Minnesota’s Computer & Information Technology Cluster
Final Report
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Executive Summary

*Between 2006 and 2016, professional-level IT jobs will account for 1 in 19 (5.26%) of all new jobs - BLS*

Minnesota’s computer-information technology (Computer-IT) cluster is diverse, comprising the following industry segments:

1. Core industry (334): Manufacturing of computers and peripheral equipment, communications equipment, audio and video equipment, semiconductor and electronic components, electronic instruments and magnetic media manufacturing and reproducing;
2. Secondary industry: Software publishers (NAICS 5112) Internet publishing and broadcasting (NAICS 5161), Telecommunications (517), ISPs, Search portals and data processing (518), Computer systems design and related services (NAICS 5415);

The cluster is also home to many IT-intensive industries, such as financial services, the defense industry, medical device manufacturers, major retail/service companies and others that rely heavily on information technology as part of their business. See the Cluster Map in Appendix A. The core cluster is concentrated in the 7-county Metropolitan area and includes parts of McLeod County to the west and Olmsted County to the south.

The cluster is critical to the region and state’s long-term prosperity for the following key reasons:

1) The cluster is comprised of over 100,000 jobs in the region and is projected to grow by 4% between 2006 and 2016. The cluster also accounted for over $7.9 billion in real GDP growth (base year: 2000) in Minnesota, nearly 4 percent, and exported over $4 billion in 2005.

2) Computer, computer components, and information technology are the backbone of many emerging high-growth sectors in Minnesota, such as biotechnology, and established sectors, such as financial services and information intensive industries.

3) Growth in computer-related jobs, e.g. software engineers (applications and systems software), system analysts and support specialists positions) will experience growth in the next ten years between 10 - 28 percent and comprise one-fifth of all jobs in the cluster.

4) The core industry in Minnesota provides high paying jobs with average hourly wage of $33.03, which is over 62 % higher than the mean hourly wage of $20.35 for all jobs in the private sector, and

5) A strong cluster will serve as a compelling image of the region’s high-tech global leadership which will serve to attract future businesses and talent.

The key findings and recommendations are based on quantitative and qualitative analysis conducted by team members. For a more comprehensive list of findings and recommendations and next steps in this effort, please see the body of the report.
Findings:

1. Workforce talent and strong work ethic are key to why industries have started and stayed in Minnesota.
2. Rapid technology change means changes in high-tech workforce skills needed by cluster employers.
3. About half of core industries have less than 10 employees and 3% of businesses account for about 38% of core industry employment).
4. Technology (e.g., cable and broadband capacity) infrastructure is critical to the clusters ability to develop and be globally competitive.
5. Increased R&D is needed to maintain and grow core cluster. Difficulty for smaller and medium-sized core businesses to finance R&D investments.
6. Multiple associations, industry organizations and both formal and informal professional groups (IFCs); however, there appears to be a gap in IFCs representing the interests of smaller high tech businesses.

Recommendations:

- **Increase STEM literacy.**
  - Define and continue to update IT skills and competencies for K-12 and higher education.
- **Upgrade worker skills.**
  - Promote Minnesota Jobs Skills Partnership (MJSP) program to IT industry.
  - Support Customized Training and efforts to expedite content development.
- **Ensure reliable & current statewide technology infrastructure.**
- **Explore whether small to medium-sized core industries have access to adequate capital.**
- **Increase core industry R&D support.**
- **Establish an IT Industry Specialist position at DEED to:**
  - Evaluate alignment between core industry support needs and IFC missions and outcomes and make recommendations based on findings.
  - Evaluate opportunities to increase cross fertilization of ideas and technology across industry segments.
  - Work with MnSCU’s Center for Strategic Information Technology and Security.
- **Have DEED BSS specialize by regional industry groups.**
- **Market DEED’s regional competitiveness initiatives & how they relate (e.g., SEED, FIRST, TARGET?).**
- **Further develop the IT-cluster project to its Next Steps.**
Introduction

