978
Metal valve manufacturing	\$ 111,754	\$ 121,406	1.086
Monetary authorities and depository credit intermediation	\$ 161,639	\$ 134,038	0.829
Warehousing and storage	\$ 59,829	\$ 50,192	0.839
Truck transportation	\$ 51,429	\$ 61,287	1.192
Custom computer programming services	\$ 73,660	\$ 80,075	1.087
Power generation and supply	\$ 453,115	\$ 360,063	0.795
Data processing services	\$ 99,056	\$ 48,261	0.487

Six of the top 20 supply chain industries are more productive in Winnebago County than in the United States. Management of companies and enterprises, the 2nd most impacted industry, is the most productive industry of the top 20. Two important industries have productivities that are less than a quarter of the national average: search, detection, and navigation instruments and all other miscellaneous professional and technical services. Some of the most productive industries in the supply chain cluster and not present at all. The truck transportation industry has a high relative productivity in Winnebago County. However, this pattern is not maintained when expanded to the other logistics industries within the top 20. Both wholesale trade and warehousing and storage have industry productivity's that are around 83% of the national average.

One weakness in the Winnebago County Aerospace industry is the relatively low productivity in the aircraft engine and engine parts manufacturing sector. This may be the result of several factors. It is possible that Winnebago County businesses producing products which have lower value. Another explanation is firms in Winnebago County are using older equipment in the manufacturing process. The lower educational attainment of the local workforce could also be a factor in explaining the lower productivity.



Overall Supply Chain Analysis

Supply-Chain Strengths

- Very strong relative presence of the 2 present aerospace industries: aircraft engine and engine parts manufacturing and other aircraft parts and equipment.
- Strong logistics industry, especially the truck and air freight transportation industries.
- Highly productive management of companies and enterprises industry.

Supply-Chain Weaknesses

- Three of 5 aerospace industries are not present in the county; they include missile and space vehicle manufacturing, propulsion units and parts for space vehicles and guided missiles, and/or an aircraft manufacturing.
- Underrepresented and declining management of companies and enterprises sector.
- Relative low productivity in the aircraft engine and engine parts manufacturing sector
- Weak presence and low relative productivity of high-tech supply chain industries such as search, detection, and navigation instruments, scientific research and development services, and architectural and engineering services.

Supply-Chain Recommendations Based On Supply Chain Analysis

- Complete a follow-up study to identify why the aerospace industry in Winnebago County trails the nation in recovery from the 2001 economic downturn.
- Build and preserve the high-tech, high-skilled industries within the supply chain, such search, detection, and navigation instruments and scientific research and development services. These smaller but vital industries play an important role in the supply chain and their existence needs to be preserved as these types of industries will continue to contribute advancement of the industry.
- Continue attraction and retention efforts in the warehousing and storage sector with a focus on high-tech, highly productive firms.

The Local Aerospace Industry

The preceding analysis utilized secondary data and economic modeling tools based on national trends to evaluate the state of Winnebago County’s aerospace industry supply chain. The following analysis focuses on aerospace industries currently present in the county. Companies were identified for participation in the study based on North American Industrial Classification System (NAICS) codes for significant industries within strong aerospace clusters. While not all companies within these classifications provide parts, products, or services to the aerospace industry, they are representative of critical supply chain partners for typical aerospace operations. Industry sectors in the analysis include the following:

NAICS	Title	Establishments
3363	Aerospace product and parts manufacturing and motor	
3364	vehicle parts manufacturing	7
	Machine shops; turned product; and screw, nut, and bolt	
3327	manufacturing	39
	Engine, turbine, and power transmission equipment	
3336	manufacturing	9
333911	Pump and pumping equipment manufacturing	2
333913	Measuring and dispensing pump manufacturing	2
333995	Fluid power cylinder and actuator manufacturing	3
333996	Fluid power pump and motor manufacturing	3
	Navigational, measuring, electromedical, and control	
3345	instruments manufacturing	6
3353	Electrical equipment manufacturing	12
5413	Architectural and engineering services	5
5415	Custom computer programming services	1
		89

Source: One-Source

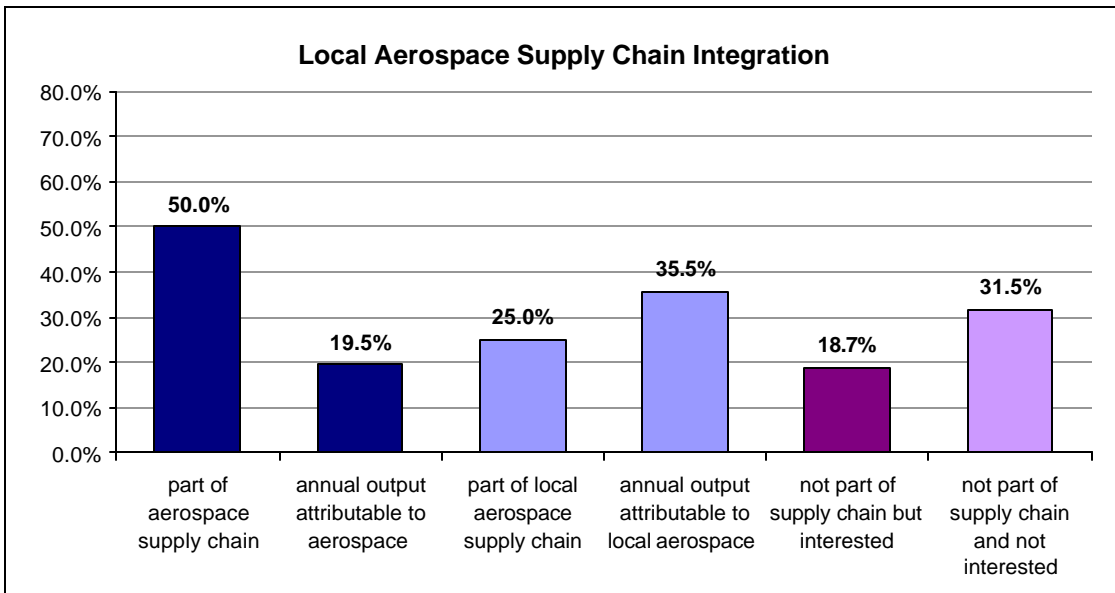
The study utilized a two-phase approach to identify and interview regional companies. First, a select group of companies were identified for one-on-one interviews and included aerospace 1st tier and other known aerospace supply chain partners. To identify additional 2nd and 3rd tier suppliers in the region, a mailed survey was sent to all companies in the classifications listed above. The survey instrument asked questions regarding level of involvement as an aerospace supply chain partner locally and nationally. Companies were also asked to participate in further discussions if interested. An additional 12 interviews

were conducted with respondents to the survey. A total of 89 Winnebago County companies from the above NAICS classifications were contacted to participate in the study. Over 29% or 26 local companies participated in interviews and/or surveys designed to gauge impressions of the regions workforce and supply chain strength for the aerospace industry.

Local Aerospace Supply Chain

One-half of companies participating in the study currently provide parts, products, or services to the aerospace industry. The total output attributable to aerospace industry parts, products, or services averages 19.5% annually. One-quarter of companies conduct business within the local aerospace supply chain and the remaining 25% conduct business with non local aerospace supply chains.

Over 18% of the companies are not currently part of the aerospace supply chain at any level but are interested in exploring potential opportunities. This would indicate significant opportunities for increasing local supply chain integration. Nearly one-third of respondents are not part of the supply chain and are not interested in becoming part of the supply chain.



The Future Aerospace Supply Chain

One of the most significant trends in aerospace supply chain management is an increased consolidation of partners to reduce the number and subsequent coordination on specifications, quality, and functionality. “To reduce costs, aerospace OEMs have increased their outsourcing to suppliers of subassemblies (such as engines, structures, landing gear, and avionics) and are concentrating on their core competencies of design, assembling and marketing aircraft. At the same time, they have made efforts to reduce, reorganize and rationalize their supply base.”¹¹

Aerospace supply chain partners will be expected to provide more in terms of complete assemblies or subassemblies as opposed to piece parts. This presents a challenge for the region’s manufacturers as they are generally smaller in size and will have difficulties meeting the demands of completing entire assemblies which often require a high mix of varying products, lower volumes, and highly specialized production.

Another shift in aerospace supply chains is increased knowledge sharing environments where OEMs work closely with partners in research and development and production. The future will bring an increased demand for genuine collaboration to develop parts and products. This may present an opportunity in the region for leadership to foster an aerospace collaborative effort towards this end. In addition to increased consolidation of the supply chains and increased knowledge sharing, aerospace OEMs will continue to require increased quality and lower costs.

The second major focus for improvement was on cost cutting strategies and improved quality manufacturing. OEMs see the need for greater assistance to the region’s manufacturers in lean manufacturing, six sigma, and quality controls. A key component to lower costs is strategic outsourcing. From the OEM’s perspective, local manufacturers need assistance in determining when and what to outsource, sending simple manufacturing overseas if needed, but retaining higher-skilled machining and assemblies.

¹¹ Niosi, Jorge and Zhegu, Majlinda. *Aerospace Clusters: Local or Global Knowledge Spillovers?* Industry and Innovation, The Charlesworth Group, Wakefield, March 2005.

Expanding the Region's Aerospace Supply Chain

According to regional 1st tier aerospace companies, supply chain partners, not currently present that would benefit the m, include a distribution center or supply logistics center to facilitate transportation and inventory management. Complex machining, particularly with aluminum products, was another suggestion for business attraction to bolster the region's aerospace supply chain.

The recent announcement of a potential \$5 million dollar grant of which \$3 million is slated for Rockford and DeKalb companies, is planned for the development of a titanium center of excellence. Initiatives and activities such as that can have a significant impact on industry attraction and emphasize the importance of research and development opportunities in the region. Should the grant come to fruition, opportunities may emerge to focus on attraction of titanium and other metal manufacturers.