This paper is the culmination of a four-member computer-information technology (IT) cluster project team that met between October 2007 and January 2008 as part of a Microeconomics of Competitiveness training program. The cluster assessment, findings, and recommendations presented in this paper are based on a combination of quantitative labor market data, academic research, and interviews with business owners and relevant stakeholders. Please note that cluster interviews did not represent all industry sectors, so interview findings may not reflect issues or concerns for the cluster population as a whole. The core of this assessment is based on industry codes as defined by the North American Industrial Classification System (NAICS). While these definitions are useful in providing a general framework for the technology industry, they can also obscure the broad range of technological activities that characterizes the actual firms. When appropriate, the authors have tried to note qualifications in the analysis. In summary, this paper is an initial step toward a more comprehensive understanding of the computer-IT cluster in Minnesota. Please see the Next Steps section at the end of this report for possible means to take this project to the next level.

Defining Minnesota’s Computer - IT Cluster

Prosperity is directly linked to an economy’s ability to innovate, adapt, and build on competitive strengths. A cluster approach to economic development can help facilitate that by encouraging government entities and businesses to think about the way their activities add value to the private sector of the economy. Rather than focusing on a specific industry, this strategy focuses economic development policies on groups of firms and the relationships they share.

When beginning a cluster study, a crucial first step is to clearly define the core industry. In practice, the more generic and dispersed a cluster, the less likely it will be to provide any final economic benefit (Davies, 2003). In order to perform meaningful analysis, therefore, the core computer-information technology cluster is being defined as establishments that fall under the North American Industrial Classification System (NAICS) code 334. This covers most high-tech manufacturing such as computer terminals (334111), small electronic components (334419), and defense electronics (334519). See Table 2 below. Medical device manufacturers (334510), while related on a number of levels, are not viewed as core to the computer-IT cluster.

The secondary industries in the cluster are comprised of: software publishers (NAICS 5112), internet publishing and broadcasting (NAICS 516), telecommunications (517), ISPs, search portals and data processing (518), and computer systems design and related services (NAICS 5415). The related industries to the computer-IT cluster are industries that are “technology”-intensive industries, e.g. financial services, the defense industry, medical device, nanotechnology, many service/retail firms and information providers that rely heavily on IT as part of their business. See the Cluster Map in Appendix A for a complete description of the cluster.
As for geography, the focus for this analysis is on regions in Minnesota with the highest employment concentrations using the NAICS description. When these concentrations were mapped for the core cluster (NAICS 33), the densest group of establishments was located in the 7-county Twin Cities metropolitan area. Outside of that region, there were also large concentrations in Hutchinson (McLeod County west of the metro area) and Rochester (Olmstead County southeast of the metro area). A more detailed analysis using wage and employment data is below.

When looking at employment by products produced in the cluster core (excluding electro-medical apparatus manufacturing), computer and peripheral equipment manufacturing makes up 34 percent (NAICS 3341). The second largest group at 29 percent is electronic instrument manufacturing (NAICS 3345). Table 2 below provides a breakdown of the components in the core manufacturing industry by employment size in the computer-IT cluster:
Today, according to Info USA’s Employer Database, most of the top employers fall within these groupings. Those employers are IBM, Seagate Technology, Boston Scientific, Honeywell Aerospace, and Hutchinson Technology Inc. With the exception of IBM in Rochester and Hutchinson Technology in Hutchinson, the majority of the companies, including the smaller employers, are based in the Twin Cities metropolitan area. *Sixty-six percent of the core manufacturing industry, however, has fewer than 50 employees and 90 percent has fewer than 250 employees.* See Table 3 below.
Table 4 (below) shows that the strength of the cluster in the next ten years, both in employment size and LQ change) will be in electronic instrument manufacturing and computer systems design and related services.

Table 4. Location Quotient Breakdown

<table>
<thead>
<tr>
<th>NAICS Code</th>
<th>Description</th>
<th>2006 Jobs</th>
<th>2006 LQ</th>
<th>2016 LQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>3341</td>
<td>Computer and peripheral equipment mfg.</td>
<td>14,273</td>
<td>5.53</td>
<td>4.77</td>
</tr>
<tr>
<td>3345</td>
<td>Electronic instrument manufacturing</td>
<td>23,491</td>
<td>4.10</td>
<td>4.69</td>
</tr>
<tr>
<td>5182</td>
<td>Data processing and related services</td>
<td>7,173</td>
<td>1.72</td>
<td>1.28</td>
</tr>
<tr>
<td>5112</td>
<td>Software publishers</td>
<td>6,057</td>
<td>1.66</td>
<td>1.61</td>
</tr>
<tr>
<td>3346</td>
<td>Magnetic media manufacturing and reproducing</td>
<td>844</td>
<td>1.56</td>
<td>2.23</td>
</tr>
<tr>
<td>5415</td>
<td>Computer systems design and related services</td>
<td>30,687</td>
<td>1.36</td>
<td>1.32</td>
</tr>
<tr>
<td>5161</td>
<td>Internet publishing and broadcasting</td>
<td>665</td>
<td>1.29</td>
<td>1.47</td>
</tr>
<tr>
<td>3343</td>
<td>Audio and video equipment manufacturing</td>
<td>466</td>
<td>1.18</td>
<td>0.58</td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and electronic component mfg.</td>
<td>7,052</td>
<td>1.17</td>
<td>0.96</td>
</tr>
<tr>
<td>5175</td>
<td>Cable and other program distribution</td>
<td>1,990</td>
<td>0.95</td>
<td>1.07</td>
</tr>
<tr>
<td>5172</td>
<td>Wireless telecommunications carriers</td>
<td>2,382</td>
<td>0.80</td>
<td>0.75</td>
</tr>
<tr>
<td>5171</td>
<td>Wired telecommunications carriers</td>
<td>5,316</td>
<td>0.75</td>
<td>0.54</td>
</tr>
<tr>
<td>3342</td>
<td>Communications equipment manufacturing</td>
<td>1,086</td>
<td>0.57</td>
<td>0.26</td>
</tr>
<tr>
<td>5181</td>
<td>ISPs and web search portals</td>
<td>988</td>
<td>0.55</td>
<td>0.47</td>
</tr>
<tr>
<td>5173</td>
<td>Telecommunications resellers</td>
<td>988</td>
<td>0.52</td>
<td>0.46</td>
</tr>
<tr>
<td>5174</td>
<td>Satellite telecommunications</td>
<td>101</td>
<td>0.41</td>
<td>0.66</td>
</tr>
<tr>
<td>5179</td>
<td>Other telecommunications</td>
<td>28</td>
<td>0.29</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>103,607</strong></td>
<td><strong>1.61</strong></td>
<td><strong>1.53</strong></td>
</tr>
</tbody>
</table>

Source: EMSI Complete Employment - September 2007

*Bubble size represents 2006 jobs in each industry.
Computer-IT Cluster Overview

History

In part, the foundations of the computer-IT cluster in Minnesota can be traced to the formation of Engineering Research Associates, Inc. (ERA) in the late 1940s. ERA emerged as a business venture between a group who worked on code-breaking technology for the United States Navy and Northwest Aeronautical Corporation (NAC) based in St. Paul. Using contracts awarded to them by the Navy, the company worked to develop what would become the first stored program computer: Atlas. In 1947, Atlas was delivered to the Navy with a commercial version entering the market shortly afterwards. In the ensuing years, ERA was acquired, absorbed, and eventually folded into UNIVAC, a subdivision of Sperry Rand.

In the late 1950s, a group of the original ERA founders created the Control Data Corporation based in Minneapolis, and by 1965, was the third largest computer maker in the country (Catlin, 1999). One of the central engineers at Control Data who was also a former ERA employee, Seymour Cray, broke away to form Cray Research where the focus also became supercomputers. By that time, ERA itself was acquired, absorbed, and eventually folded into UNIVAC; a subdivision of Sperry Rand.

During that period, the computer-IT industry in the Twin Cities benefited greatly from the Cold War and was in part sustained by government contracts. However, that dependence eventually became a hindrance for many of Minnesota’s original computer companies as defense spending declined in the late 1980s and the computer market shifted toward personal computer use (Catlin, 1999). Cray Research was bought by a California-based company in the 1990s while Control Data was carved up with part of it being bought out by Seagate Technology. During that time, a software industry emerged and capitalized on the technological capacity of the population; particularly in the Twin Cities. By the mid 1990s, Minnesota ranked fourth in the country in the number of software companies with $850 million in annual revenue (Munich et al., 1995, pg. 27).