Aerospace Industry Attraction and Retention

According to the Aerospace Industries Association, critical challenges facing the aerospace industry nationally include workforce shortages, longer product life cycles, declining number of new platforms being developed, and reduced overall spending on research and development.¹² While product life cycles and new platforms are outside of the scope of most attraction and retention efforts, there are opportunities to address workforce availability and research and development efforts.

Workforce availability is the most critical factor in aerospace industry and supply chain attraction and retention efforts. Carter & Burgess, Inc. conducted a Target Industry Analysis under contract with the Rockford Area Economic Development Council in February 2006.¹³ As part of this study, regional strengths and weaknesses were identified for target industries including aerospace research and development. According to this analysis, the following are the most significant site selection criteria for aerospace in order of importance;

- Access to aerospace engineering and other technical talent
- Other aerospace R&D operations in the region
- Close access to a major research university with aerospace programs
- Training and higher education access
- High quality of life and culture
- Access to an airport site/building for testing and prototyping
- Commercial air service

Workforce availability, particularly in terms of engineering and skilled machinists, is the most important criteria for companies evaluating sites for development or expansion. The second most important criteria is other aerospace research and development operations that support knowledge sharing and expand development capabilities.

Winnebago County aerospace companies and supply chain partners provided feedback on the importance of site selection criteria along with ratings for Winnebago County. The most significant criteria support the finding of the Carter and Burgess, Inc. study with workforce availability rated as very important, 9.3 on a 10 point scale. However, workforce availability in Winnebago County was rated just 4.7 or average by employers.

¹² Grimson, Matt. *Industry, Government Strategize to Avert Workforce Crisis*. Aerospace Industries Association, P.A. Rel. 2004-42.

¹³ Carter & Burgess, Inc. Rockford Area, IL Target Industry Analysis, February 2006.

While 1st tier aerospace suppliers report little difficulty in attracting a quality workforce, 2nd and 3rd tier supply chain partners report significant challenges in workforce availability and attraction, particularly in engineering, skilled machining, and other professional and technical positions.

	Level of Importance	Winnebago County Rating
Labor availability	9.3	4.7
Quality of life	8.2	6.6
Access to training	8.1	5.7
Access to markets	8.1	6.0
Access to interstates	7.0	8.6
Proximity to supply chain	6.7	8.6

Source: Winnebago County Aerospace Interviews, May 2006.

The following analysis captures Winnebago County employer perspectives on site selection criteria summarize by the following categories for analysis:

- Workforce availability and development
- Proximity to supply chain and other partners
- Quality of life
- Availability of sites
- Location and access

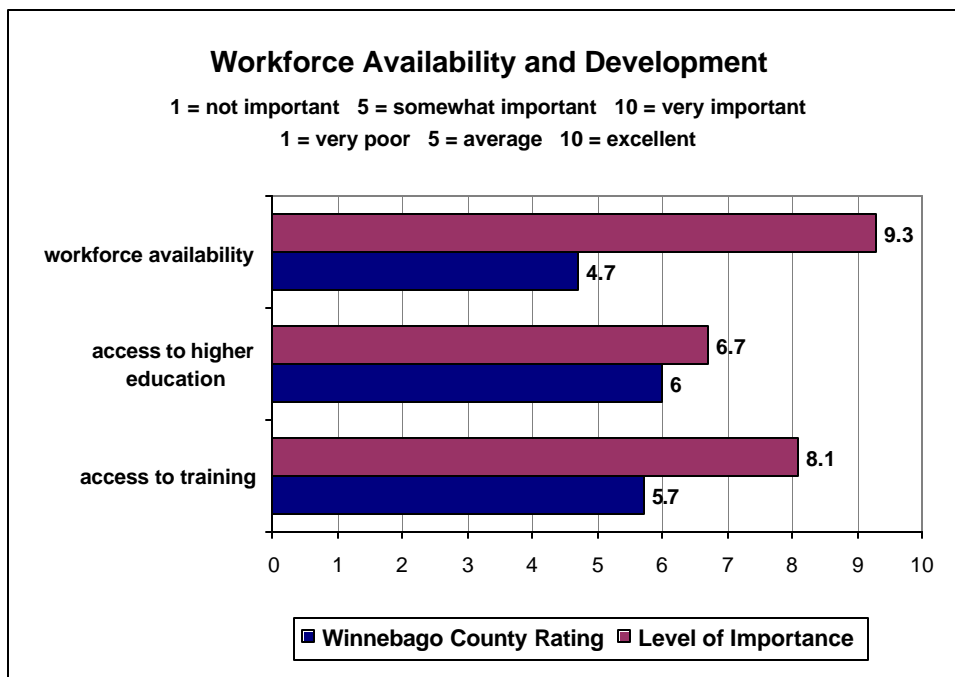
Workforce Availability and Development

The availability of engineers, skilled machinists, and other technical talent is critical to aerospace industry and supply chain attraction and retention. Regional employers rated workforce availability 9.3 on a 10 point scale. However Winnebago County was rated just 4.7 or *average* for workforce availability. Aerospace OEMs and 1st tier suppliers do not face the same challenges as 2nd and 3rd tier supply chain partners in attracting and retaining quality workforce. Despite this, OEMs and 1st tier suppliers are more concerned about workforce availability for their supply chain partners in the region. Aerospace supply chain partners that cannot attract and retain a quality workforce can negatively impact product availability and quality.

Other significant gaps in importance and regional ratings are seen in access to higher education and training. Access to training for workforce development was rated *important* but access to training in Winnebago County was rated as *average*.

Access to higher education was rated 6.7 and ratings of Winnebago County 6.0, indicating a small gap in needs versus availability. Over two-thirds of employers participating in the study do not believe that the lack of a university in Winnebago County affects their ability to attract and retain a quality workforce. The proximity of Northern Illinois University and its Rockford campus along with programs available through Rock Valley College and other local providers allows for adequate access to higher educational opportunities. Nevertheless, nearly one-third of employers believe more should be done in the region to expand higher education opportunities, especially for younger engineers interested in completing a masters or doctoral program.

When asked what higher education needs are not being met, many employers noted that easier access to masters and doctoral programs, machining education and skills, and promotion of manufacturing careers along with math and computer skills would promote stronger workforce availability.

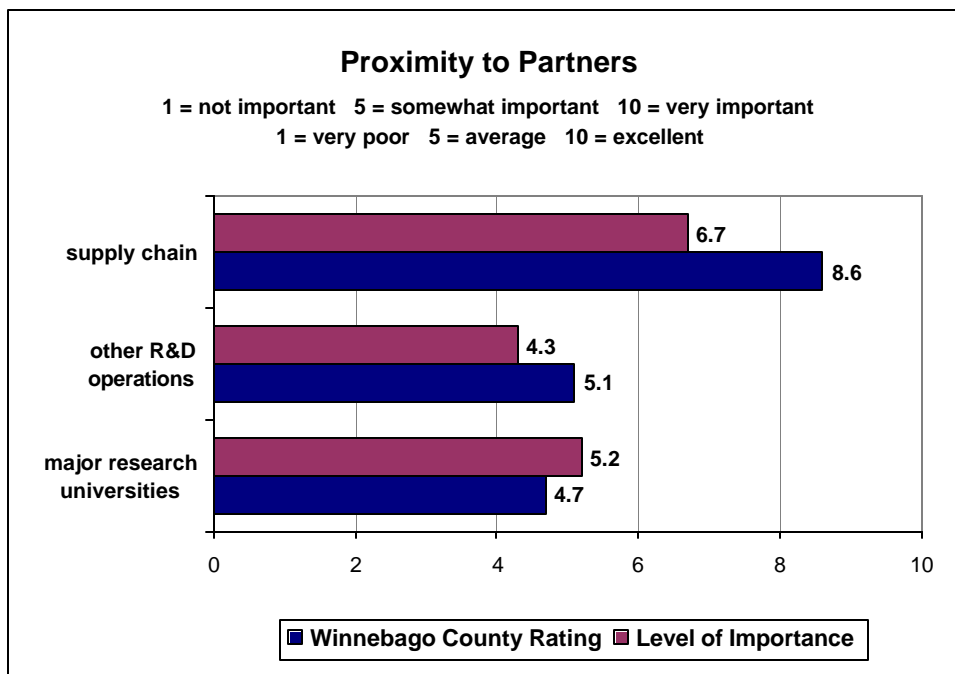


Source: Winnebago County Aerospace Interviews, May 2006.

Proximity to Supply Chain and Other Partners

Another key factor in site selection for the aerospace industry is proximity, not only to supply chain partners, but also proximity to other research and development operations and major research universities. Winnebago County aerospace OEMs recognize the strong cluster already present in the region. The importance of proximity to supply chain partners was rated 6.7 or *important* and the rating of Winnebago County's supply chain was 8.6 or *excellent*. However, the proximity to other research and development operations and a research university was rated *average* in both importance and rating.

While research and development and research universities were rated *average* in importance now, their future significance will likely increase. Of increasing importance to the industry is the presence of technology transfer and ability to create knowledge centers or centers of expertise. A recent collaboration between Hamilton-Sundstrand, LMC in DeKalb and Northern Illinois University may result in a \$5 million grant, a majority of which will go towards research and development of titanium manufacturing. The funding targets fabrication technology and the creation of a national center for titanium machining. These types of initiatives can provide leverage for increased aerospace attraction, retention, and growth in the region.