Through the early 2000s and up today, however, the high-tech industry in the United States and Minnesota has shifted significantly yet again. While the software industry contracted, the state’s computer and electronic manufacturers have grown. Additionally, future growth is projected for high-tech services segments such as data processing, custom computer programming, and other computer related services.

Minnesota’s computer-IT cluster is uniquely broad in the industry segments it includes ranging from manufacturing computers and peripheral equipment, electronic measurement and control instruments, software publishing, computer systems design, and other IT-focused services. Along with supporting itself, the cluster is also a critical contributor to other clusters in the state. Over the last fifty years, the cluster has developed into one of the most profitable and most highly integrated in the region.
Cluster Context (The “Diamond Model”).

The broadly defined high-tech industry (including computers, electronics, telecommunications, information technology services, etc) in the United States has experienced some significant growing pains over the last several years. Between 2000 and 2006, for example, there was a 12 percent decline in overall employment (Kazmierczak et al., 2007, p. 6). Along with the employment declines, average annual wages and payrolls also fell noticeably for high-tech industry workers and firms, but still remain high compared to the economy as a whole. In 2005, the average annual wage for high-tech industry workers was $75,500 while the average private sector wage was of $40,500 (in 2005 dollars adjusted for inflation).

These national trends, while not always as amplified, have also been present in Minnesota. From 2000 to 2005, the state lost about 22,800 high-tech jobs representing a 15 percent decline (Kazmierczak et al., 2007, p. 71). According to DEED’s Labor Market Information database, within NAICS 334, average employment decreased by 11.4 percent between 2001 and 2006 (See Table 5). In real terms, the sector went from 61,852 jobs in 2001 to 54,782 in 2006, which is a net loss of 7,070 jobs. Extracting electro-medical apparatus manufacturing employment figures from this equation, a higher job loss of 9,734 (18.8 percent decrease) was reported.

Table 5

| Year | Employment | Establishments |
| 2001 | 60,000 | 500 |
| 2002 | 50,000 | 450 |
| 2003 | 40,000 | 400 |
| 2004 | 30,000 | 350 |
| 2005 | 20,000 | 300 |
| 2006 | 10,000 | 250 |

Source: DEED LMI ALMIS Database 2001-2006 Annual Employment Data

Location Quotient

Another way to establish the context of a cluster is through a location quotient and shift share analysis. Generally, a location quotient greater than 1 means that percentage of local employment in a sector or industry is greater than the percentage nationally. Table 6 below...
gives an overview of the relative importance of various industries/sectors in Minnesota comparing to computer and electronic manufacturing industry with electro-medical apparatus manufacturing (red-dot circle) and without (turquoise circle). Between 2001 and 2006, for example, the location quotient statewide for all establishments under NAICS 334 experienced an increase of 19 percent. Without the medical apparatuses manufacturing, the core industry still had a relatively large location quotient of 1.66 in 2006 vs. 1.49 in 2001.

Therefore, drilling down further to the regions interests provides a clearer picture. In most of these areas (Economic Development Regions 6e, 10, and 11), the location quotients for the core industry have been well above 1. Regions 6e and 11 experienced increases of 47 percent and 28 percent respectively between 2001 and 2006. The location quotient in Region 10 actually decreased slightly. As noted previously, these areas also happen to be where the largest concentrations of computer manufacturing and IT employment are located. It must be noted again, of course, that some aspects of the medical device industry are included in these measures. As for the shift share analysis, both statewide and the specific Economic Development Regions point to a competitive cluster.

The high-tech services side of the cluster, or the secondary industries, also shows promising growth in specific regions using this preliminary quantitative analysis, but due to incomplete data at this time, the conclusions drawn are not totally reliable. As a whole, though, the observed growth suggests future opportunities for continued success.