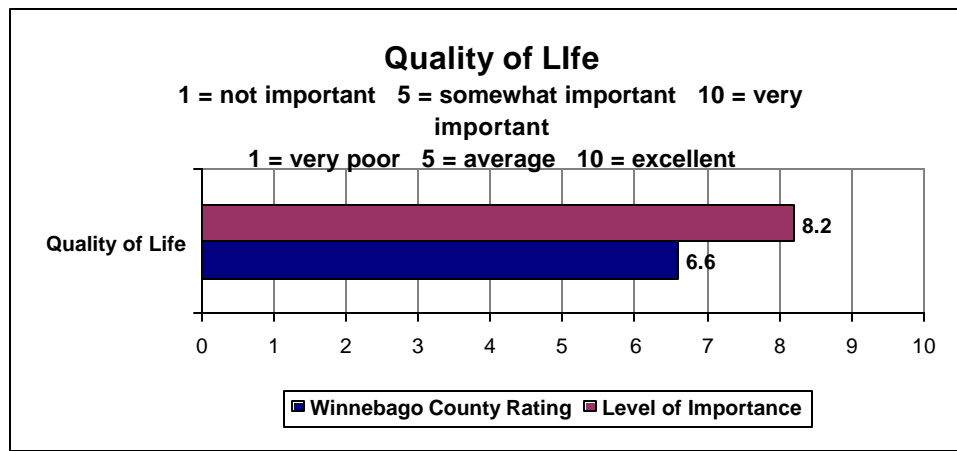


Source: Winnebago County Aerospace Interviews, May 2006.

Quality of Life

Quality of life is another important factor in site selection, not necessarily by itself, but for its impact on workforce availability and quality. A region with higher quality of life factors will be better positioned to attract and maintain a high quality workforce.

Quality of life was rated as *very important* yet the rating of Winnebago County was *above average* indicating employers believe improvement could be made to regional quality of life factors.



Source: Winnebago County Aerospace Interviews, May 2006.

Quality of life can take on a many different forms and meanings. Therefore, aerospace employers were asked to focus on the perceived components of quality of life for their professional and technical workforce such as engineers and skill machinists. Over half indicated the importance of recreational activities to high quality of life and 46% indicated affordable housing and low cost of living. Access to higher education, quality schools, and low crime were listed as indicators of quality of life by just 9.1% of respondents.

What is Quality of Life?	Percent
Recreational activities	54.5%
Affordable housing/low cost of living	45.5%
Proximity to large metro area	18.2%
Salary	18.2%
Transportation	18.2%
Salary	18.2%
Family environment	18.2%
Low crime	9.1%
Access to higher education	9.1%
Quality K-12 schools	9.1%
Work close to home	9.1%

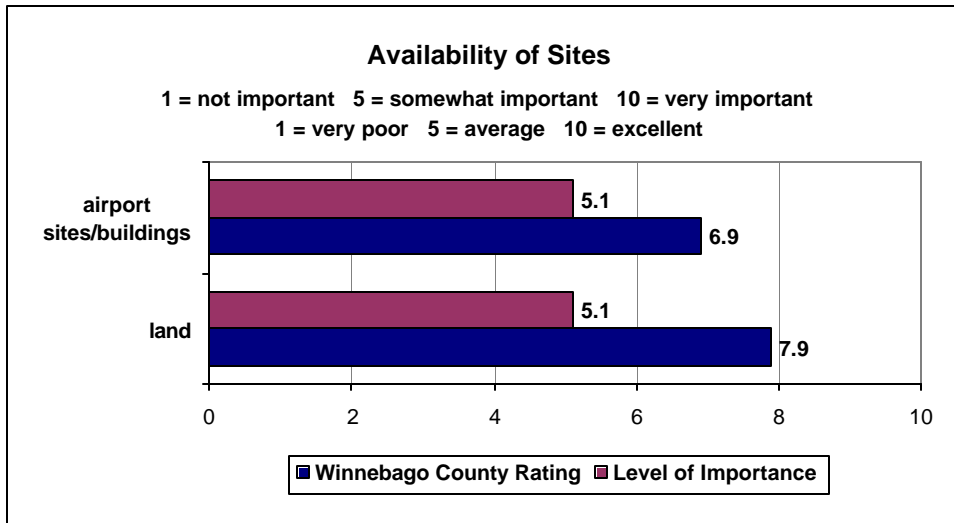
While only 9.1% indicated a quality K-12 education was an important element to quality of life, 44.4% recommended improving the K-12 education system as a method to improve quality of life in Winnebago County. Similarly, only 9.1% indicated access to higher education was an important element to quality of life, yet 22.2% suggested expanding access to higher education as a strategy to improve quality of life. This is explained in part because for many, the importance of quality educational opportunities at all levels transcends quality of life.

Overall, factors most frequently used to define quality of life need little improvement such as recreational activities, low cost of living and affordable housing. Factors less frequently used in defining quality of life--quality of K-12 schools and access to higher education--are the ones perceived to need improvement.

How can we improve quality of life?	Percent
Improve K-12 education system	44.4%
Expand access to higher education	22.2%
Improve and expand transportation	22.2%
Lower crime	11.1%
Address poverty	11.1%
Expand cultural events	11.1%
Improve infrastructure	11.1%
Increase community involvement	11.1%

Availability of Sites

Availability of airport sites and land for potential development were both rated of average importance for site selection. However the region's employers rated Winnebago County *good* in both sites/buildings and land availability. Clearly the impression among the region's aerospace industry and supply chain is that Winnebago County has much to offer potential new business attraction.



Source: Winnebago County Aerospace Interviews, May 2006.

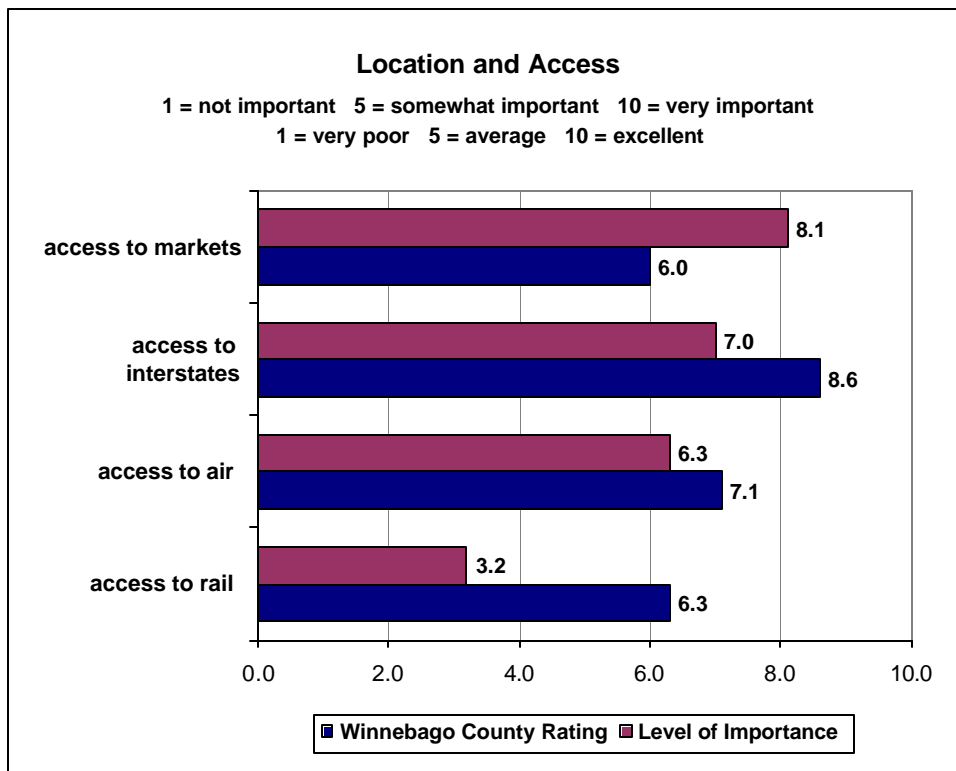
Location and Access

Location and access to markets and transportation infrastructure are generally significant concerns for site selection activities. For the regions aerospace industry, access to markets, interstates, air and rail was rated *important*. However, many believe that an established company location built from decades of presence in the region is more important than access to markets. Access to markets and proximity to suppliers are more important to aerospace supply chain partners than the OEMs or 1st tier suppliers.

For many of the supply chain partners, access to markets is defined by the transportation infrastructure available in the region which facilitates the delivery of parts and products. The rating of Winnebago County's access to interstates, air, and rail services was significantly higher than perceived importance. This indicates that while access to markets is still important to the industry, the Winnebago County region provides sufficient infrastructure to overcome the lower rating of access to markets.

Second to interstate access is access to air services. Air services for both cargo and business travel are important elements to successful business attraction, particularly for 1st tier aerospace partners who may not be proximally located to OEMs. As this is the situation in Winnebago County, the Greater Rockford Airport Authority's growth and expansion over the past decade can play a pivotal role in business attraction and retention efforts. The potential addition of Ryan International Airlines, a charter service whose customers include the Department of Defense, provides further potential for business attraction efforts focused on the aerospace supply chain.

Not only are air services important for ongoing business activities, they can generate a unique opportunity for collaborations in both training and research and development. Regional air service providers including Kaney Jet Services and Greater Rockford Airport Authority expressed interest in the development of training and R&D efforts and provide further opportunity for exploration of further collaborations for federal and state grants similar to the potential titanium manufacturing grant aimed at titanium manufacturing technology and associate center of excellence. Bringing these types of partners together with the region's supply chain partners may be a role for local and regional economic and workforce for development organizations.



Source: Winnebago County Aerospace Interviews, May 2006.

Labor Market Analysis

Establishments and Employment

2003 Winnebago County manufacturing employment included over 30,000 positions and nearly 700 establishments. The aerospace industry sector, 3364 – Aerospace Product and Parts Manufacturing, accounted for 3802 positions and 5 establishments. Expanding this to include key 2nd and 3rd tier aerospace supply chain industry sectors, the region includes an additional 6,664 positions and 80 establishments.

Aerospace Industry Establishment and Employment in Winnebago County, 2003			
	Number of Employees for week including March 12, 2003	Annual Employee Compensation	Total Establishments
Manufacturing Total	30263	1322180	696
Aerospace Product and Parts Manufacturing	3802	241892	5
Turned Product and Screw, Nut, and Bolt Manufacturing	3400	150866	49
Engine, Turbine, and Power Transmission Equip Mfg	963	40174	9
Pump and Compressor Manufacturing	10	*	2
Fluid Power Cylinder and Actuator Manufacturing	172	7402	7
Fluid Power Pump and Motor Manufacturing	871	43404	4
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	648	*	3
Electrical Equipment Manufacturing	600	*	6
* data not available			
Source: 2003 County Business Patterns			

Occupational Growth

The largest clusters of occupations critical to the aerospace industry include engineering, machining, maintenance, and computer software and systems occupations. Overall these occupations are anticipated to experience average annual job openings of 209 positions with nearly all coming from replacements or turnover. The majority of job openings will be in assembly, machining, and CNC occupations.

Nearly all of the annual job openings in engineering and machining occupations will be from replacements. Occupations experiencing the largest grow include general maintenance and repair workers. Grow will also occur in computer software and systems engineering and analysts.

Standard Occupational Classification (SOC) Title	Base	Projected	Employment		Average Annual Job		
	Year	Year	Change		Openings		
	Empl.	Empl.	2002 - 2012		Due To		
	2002	2012	Number	Percent	Growth	Replacements	Total
Total, All Occupations	148,623	159,133	10,511	7.07	1,051	3,500	4,551
Computer Software Engineers, Applications	184	210	26	14.15	3	2	5
Computer Software Engineers, Systems	120	141	21	17.52	2	1	3
Computer Systems Analysts	346	416	70	20.23	7	4	11
Aerospace Engineers	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Civil Engineers	97	105	8	7.98	1	2	3
Electrical Engineers	116	112	-4	-3.22	0	2	2
Electronics Engineers, except Computer	96	104	8	8.24	1	2	3
Industrial Engineers	327	346	19	5.86	2	8	10
Mechanical Engineers	579	556	-24	-4.10	-2	16	14
Aerospace Engineering & Operations Technicians	9	12	3	29.42	0	0	0
Civil Engineering Technicians	67	72	4	6.24	0	1	1
Electrical and Electronic Engineering Technicians	143	152	8	5.87	1	3	4
Electro-Mechanical Technicians	29	31	2	6.30	0	1	1
Industrial Engineering Technicians	118	123	6	4.89	1	2	3
Mechanical Engineering Technicians	88	96	8	9.55	1	2	3
Avionics Technicians	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Aircraft Mechanics and Service Technicians	31	43	12	37.27	1	1	2
General Maintenance and Repair Workers	1,365	1,509	143	10.48	14	26	40
Aircraft Struct/Surfaces/Rigging Sys Assemblers	27	29	2	6.95	0	1	1
Team Assemblers	2,808	2,593	-215	-7.64	-21	73	52
Computer-Controlled Machine Tool Operators	613	614	2	0.24	0	10	10
Machinist s	1,452	1,418	-34	-2.36	-3	34	31
Metal Workers and Plastic Workers, AO	500	480	-21	-4.11	-2	12	10
					6	203	209

Source: Illinois Department of Employment Security, OES Statistics 2000

Occupational Wages

The total average wage for all occupations is 7.6% lower in Winnebago County than Illinois. Engineering salaries are lower in Winnebago County with the exception of civil engineers. The median wage for civil engineers is 25.5% higher in Winnebago County which could be driven by the lack of civil engineering programs in the region. Manufacturing salaries for assemblers, CNC operations, and metalworkers are 14.4% to 24.6% higher in Winnebago County than Illinois.

Regional salaries generally fluctuate based on demand and supply. As demand exceeds supply, salaries increase to attract the available workforce. As supply catches up with demand, salaries start to decline and align with statewide averages. Based on this assumption, the region has an ample supply of engineers with the exception of civil engineers. However, the region has been experiencing a shortage in manufacturing workers which has driven up average wages in the region.

SOC Occupational Title	Winnebago County		Illinois		Percent Difference
	Median Wage		Median Wage		
	Hourly	Annual	Hourly	Annual	
Total all occupations	\$13.60	\$28,283	\$14.63	\$30,442	-7.6%
Computer Software Engineers, Applications	\$32.71	\$68,038	\$38.55	\$80,181	-17.9%
Computer Software Engineers, Systems Software	\$24.06	\$50,043	\$33.57	\$69,831	-39.5%
Aerospace Engineers	*	*	\$38.83	\$80,751	
Civil Engineers	\$28.82	\$59,925	\$30.85	\$64,172	-7.0%
Electrical Engineers	\$31.58	\$65,670	\$33.90	\$70,512	-7.3%
Electronics Engineers, Except Computer	\$28.73	\$59,770	\$33.53	\$69,753	-16.7%
Industrial Engineers	\$27.69	\$57,597	\$29.40	\$61,145	-6.2%
Mechanical Engineers	\$27.20	\$56,584	\$30.95	\$64,379	-13.8%
Aerospace Engineering & Operations Technicians	*	*	\$24.70	\$51,367	
Civil Engineering Technicians	\$21.63	\$44,979	\$16.11	\$33,521	25.5%
Electrical and Electronic Engineering Technicians	\$20.93	\$43,524	\$21.66	\$45,061	-3.5%
Electro-Mechanical Technicians	\$20.27	\$42,157	\$20.69	\$43,020	-2.1%
Industrial Engineering Technicians	\$21.25	\$44,196	\$20.94	\$43,554	1.5%
Mechanical Engineering Technicians	\$19.56	\$40,685	\$21.58	\$44,882	-10.3%
Avionics Technicians	*	*	\$25.70	\$53,448	
Aircraft Mechanics and Service Technicians	*	*	\$25.46	\$52,957	
Industrial Machinery Mechanics	\$20.51	\$42,671	\$18.88	\$39,270	7.9%
Maintenance and Repair Workers, General	\$15.48	\$32,194	\$17.59	\$36,587	-13.6%
Maintenance Workers, Machinery	*	*	\$18.41	\$38,292	
Team Assemblers	\$14.29	\$29,720	\$10.77	\$22,395	24.6%
Computer-Controlled Machine Tool Operators	\$17.14	\$35,652	\$14.67	\$30,509	14.4%
Machinists	\$15.70	\$32,659	\$16.09	\$33,467	-2.5%
Metal Workers and Plastic Workers, All Other	\$16.05	\$33,388	\$12.71	\$26,436	20.8%
* DATA NOT AVAILABLE					
<i>Source: Illinois Department of Employment Security, OES Statistics 2000</i>					

Workforce Availability

The three most critical and difficult to fill occupations in the aerospace industry and supply chain include engineers, machinists and operators, and CNC machinists and operators. Over 50% of the employers interviewed reported that, not only are engineering positions most critical to their business, but they are also the most difficult to fill. Machinist and operator positions were most critical for 30% of respondents and most difficult to fill by 40% of respondents. CNC machinists and operators were most critical and most difficult to fill by 20% of respondents. Highest turnover occupations include unskilled or low skilled positions such as laborers, 45.5% as well as the top three most critical and difficult to fill occupations - Engineers, Machinists and CNC Machinists - indicating a degree of churning and/or retirements in the regional workforce.

Occupation	Most Critical	Difficult to Fill	Highest Turnover
Assemblers	10%		
CNC machinist and operators	20%	20%	22%
Engineers	50%	53.3%	22%
Grinders	10%		
Laborer and low skilled positions			45.5%
Machinists and operators	30%	40%	22%
Welders	10%	15%	

Over one-third of employers report the professional and technical workforce change jobs for better salary. However, 20% of the employers indicated that job changes occur for more entrepreneurial reasons such as starting their own business. Another 20% indicate job changes are due to perceived job stability and the desire to live closer to home.

Why does your workforce leave?	Number
Salary	40%
Open own business	20%
Job stability	20%
Move back home	20%
Location/shorter commute	10%
Long hours	10%

Educational Requirements and Access

In general, a bachelor's degree is the minimum educational requirement for engineers and other professional workforce in the Winnebago County region. A high school diploma along with five years of experience is preferred for CNC and other skilled machinist positions. However, there are no formal educational requirements for skilled machining occupations.

Over 67% of aerospace industry employers and supply chain partners believe the lack of a university based in Winnebago County has little or no impact on workforce attraction and retention. Many indicated that the presence of Northern Illinois University in DeKalb with its NIU Rockford campus, programmatic offerings through Rock Valley College, and other training opportunities are sufficient for workforce attraction and retention.

On the other hand, one-third of aerospace industry employers and supply chain partners do believe the lack of a university has an impact on workforce attraction and retention, primarily in engineering occupations. While the minimum educational requirement for engineers locally is a bachelor's degree, the opportunity to continue education through a masters or doctoral program may be appealing to the existing workforce. Providing more local opportunities for graduate studies in engineering may not be as beneficial for workforce attraction, but it plays a greater role in workforce retention, particularly among younger engineers.

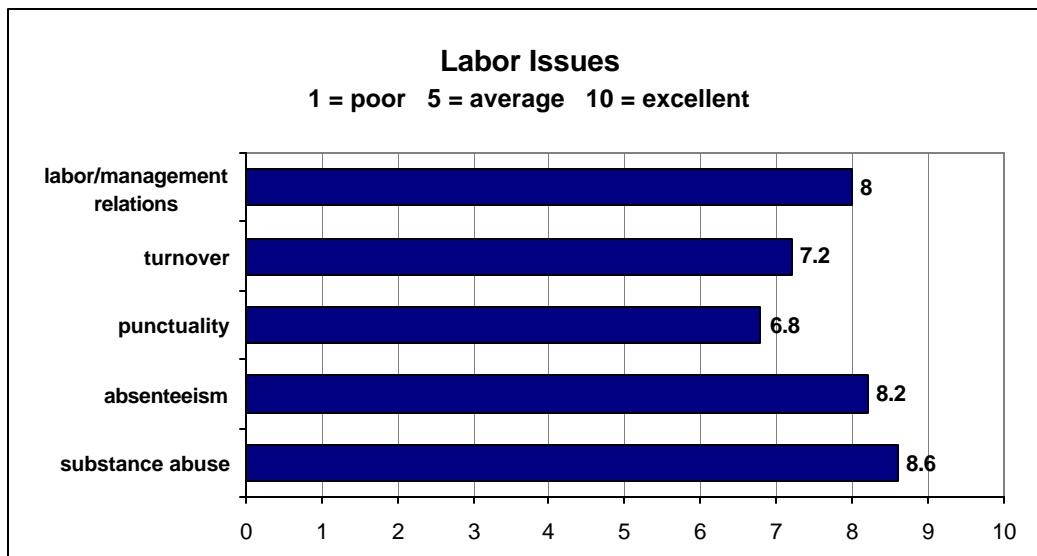
Nevertheless, until aerospace companies increase minimum education and training requirements for engineers to graduate degrees, the implementation of masters or doctoral programs in Rockford will continue to be difficult to maintain with sufficient enrollments as history has shown.