Table 6
Diamond Model

Central and Southeast MN Computer-IT Cluster

Firm Strategy and Rivalry

National: National/Global companies with large bases of operation in MN
Brand name recognition of many products

Regional and Cluster: Close proximity to research facilities for collaboration
Entrepreneurial environment
Many regional and national competitors in most cluster segments
Highly sophisticated manufacturing operations

Chance

Factor (Input) Condition

Transportation
Access to energy resources
Broadband connections
Venture capital investments
Educational Institutions for R&D - U of MN, MnSCU
Human capital - Access to skilled labor
Scientific & Tech Infrastructure
Communication Infrastructures
Management Information Systems of major coop. HQs

Factor (Input) Condition

Demand Conditions

Sophisticated consumers - local, regional, national, worldwide
IT security - Financial services, defense

Users of computer, peripheral equipment
Semiconductors - Micro producers

Government

Related and Supporting Industries

Banking/Financial services
Distribution/ Warehouses centers
Institutional networks
Equipment Manufacturers
Packaging Manufacturers
Telecommunications Companies
Medical Devices manufacturers
Electronic publishing
Venture capital firms

Local, state, national
DEED
Import/Export Policies
Environmental - EPA
Safety - OSHA
Legislative Policies
Laws and Regulations
Fiber optic infrastructure expansion
Factor (Input) Condition

1. Employment & Workforce

According to the most recent American Electronics Association “Cyberstates” report, Minnesota ranks high in several “high tech” performance measures. By 2005, the state’s computer and peripheral equipment manufacturing establishments (includes NAICS 334111-113, 334119) ranked fifth in the country in terms of employment. Similarly, Minnesota ranked seventh overall in electronics components manufacturing employment (Kazmierczak et al., 2007, p. 74). Among other sectors, such as semiconductor manufacturing and defense electronics manufacturing, Minnesota is also in the top twenty.

Minnesota also has a large number of people employed in the secondary industry group of computer-related occupations, jobs which fuel Minnesota’s high-tech industries. In 2005, Minnesota ranked 17th in the nation in employment in computer and mathematical occupations. The largest occupations within the Computer and Mathematical occupational category are Computer Software Engineers, Applications; Computer Support Specialists and Computer Systems Analysts. Between 2006 and 2016, employment growth of over 13 percent is projected for occupations in the secondary Computer/IT cluster. Computer software engineers (applications) are projected to grow from 6,435 jobs to 8,992 jobs (40 percent); systems software engineers from 3,215 to 4,182 (30 percent) and computer systems analysts from 2,786 to 3,373 (21 percent). See Appendix G for a complete Career Cluster Report.

All of the businesses interviewed identified the quality of the workforce (work ethic and education) in Minnesota as a strong factor in their business success. Minnesota ranks number 17 in the number of people employed in computer-related occupations. The professional and business services industry employed almost 26,000 computer and mathematical workers in 2005, the largest number of any industry. Minnesota’s high-tech businesses can rely on a strong growth of computer occupations.

2. Education

The Minnesota Department of Employment and Economic Development (DEED) projects that science, technology, engineering and math (STEM) jobs are projected to grow at above-average rates in the foreseeable future - 23 percent between 2004 and 2014 - which is much higher than the rate of growth projected for the private sector as a whole (12 percent), and higher than projected growth for jobs requiring post-secondary education (17%).

However, this rapid rate of growth is driven by some fields within STEM more than others. Despite job losses during the “dot-com” bust and ongoing global outsourcing of jobs, rapid growth is projected in IT particularly due to the fact that IT workers are needed in all companies, not just IT companies, and that many of those are direct-service jobs that can’t be outsourced. Table 7 below shows that in some STEM occupations (e.g. engineering, technicians, and mathematicians) the rate of growth is expected to be below the statewide average for jobs requiring post-secondary education. Information technology job growth, however, is expected to outpace other STEM occupations.
Table 7 (above) % Change in Employment, 2004 - 2014

Table 8 Among STEM Occupations, only IT Shows Signs of Worker Shortage

3. Resources - Venture Capital

According to the most recent American Electronics Association “Cyberstates” report, Minnesota ranks high in several “high tech” performance measures. In venture capital and total research and development investments into the high tech industry, Minnesota ranked fourteenth and fifteenth in 2006, respectively: $321.6 million in venture capital investments and $5.99 billion in total R & D (Kazmierczak et al., 2007, p. 129, 131). The medical devices and health care industries combined attracted nearly $200 million, or 62 percent of venture capital investment in Minnesota in 2006. Other industries receiving major venture capital investment were IT services.
($48 million or 15 percent) and software ($35 million or 11 percent). According to Money Tree, Minnesota’s investment in venture capital in 2006 breaks down as follows.