Aerospace employers also report a need for greater emphasis on machining careers and education in math and computers skills to build a stronger workforce for the next generation manufacturing workforce. The Aerospace Industry Association (AIA) provides an Educational Outreach program which is focused on developing interest in outer space and space travel. This program has been implemented in Chicago and is continually exploring opportunities for expansion. Incorporating programs such as the AIA Educational Outreach program in the region's public school systems could benefit workforce development in manufacturing.

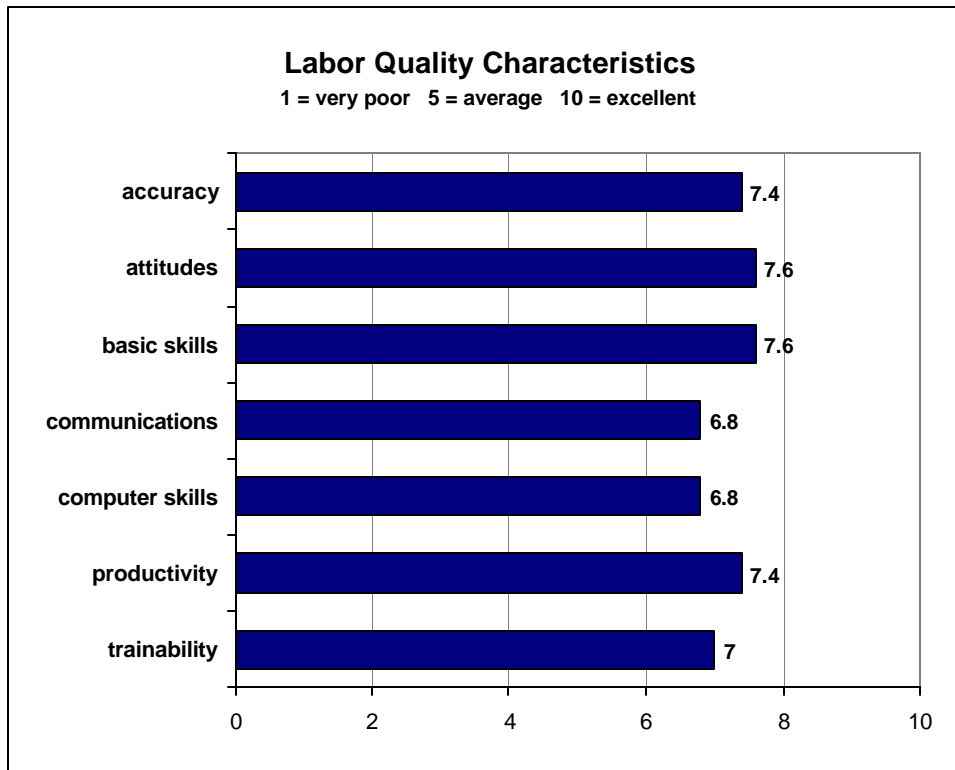
Labor Issues and Quality

Employer interviews and surveys were conducted to ascertain the quality of the region’s aerospace industry workforce. Labor quality was measured based on two components. The first component of labor quality includes absenteeism, turnover, punctuality, substance abuse, and labor/management relations. The second component of labor quality includes labor characteristics such as attitudes, trainability, and productivity. Labor issues and characteristics were rated by area employers based on a 1-10 point scale (1 = poor; 10 = excellent). In addition to measuring labor quality characteristics, the interviews identified significant labor availability trends for the area.

Labor issues and quality characteristics for the region’s aerospace workforce are rated more positive overall than other industries in the region. In terms of labor issues, regional employers rated the existing workforce “*Good*” to “*Excellent*” with a minimum score of 6.8 for punctuality and a maximum score of 8.6 for lack of substance abuse issues. In terms of quality characteristics, regional employers rated the existing workforce “*Good*” with a minimum score of 6.8 for communications and computers skills and a maximum score of 7.6 for attitudes and basic skills.



Source: Winnebago County Aerospace Employer Interviews, 2006



Source: Winnebago County Aerospace Employer Interviews, 2006

Workforce Strengths and Weaknesses

Over one-third of employers believe the aptitude, capabilities, and skills of the workforce are a significant strength for Winnebago County. Another one-third believes the work ethic in the region is strong as well. Regional workforce weaknesses stem from engineering shortages, lack of support for manufacturing careers, and the quality of K-12 educational systems.

Workforce Strengths	Number
Aptitude, capabilities and skills of workforce	33.3%
Work ethic	33.3%
Lower labor costs associated with lower cost of living	22.2%

Workforce Weaknesses	Number
Quality of K-12 education	22.2%
Lack of support for manufacturing careers	22.2%
Lack of engineers	22.2%
Taxes	11.1%
Lower work ethic	11.1%

Cost of Doing Business

An important objective of this study is to evaluate the cost of doing business for the aerospace industry in Winnebago County compared to other regions. Regions were selected for comparison based on the level of aerospace employment and comparable locations. A detailed operating cost comparison was conducted for selected regions by the Boyd Company, Inc.¹⁴ and includes comparisons of labor, energy, construction and amortization, property and sales tax, and shipping costs. The comparative regions selected for this analysis include:

Essex County Massachusetts	Lake County Ohio
Hamilton County Ohio	Marion County Indiana
Imperial County California	Montgomery County Ohio
Jefferson County Colorado	

Comparative Regional Analysis

A comparative operating cost analysis was compiled by the Boyd Company Inc. based on the regions selected for this study. This analysis was based on a 275,000 square foot mature plant in its third year of operation with 450 employees. A summary analysis was prepared from the Boyd reports based on five primary cost categories: labor, energy, construction/amortization, property, and shipping costs. Using Winnebago County as the base, the percent differential in cost compared to Winnebago County was calculated.

Only two regions were more expensive than Winnebago County, Essex County and Imperial County. However, regions that were lower than Winnebago County were not significantly lower, only 5.6% less expensive overall, indicating a narrow margin between comparative operating costs. The most expensive region in the analysis is Essex County with costs 12.0% higher than Winnebago County. The least expensive region is Marion County with costs 5.6% lower than Winnebago County.

¹⁴ The Boyd Company, Inc. is a location consultant specializing in comparative business cost analysis utilizing proprietary operating cost data bank. The Boyd Company Inc. compiled and prepared *A Comparative Operating Cost Analysis for the Aerospace Manufacturing Industry* specifically for this study focusing on comparative regions identified for this study.

	Total Annual Operating Costs	Winnebago Comparison
Winnebago County, IL	\$34,078,336	
Essex County, MA	\$38,179,952	12.0%
Imperial County, CA	\$35,292,258	3.6%
Jefferson County, CO	\$34,050,553	-0.1%
Lake County, OH	\$33,822,968	-0.7%
Montgomery County, OH	\$32,868,712	-3.5%
Hamilton County, OH	\$32,694,025	-4.1%
Marion County, IN	\$32,161,718	-5.6%

In terms of the major cost categories, Winnebago County is relatively competitive in labor and shipping costs but challenged in energy, property, and sales tax costs. Winnebago County had the highest overall property and sales tax costs. The second highest region, Jefferson County was still 12.4% lower than Winnebago County. Property and sales tax costs are more than 50% less in Marion County and 44.8% less in Hamilton County. This represents a major challenge for business attraction efforts in the region and should be a focus for structured incentive programs.

Energy costs including both electric power and natural gas costs represent another challenging area for Winnebago County. While energy costs are over 53% higher in Essex County, they are 22.5% lower in Jefferson County. Winnebago County is more competitive than many regions in terms of electric power costs; they are as much as 27% higher than three of the lower cost regions. The county is more competitive in natural gas costs; 25% higher than the most competitive region, and less than 5% higher than the second and third most competitive regions.

Winnebago County is the second highest region for both property tax and sales tax costs. Property tax costs in the region are 64% higher than Indiana and 44%-53% higher than Ohio. While Winnebago County is more competitive in sales tax costs, it is still 11%-37% higher than other comparative regions.

Strategies for overcoming these significant discrepancies in operating costs can be address through structured incentive programs. Electric, natural gas, property tax, and sales tax costs should all be evaluate for programs targeting new business attraction.