Table 9

<table>
<thead>
<tr>
<th>Industry</th>
<th>Investment (in millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronics / Instrumentation</td>
<td>$2.5M</td>
</tr>
<tr>
<td>Computer &amp; Peripheral</td>
<td>$2.5M</td>
</tr>
<tr>
<td>Consumer Products &amp; Services</td>
<td>$2.1M</td>
</tr>
<tr>
<td>IT Services</td>
<td>$2.2M</td>
</tr>
<tr>
<td>Medical Devices and Equipment</td>
<td>$2.3M</td>
</tr>
<tr>
<td>Industrial Energy</td>
<td>$1M</td>
</tr>
<tr>
<td>Media Entertainment</td>
<td>$0.5M</td>
</tr>
</tbody>
</table>

4. **Scientific and technological infrastructure**

Minnesota ranks eighth in the U.S. National State Technology and Science Index. The 2004 State Technology and Science Index encapsulates each state’s comprehensive inventory of technology and science assets that can be leveraged to promote economic development. The index uses 75 indicators in five categories to measure how well a state will perform in today’s knowledge-based economy. The five composite categories are:

- Research and development inputs;
- Risk capital and entrepreneurial infrastructure;
- Human capital investment;
- Technology and science workforce; and
- Technology concentration and dynamism.

Minnesota also has a high rank in the number of registered utility patents issued between 2001 - 2005 and currently ranks 10th in the nation. Registered utility patents, “patents for invention,” are frequently used as a measure of technology and innovation. In patents per capita, Minnesota ranks among the top five states, with 47 new patents registered per 100,000 residents in 2005. Private companies in Minnesota registering the largest number of patents between 2001 and 2005 were 3M (1,758 patents), IBM (1,049 patents), Seagate Technology (535 patents), Medronic (523 patents), and Honeywell International (458 patents).

5. **Availability of information** (institutions for collaboration, government-sponsored studies, etc.)

Appendix C provides a description of computer-IT institutions for collaboration. Many large businesses rely on the Minnesota High Tech Association or The Collaborative for networking and information sharing. Many of the smaller businesses interviewed indicated that the IFCs in
Minnesota were not adequately representative. Many Twin Cities chapters of national organizations struggle for membership and are in the process of rebuilding.

Smaller IFCs include: Twin Cities System Administrators, The Black Data Processing Associates (TC Chapter), Association for Women in Computing (TC Chapter), Minnebar and Trusted Adoption of Open Source in the Enterprise.

The Minnesota State Colleges & Universities-sponsored Center of Excellence in Information Technology and Security (www.strategicit.org) is working to fill this need, both as an IFC in its own right, but also through the development of Web-based resources for businesses and students. The Center’s Web site, for example, has a comprehensive list of IFCs, both national and Minnesota-based. The Center will also be hosting conferences to provide a forum for government or privately-sponsored information on the computer and IT workforce, particularly in the area of training and education for the growing specialty of computer security.

6. **IT Infrastructure** - MNET, a public-private partnership, delivers statewide network and integrating private sector telecommunication services for use by government and education since 1993.

**Related and Supporting Industries**

In this region, the outlook for providers of “raw” materials and component products are not a strong determining factor for the future of this cluster. The following data show that these industries are expected to decline in overall employment and location quotient in the next ten years.