Operating Cost Comparison

	Winnebago County IL	Essex County MA	Hamilton County OH	Imperial County CA	Jefferson County CO	Lake County OH	Marion County IN	Montgomery County OH
Weighted Average Hourly Earnings	\$21.18	\$23.21	\$20.65	\$21.47	\$21.73	\$21.03	\$20.71	\$20.77
Annual Base Payroll Costs	\$18,147,024	\$19,886,328	\$17,692,920	\$18,395,496	\$18,618,264	\$18,018,504	\$17,744,328	\$17,795,736
Fringe Benefits	\$6,714,399	\$7,357,941	\$6,546,380	\$6,806,334	\$6,888,758	\$6,666,847	\$6,565,401	\$6,584,422
Labor Costs	\$24,861,423	\$27,244,269	\$24,239,300	\$25,201,830	\$25,507,022	\$24,685,351	\$24,309,729	\$24,380,158
Percent Difference - Winnebago County		9.6%	-2.5%	1.4%	2.6%	-0.7%	-2.2%	-1.9%

Electric Power Costs	\$451,524	\$900,396	\$457,152	\$832,749	\$384,692	\$542,868	\$327,516	\$358,500
Natural Gas Costs	\$1,103,400	\$1,491,300	\$1,377,000	\$1,049,400	\$820,800	\$1,377,000	\$1,044,900	\$1,377,000
Energy Costs	\$1,554,924	\$2,391,696	\$1,834,152	\$1,882,149	\$1,205,492	\$1,919,868	\$1,372,416	\$1,735,500
Percent Difference - Winnebago County		53.8%	18.0%	21.0%	-22.5%	23.5%	-11.7%	11.6%

Construction and Amortization Costs	\$4,034,339	\$4,408,002	\$3,814,133	\$4,449,858	\$3,932,245	\$3,998,507	\$3,866,519	\$3,729,754
Percent Difference - Winnebago County		9.3%	-5.5%	10.3%	-2.5%	-0.9%	-4.2%	-7.5%
Property and Sales Tax Costs	\$1,891,640	\$1,577,348	\$1,043,890	\$1,344,112	\$1,656,505	\$1,373,902	\$943,849	\$1,246,264
Percent Difference - Winnebago County		-16.6%	-44.8%	-28.9%	-12.4%	-27.4%	-50.1%	-34.1%

Shipping Costs	\$1,736,010	\$2,558,637	\$1,762,550	\$2,414,309	\$1,749,289	\$1,845,340	\$1,669,205	\$1,777,036
Percent Difference - Winnebago County		47.4%	1.5%	39.1%	0.8%	6.3%	-3.8%	2.4%

Total Annual Geographically-Variable Operating Costs	\$34,078,336	\$38,179,952	\$32,694,025	\$35,292,258	\$34,050,553	\$33,822,968	\$32,161,718	\$32,868,712
Percent Difference - Winnebago County		12.0%	-4.1%	3.6%	-0.1%	-0.7%	-5.6%	-3.5%

Wage, Housing, and Cost of Living Comparison

While Winnebago County has the 5th highest average aerospace wage within the comparative regions, it has the lowest median housing value based on 2003 Census statistics. The overall ratio of housing costs to wages is the lowest of the 8 comparative regions at 2.4 times greater than annual wages. In general, housing values should be no greater than 4.0 times annual wages. This is a significant advantage in Winnebago County, allowing the workforce greater purchasing power in the regional housing market. Overall the data indicates that while Winnebago County may not pay the highest wages in the aerospace industry, it has very competitive housing values and housing costs.

Housing costs are a significant contributor to the overall cost of living index. Other costs included in the index are utilities, food, transportation, and health care. Winnebago County's cost of living index is 88.2, the third lowest of the comparative regions. Only Marion County, IN and Montgomery County, OH have lower cost of living indexes at 82.8 and 83.6 respectively.

Wage purchasing power is calculated by dividing average annual wages by the cost of living index. Winnebago County scores third highest in wage purchasing power with Marion County, IN and Montgomery County, OH less than 2% higher. Other comparative regions have significantly lower wage purchasing power. Imperial County, CA has the lowest overall wage purchasing power of the 8 comparative regions and 54% less than Winnebago County.

Based on 2005 U.S. Census statistics the mean travel time in Winnebago County is 21.4 minutes compared to 26.8 minutes in Marion County, IN and 20.4 minutes in Montgomery County, OH. The lowest commute time of the comparison regions is Imperial County, CA just outside of San Diego, CA. However wages in Imperial County, CA are just slight higher and housing values and costs significant higher than Winnebago County.

Winnebago County wages are competitive with other comparative aerospace regions and yet provide lower housing values, housing costs and overall cost of living. The combined analysis provides strong support for workforce attraction efforts across comparative regions.

Wage, Housings, Commute and Cost of Living Comparison

	Winnebago County IL	Essex County MA	Hamilton County OH	Imperial County CA	Jefferson County CO	Lake County OH	Marion County IN	Montgomery County OH
average annual wages (1)	\$44,054	\$48,277	\$42,952	\$44,658	\$45,198	\$43,742	\$43,077	\$43,202
median housing value (2)	\$105,810	\$319,815	\$131,513	\$158,117	\$238,726	\$127,481	\$114,240	\$109,088
housing/wage ratio	2.4	6.6	3.1	3.5	5.3	2.9	2.7	2.5
cost of living index (3)	88.2%	145.3%	87.8%	188.7%	110.4%	183.0%	82.8%	83.6%
wage purchasing power Winnebago comparison	\$51,081	\$33,257	\$48,920	\$23,666	\$40,940	\$23,902	\$52,025	\$51,677
		-35%	-6%	-54%	-20%	-53%	2%	1%
mean travel time in minutes (4)	21.4	27.1	21.7	18.8	26	23.4	26.8	20.4

(1) Boyd Company BizCosts Report on Aerospace Industry

(2) 2003 American Community Survey, U.S. Census Bureau American Factfinder. Lake County data drawn from Easi Analytical Inc 2006 estimates.

(3) Imperial County cost of living based on San Diego; Lake County OH based on Cleveland-Lorain-Elyria

(4) 2005 American Community Survey, U.S. Census Bureau American Factfinder. Imperial and Lake County data drawn from Easi Analytical Inc 2006 estimates.

Strengths, Challenges, and Opportunities

Winnebago County has significant strengths for developing the aerospace cluster in the region in terms of both access and location. The most significant challenges for the region includes taxes and workforce availability for specific occupations, primarily engineers and skilled machinists. However, “relocation of corporate employees should be a relatively ‘easy sell’ when you combine competitive prices and the good quality of life offered in the Rockford area.”¹⁵ Winnebago County is an attractive location for workers, particularly in terms of cost of living, housing affordability, and availability of recreational activities.

While quality of life for the region is perceived to be a significant strength, the quality of K-12 education system is a concern. Addressing issues of this nature can fall beyond the scope of economic development organizations. What can be done from an economic development perspective is to provide information on the initiatives undertaken by the public school systems and the degree of success in implementation.

One of the more significant challenges is the cost of doing business in the region. Taxes, health care costs, and energy costs are moderately to significantly higher than other comparative regions, making business attraction and retention difficult. Pre-established, structured incentive packages can provide offsets these types of business costs and provide adequate reparation for regional cost differentials.

	<i>Strength</i>	<i>Challenge</i>
Location	<ul style="list-style-type: none"> - Location and potential for growth - Diversity and cluster of advanced manufacturing capabilities - Proximity to Chicago - Interstate highway systems - Passenger and cargo air services 	<ul style="list-style-type: none"> - Proximity to aerospace OEM's
Access¹⁶	<ul style="list-style-type: none"> - Aerospace engineering and technical talent - Other aerospace research and development - Airport sites/buildings for testing, prototyping 	<ul style="list-style-type: none"> - Civil engineering programs
Workforce	<ul style="list-style-type: none"> - General workforce availability - Access to high skilled machinists - Productive workforce 	<ul style="list-style-type: none"> - Workforce attraction for some companies of professional and skilled occupations such as engineers , designers ,

¹⁵ Carter & Burgess, Inc. Rockford Area, IL Target Industry Analysis, February 2006, Page 44.

¹⁶ Ibid, Page 47.

	- Dedicated workforce - Midwest regional values and work ethic	machinists, assembly - Lack of next generation workforce
<i>Quality of Life</i>	- Quality of life - Low cost of living, housing affordability - Recreational Activities - Access to higher education and training	- Quality of public schools - Access to specific program in higher education
<i>Cost of Doing Business</i>	- Lower overall wages - Lower shipping costs	- Payroll, property and sales taxes - Health care costs - Raw materials costs

Opportunities for Improving Aerospace Business Climate

From the aerospace industry’s perspective, improving the region’s business climate will require focus in three primary areas, partnerships, capabilities, and workforce. Manufacturing partnerships foster more innovative environments and bolster the region’s ability to compete in the global economy. Increasing and expanding manufacturing capabilities can provide smaller manufacturers with the ability to provide more comprehensive assembly and subassembly products in demand by the aerospace industry. Finally, increasing the capabilities of the region’s workforce will position Winnebago County for the development of the next generation of manufacturing workforce.

Partnerships focused on

- Collaborations to strengthen global competitiveness
- Developing an environment of knowledge sharing
- Developing Partnerships to grow cooperation among companies
- Establishing engineering programs and cooperatives such as activities at Eigerlab and the Entrepreneurial Center in Rockford
- Retaining the region’s skilled manufacturing capabilities

Increasing quality and capabilities of existing manufacturing companies

- Developing capabilities to increase the regional ability to do high mix, low volume, high specialization production
- Focusing on cost cutting through strategies such as lean manufacturing and strategic outsourcing
- Developing and expanding airport services geared toward business

Increased workforce capabilities

- Expanding assembly and machining training programs
- Attracting a new generation of skill manufacturing
- Strengthening math and science skills in the educational systems
- Creating increased internship opportunities with local manufacturing companies

Next Steps in Developing the Region's Aerospace Industry

The pinnacle of this study is a translation of results into logical and actionable strategies for regional economic development. In addition to providing statistical and anecdotal feedback on the state of the aerospace industry in the region, three categories of potential focus for strengthening the industry surfaced; workforce availability, partnerships and collaborations, and manufacturing quality and capabilities.

1. Expand Aerospace Partnerships and Collaborations

According to the Aerospace Industries Association (AIA) “Intellectual capital could be the most important factor determining the competitive success of U.S. aerospace products in the global economy.”¹⁷ Opportunities to organize and expand the region's intellectual capital should be explored through promotion or facilitation of discussions on development of additional centers of excellence in the region. The growth and development of collaborations between the public and private sectors can expand opportunities to develop the region's aerospace intellectual capital.

Expand Regional Approach to Funding Opportunities

The recent announcement of a potential \$5 million grant, a majority of which would go to Rockford and DeKalb companies for the development of a titanium center of excellence, emphasizes the importance of research and development opportunities. If established, the center for titanium machining will focus on enabling U.S. availability of titanium through the creation of an advanced titanium manufacturing center in northern Illinois.¹⁸

Similar initiatives can often provide opportunities for complimentary aerospace industry attraction including but not limited to aerospace testing, prototype certifications, testing, and calibration of machined products. Regional leadership would be needed to champion and coordinate early efforts in collaborative projects in training, skilled machining, and research and development with partners including aerospace supply chain partners and air service organizations such as the Greater Rockford Airport Authority and Kaney Jet Services.

¹⁷ Khan, Karim. *Aerospace – Turning the Aerospace Industry Around in the U.S. Seems like Inevitability – Are you prepared to Expand?* Business Facilities, November 2003.

¹⁸ *DeKalb Firm May Get \$5M Grant*. DeKalb Daily Chronicle, June 25, 2006.

Support Existing Manufacturing Collaborations

The Manufacturing Alliance of the Rock River Valley (MARRV) provides the connection for small, local manufacturers interested in using flexible networks to combine their core competencies. Flexible networks are intercompany collaborations created to achieve a desired economic outcome that the individual firms could not achieve separately. As a result, fiercely independent small manufacturers are being forced to learn a new skill - cooperation. Such networks allow businesses to develop joint solutions to shared problems and opportunities. Networking businesses combines resources to gain economies of scale, acquire technologies and resources, gain knowledge, and enter markets beyond their individual capabilities.¹⁹

The *EIGERlab* hosts the creative commercial uses of advanced manufacturing technologies, such as micro-machining. It brings to Rockford the mechanical and industrial engineering expertise of Northern Illinois University, Northwestern University, University of Illinois (Urbana), and Alion Science and Technology. Researchers from these organizations, in conjunction with engineers and technicians from area companies, develop prototypes of precision manufacturing systems and devices; conduct field tests and process evaluations; and demonstrate the efficacy of these to the Department of Defense and potential commercial users in the region.²⁰

EIGERlab has recently announced the formation of the Rockford Innovation Initiative whose primary focus is to prototype a new dynamic economic development model. The region's aerospace industry would make an excellent target for this initiative. The goal is to transform the Rockford economy into one that is creative and innovation driven. The approach is to maximize linkages and relationships with customers, suppliers and sources of creativity among local stakeholders on a global basis. The result will be faster commercialization of new-to-the-world products and services. By strengthening the Rockford collaboration infrastructure, a unique regional innovation ecosystem will evolve to propel the next generation of economic growth, business start-ups and jobs. The Rockford Innovation Initiative is being launched as collaboration between Rockford Area Ventures, Eigerlab, Rockford Area Economic Development Council, City of Rockford, Northern Illinois University, and the Center for Accelerating Innovation.

¹⁹ <http://www.marrv.org/Root/introduction.htm>

²⁰ <http://www.eigerlab.org/faqs.htm>

Support Expansion of Broadband and Telecommunications Infrastructure

Northern Illinois University is building and linking an ultra-fast, fiber-optic communications network that will extend next-generation technology currently available only at elite research facilities in Chicago to the rest of the region. Dubbed “NIUNet,” the roughly 175-mile fiber optic loop is being touted as a huge boon to research and economic development efforts throughout the western suburbs and greater northern Illinois region.²¹

The fiber optic loop will stretch from DeKalb to Batavia to Naperville along I-88, connecting into Chicago, the I-WIRE network, Argonne National Laboratory and other national research networks through the connection at Fermi National Accelerator Laboratory in Batavia. NIUNet would then loop back along I-90 to Hoffman Estates and west to Rockford before heading south along I-39 to Rochelle and back to DeKalb. In the end, municipalities, schools, hospitals, research facilities, and other potential NIUNet partners could connect.

Federal and state funding opportunities exist to build the needed telecommunication infrastructure to support the aerospace and other industries. These funding opportunities generally require match funds providing a critical need to join private companies with public organizations to meet granting requirements.

Develop and Support Partnerships with State and National Aerospace Associations

Another opportunity exists in providing incentives for local company involvement with national aerospace associations. The AIA offers an Associate membership to small- and medium-sized suppliers engaged in the production of aerospace systems. Associate membership provides access to activities and participation in the Supplier Management Council (SMC). The SMC is a unique organization within AIA that is the only industry forum where suppliers can identify their unique issues and bring them to the attention of aerospace industry leaders, legislators, regulators, and decision makers. Fees to join AIA as an Associate member range from \$3,000 - \$5,000 annually and include the following benefits:

- Recognition among prime and major subcontractors
- Insight into the future of the aerospace industry
- Support for conducting business in the global marketplace
- Interaction with customers, competitors, and peers
- Participation in supplier legislative action groups

²¹ <http://www.niunet.niu.edu/niunet/about.html>

- Identification of common issues between suppliers and customers
- Participation in the AIA Supplier Management Council, Electronic Enterprise Integration Committee, Electronic Business Steering Group, and National Aerospace Standards Committee

Regional economic development could sponsor a scholarship program for aerospace supply chain companies to become involved in these activities, not only for company growth and development, but also for regional recognition in the aerospace industry. Lenora Hanford manages Associate memberships and can be contacted at 703-358-1098.

The Aerospace States Association (ASA) is another key aerospace organization which focuses on national aviation and space policy development, economic advancement, and scientific enrichment. The ASA provides aerospace companies with information on the quality of business environments and is involved in various state-supported public-private partnerships to evaluate the vitality of the industry. ASA was formed to promote a state-based perspective in federal aerospace policy development and support state aerospace initiatives that enhance student/teacher education outreach and economic development opportunities. ASA mobilizes industry within states and local communities, working with federal agencies, informing the media, and bringing together state congressional delegations. The Illinois representative and treasurer of ASA is Sandra Bast of Bast Services, Inc. in Highland Park, 847-831-3508.

Develop and Support Educational Collaborations

Other potential partnerships and collaborations focus on workforce development initiatives and support for initiatives that focus on the development of an Aerospace Center for Excellence in Rockford. Such programs could be built from existing regional programs such as the Rock Valley College Certified Mechanic's program. Support for other potential certification and credentialing programs could be provided for programs in manufacturing associate which offers potential funding through the Department of Labor grants.

Other regional partnerships include the Higher Education Alliance of the Rock River Region (HEARRR) which jointly develop programs to meet the needs of the manufacturing industry. HEARRR is an alliance of four, non-profit, higher education institutions that share a long-term commitment to the vitality of the Rock River valley. HEARRR brings millions in federal money and expertise to assist manufacturing to revitalize operations for the 21st Century. HEARRR could be engaged to explore opportunities and initiatives that focus on the aerospace industry.

HEARRR member institutions include Northern Illinois University, Rockford College, Rock Valley College, and University of Illinois College of Medicine at Rockford. All four members have worked actively for decades to improve the education, the economy, the workforce, health services, culture, and social well being across the region. In addition to serving this region well for a very long time, they also deliver high-quality, fully accredited programs. HEARRR members are committed to addressing the needs and aspirations of this area and have allocated fiscal, physical, and human resources, and have created entrepreneurship systems to advance economic development. Collaborative activities focus on two economic clusters including manufacturing and health care in addition to two education issues that affect the pipeline for a skilled workforce.

There are many avenues available to pursue in terms of partnerships and collaborations, all bringing together the region's companies, resources, and talent to develop the manufacturing network of 1st, 2nd and 3rd tier aerospace supply chain partners for joint education and training initiatives, expansion of research and development activities, and expansion of airport services.

2. Improve Manufacturing Quality and Capabilities

The most significant message from aerospace 1st tier suppliers in the region is simple, “*don’t help us, help our suppliers.*” Major aerospace companies do not need assistance themselves, but would like efforts focused on assisting 2nd and 3rd tier supply chain partners in retaining skilled workforce, improving processes through six sigma, lean manufacturing, and quality. In order to retain positions in the supply chain, companies need to expand capabilities for more comprehensive products and lower costs through improved processes or strategic outsourcing.

One of the most significant trends in aerospace supply chain management is an increased consolidation of partners to reduce the number and subsequent coordination on specifications, quality, and functionality. “To reduce costs, aerospace OEMs have increased their outsourcing to suppliers of subassemblies (such as engines, structures, landing gear, and avionics) and are concentrating on their core competencies of design, assembling and marketing aircraft. At the same time, they have made efforts to reduce, reorganize, and rationalize their supply base.”²²

²² Niosi, Jorge and Zhegu, Majlinda. *Aerospace Clusters: Local or Global Knowledge Spillovers?* Industry and Innovation, The Charlesworth Group, Wakefield, March 2005.

Aerospace supply chain partners will be expected to provide more in terms of complete assemblies or subassemblies as opposed to piece parts. This presents a challenge for the region's manufacturers as they are generally smaller in size and will have difficulties meeting the demands of completing entire assemblies which often require a high mix of varying products, lower volumes, and highly specialized production.

To work toward this end, the region should develop an aerospace manufacturing network of subject matter experts to build capacity for more comprehensive manufacturing services and competitive manufacturing capabilities. Forming these alliances and joint ventures can require assistance from external organizations to facilitate the process. These networks could be formal or informal and involve joint production, resource sharing, joint marketing, and/or knowledge sharing.

Other initiatives could focus on building partnerships with RAEDC, RVC, NIU, and Illinois Manufacturing Extension Center to develop and collectively implement lean manufacturing training programs specific to the needs of the aerospace industry supply chain. In addition to lean implementations, regional manufacturing partnerships could work cooperatively to assist small to medium manufacturers in identifying and strategically off shoring parts and products while retaining high-skilled, high-value added products.

3. Strengthen Workforce Availability

Critical for site selection, business attraction, and business retention is the availability of a quality and appropriately skilled workforce. The region's 1st tier aerospace supply chain partners report few, if any, problems attracting and retaining the workforce due in part to size and reputation in the industry. They are, however, concerned for other 2nd and 3rd tier supply chain partners in the region who face more significant challenges.

Moving beyond the 1st tier aerospace suppliers, companies are generally smaller, more specialized and less established, making workforce attraction and retention more difficult. "Skilled workers such as transportation equipment and industrial machinery, particularly welders, CNC machinists and some other equipment operations, are tougher to recruit in this market."²³ Engineers and other professional and technical positions are equally challenging for many companies to attract and retain.

²³ Carter & Burgess, Inc. Rockford Area, IL Target Industry Analysis, February 2006, Page 33.

Regional marketing initiatives need to focus on the combined impact of reasonable wages, low cost of living, and housing affordability. Average annual aerospace wages are lower than many of the comparative regions. However, Winnebago County has the lowest median housing value and fourth lowest cost of living score.

Wage purchasing power is calculated by dividing average annual wages by the cost of living index. Winnebago County scores third highest in wage purchasing power with Marion County, IN and Montgomery County, OH less than 2% higher. Other comparative regions have significantly lower wage purchasing power. Imperial County, CA is the lowest in wage purchasing power of the 8 comparative regions and 54% lower than Winnebago County.

	Average Annual Wages	Median Housing Value	Cost of Living	Purchasing Power	Winnebago Comparison
Winnebago County, IL	\$44,054	\$105,810	88.2	\$51,081	
Essex County, MA	\$48,277	\$319,815	145.3	\$33,257	-35%
Hamilton County, OH	\$42,952	\$131,513	87.8	\$48,920	-6%
Imperial County, CA	\$44,658	\$158,117	188.7	\$23,666	-54%
Jefferson County, CO	\$45,198	\$238,726	110.4	\$40,940	-20%
Lake County, OH	\$43,742	\$127,481	183.0	\$23,902	-53%
Marion County, IN	\$43,077	\$114,240	82.8	\$52,025	2%
Montgomery County, OH	\$43,202	\$109,088	83.6	\$51,677	1%

A tight workforce supply for the aerospace industry is not unique to Winnebago County; rather it is a national trend. According to the Aerospace Industries Association, critical challenges facing the aerospace industry nationally include workforce shortages, longer product lifecycles, declining number of new platforms being developed, and reduced overall spending on research and development.²⁴

Develop Regional Workforce Training Incentives and Expansion Programs

Many states are incentivizing aerospace relocation or expansion through worker training grants and initiatives strategically designed to address significant workforce issues. One source to explore for opportunities and programs is the Aerospace Industries Association (AIA) who works with interested stakeholders, including representatives of industry, government, labor, and academia on workforce revitalization for the aerospace industry.

²⁴ Grimson, Matt. *Industry, Government Strategize to Avert Workforce Crisis*. Aerospace Industries Association, P.A. Rel. 2004-42.

AIA in partner with the National Defense Industrial Association and Defense Department has been working on strategies to address and avoid a future workforce crisis within the aerospace industry nationwide. Some of the strategies developed include the following:²⁵
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- Launching a national public awareness media campaign on aerospace careers
- Developing comprehensive supply and demand tracking capabilities for science, technology, engineering, mathematics, and foreign language workers
- Chartering an organization to bring coherence to workforce activities
- Developing best practices to attract, to retain, and to train aerospace and national security workers
- Building capacity in critical higher education disciplines
- Creating an inventory of in-demand jobs

In addition to the above strategies, the AIA's Department of Educational Outreach provides programming focused on youth interest in outer space and space travel. AIA has implemented the program in Chicago public schools and is continually exploring opportunities for expansion. Incorporating programs such as the AIA Educational Outreach program in the region's public school systems could benefit workforce development in manufacturing in the long term.

Business attraction efforts should place emphasis on development of training grants and incentives in addition to developing relationships and partnerships with AIA, ASA, and other related organizations for access to available resources, potential leads for site selection, as well as increasing and expanding the region's visibility with national aerospace organizations.

4. Additional Strategies for Strengthening the Aerospace Industry

Given the region's established aerospace cluster, there are many positive attributes, initiatives and collaborations already under way in the region. This information should be brought together to develop marketing material that focuses on the region's aerospace cluster, emphasizing manufacturing capabilities, existing collaborations, and potential future developments. Florida and other regions strong in aerospace have completed similar media materials aimed at business attraction and retention, workforce development, and aerospace supply chain development.

²⁵ *Industry, Government Strategies to Avert Workforce Crisis*. Aerospace Industries Association. Press Release, December 2004.

²⁶ *Implement a National Plan to Revitalize the U.S. Aerospace and National Security Workforce*. Aerospace Industries Association, 2005.

Some regions are providing direct financial assistance which may be beneficial to Winnebago County's aerospace development. The State of Florida developed a not-for-profit corporation to expand aerospace business opportunities. The program is designed to attract customers of the aerospace (space, aviation, and defense) industries including space, aviation, and defense, and to encourage business activities in Florida. The goal of the program is to develop new aerospace-related investment, operations, and business and to assist in the retention and expansion of existing aerospace-related businesses.

While regional wages are relatively competitive, the cost of doing business in Winnebago County in terms of energy, property tax, and sales tax costs is detrimental to successful attraction efforts. Customized business incentive packages for the aerospace industry can be developed to address and mitigate these costs. Additionally, workforce development and training grants could be included such as those available through the Aerospace Industries Association. Development of incentive packages addressing energy, and property and sales tax costs as well as workforce training grants is essential for further development and growth of the region's aerospace cluster.

Winnebago County business attraction efforts should continue focusing on distribution and warehousing with emphasis on a focus on high-tech, highly productive firm compatible with the needs of the aerospace industry. According to regional 1st tier aerospace companies, supply chain partners not currently present that would benefit the regional supply chain include a distribution center or supply logistics center to facilitate transportation and inventory management.

Appendix A

Comparative Operating Cost Summary

EXHIBIT I: COMPARATIVE ANNUAL OPERATING COST SUMMARY (1)

	Winnebago County IL	Essex County MA	Hamilton County OH	Imperial County CA	Jefferson County CO	Lake County OH	Marion County IN	Montgomery County OH
Weighted Average Hourly Earnings (2)	\$21.18	\$23.21	\$20.65	\$21.47	\$21.73	\$21.03	\$20.71	\$20.77
Annual Base Payroll Costs (2)	\$18,147,024	\$19,886,328	\$17,692,920	\$18,395,496	\$18,618,264	\$18,018,504	\$17,744,328	\$17,795,736
Fringe Benefits (3)	\$6,714,399	\$7,357,941	\$6,546,380	\$6,806,334	\$6,888,758	\$6,666,847	\$6,565,401	\$6,584,422
Total Annual Labor Costs	\$24,861,423	\$27,244,269	\$24,239,300	\$25,201,830	\$25,507,022	\$24,685,351	\$24,309,729	\$24,380,158
Electric Power Costs (4)	\$451,524	\$900,396	\$457,152	\$832,749	\$384,692	\$542,868	\$327,516	\$358,500
Natural Gas Power Costs (5)	\$1,103,400	\$1,491,300	\$1,377,000	\$1,049,400	\$820,800	\$1,377,000	\$1,044,900	\$1,377,000
Total Annual Energy Costs	\$1,554,924	\$2,391,696	\$1,834,152	\$1,882,149	\$1,205,492	\$1,919,868	\$1,372,416	\$1,735,500
Construction and Amortization Costs (6)	\$4,034,339	\$4,408,002	\$3,814,133	\$4,449,858	\$3,932,245	\$3,998,507	\$3,866,519	\$3,729,754
Real Property Tax (7)	\$891,640	\$952,348	\$418,890	\$331,612	\$769,005	\$498,902	\$318,849	\$433,764
Annual Sales Tax Cost (8)	\$1,000,000	\$625,000	\$625,000	\$1,012,500	\$887,500	\$875,000	\$625,000	\$812,500
Total Annual Tax Costs	\$1,891,640	\$1,577,348	\$1,043,890	\$1,344,112	\$1,656,505	\$1,373,902	\$943,849	\$1,246,264
Shipping Costs (9)	\$1,736,010	\$2,558,637	\$1,762,550	\$2,414,309	\$1,749,289	\$1,845,340	\$1,669,205	\$1,777,036
Total Annual Geographically-Variable Operating Costs	\$34,078,336	\$38,179,952	\$32,694,025	\$35,292,258	\$34,050,553	\$33,822,968	\$32,161,718	\$32,868,712

FOOTNOTES

- (1) For mature plant in third year of operation based on current wage rates and fringe benefits. Wage rates reflect Boyd field research, industry sources, and Boyd BizCosts® data bank placing firm in a competitive hiring position in each respective labor market. Job descriptions reflect a representative mix of key direct and indirect job functions for a hypothetical aerospace products plant employing 450 workers.
- (2) Assumes 1,904 hours worked per year per employee based on 12 paid holidays and a two-week vacation for mature plant.
- (3) Based on an estimated 37 percent of total annual base payroll costs. Costs include all statutory benefits, pay for time not worked and company-sponsored benefits.
- (4) Based on assumed monthly demand of 1,000 kWh monthly consumption. Annual costs reflect comparative industrial general service rates.
- (5) Annual costs reflect an assumed monthly use of 75,000 therms of natural gas. Gas prices are based on latest monthly state averages for industrial -use gas.
- (6) Assumes 25-year level amortization payments at 7.5 percent.
- (7) Based on nominal real property tax rate and assessment practices at each location based on \$1,000 of valuation. Petitions for abatements and lower assessments not considered. Effective tax rates are considered representative property tax levy amounts. Actual rates will vary based on alternate municipal, school, fire, and special assessment districts within each surveyed metropolitan area.
- (8) Based on prevailing local and state sales tax levies on taxable purchases of supplies, furnishings, equipment, and other taxable goods.
- (9) Annual charges reflect truckload lots of 40,000 lbs. using private over-the-road carrier to each market city location. Projected charges based on estimated \$1.45 per mile which includes cost factors such as labor, fuel, maintenance, insurance certificates, and operating rights. Market region destination locations reflect the optimum 10-center distribution warehouses configuration for serving a nationwide U.S. market.

Appendix B

A Comparative Operating Cost Analysis for the Aerospace Industry

**The Boyd Company, Inc.
Princeton, NJ**