<table>
<thead>
<tr>
<th>Selected Industries</th>
<th>2007 Industry Jobs</th>
<th>2017 Industry Jobs</th>
<th>Total Change</th>
<th>Total % Change</th>
<th>2006 Average Earnings/Worker</th>
<th>2007 Location Quotient</th>
<th>2017 Location Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastics and rubber products manufacturing (NAICS 326)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$66,848</td>
<td>1.17</td>
<td>1.11</td>
</tr>
<tr>
<td>Nonmetallic mineral product manufacturing (NAICS 327)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary metal manufacturing (NAICS 331)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fabricated metal product manufacturing (NAICS 332)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery manufacturing (NAICS 333)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: EMSI Complete Employment - September 2007

Most companies interviewed identified supply markets outside of the region that supported their production (or services) and future growth. Many respondents mentioned that components (printed circuit boards, capacitors, for example) are purchased from overseas markets at a lower cost than found on the domestic market. As a result, the computer-IT cluster depends heavily on a local infrastructure that supports the movement of goods including reliable and
regular passenger air travel, air freight service, roads and a technology infrastructure that supports substantial internet connectivity.


Demand Conditions

Minnesota’s economy has benefited from an increase in the number of Fortune 500 companies from 14 in 2000 to 20 in 2007. Overall, the state is home to 34 Fortune 1,000 companies, representing a wide variety of industries including, but not limited to, insurance, banking, chemical manufacturing and food processing. In addition, Minnesota’s high-tech companies offer a wide variety of goods and services such as computer systems design (Seagate Technology, Ceridian Corp., Rimage Corp.), electronic instruments manufacturing (3M, Alliant Techsystems Inc., Honeywell Aerospace), software publishing (Lawson Software, NCS Pearson Inc.) and chemical and pharmaceutical manufacturing (Mosaic Corp, Valspar, Upsher-Smith Laboratories).

Specifically, the Twin Cities area is home to many computer-IT intensive industries including major companies in financial services (Travelers, US Bancorp, TCF Financial, Ameriprise Financial, Deluxe, Piper Jaffrey, MoneyGram International, Fair Isaac Corp., KMG America); high-tech manufacturing (Toro, Alliant Techsystems, Polaris, Arctic Cat, Apogee Enterprises, General Mills, Hormel); medical device companies (Possis, St. Jude Medical, Medtronic, MGI Pharma); defense companies (Honeywell Aerospace, Rosemount Inc., Goodrich) and major headquarters for retail/services companies (Target, Best Buy, Northwest Airlines, SuperValu).

Notwithstanding, many companies interviewed did not consider this local demand as sufficient for their customer base. While the variety and depth of these industries are seen as vital to the region’s economy, many computer and information technology companies are national and international in scope. Most companies have some aspect of their business (e.g. sales or production) located elsewhere in the country or the world. Increasingly, they see their business growth as targeting international markets.

Firm Strategy and Rivalry

As for computer and IT establishments, Minnesota had an average of 525 listed under NAICS code 334 in 2006. As Table 1 shows, roughly 66 percent of those establishments employed forty-nine or fewer people. However, 92 percent of the employment occurred with employers hiring 50 or more employees. Furthermore, of the $2.72 billion paid out in wages, 93.2 percent came from establishments with 50 or more employees.

Each of these establishments is continually trying to increase marginal profits by exploiting certain competitive advantages. A value chain, a generalized representation of a firm’s functions broken up into a series of primary and support activities, can be a useful tool for dividing “a company’s activities into the technologically and economically distinct activities it performs to do business” (Porter, p. 77). Advantages occur as a result of the linkages between value categories and the more distinct activities specific to a firm’s business. The support activities include
functions such as infrastructure, human resource management, technological development, and procurement. Primary activities cover inbound logistics, operations, outbound logistics, marketing and sales, and service (see Value Chain in Appendix D).

Within the computer-IT cluster, firms perform most value activities found in other clusters, but some are much more important than others. In the area of support activities, a typical high-tech firm will place a great deal of importance on its legal department and/or legal representation. These services are critical for high-tech companies that operate globally and face concerns over intellectual property rights. Being able to train workers (both in-house and through an outside provider) is another crucial support activity for a firm due to the rapid adoption of new technologies. Additionally, strong research and development capabilities can be a crucial area for gaining a competitive advantage or product differentiation.

Depending on the type of high-tech firm, procurement of raw materials as well as inbound and outbound logistics will take on different levels of importance. For manufacturers of computers and peripheral components, acquiring raw materials and partially finished products efficiently is very important. For IT-focused firms, procurement and storage is a much smaller consideration if even one at all. However, recruiting and hiring employees with specific skill sets is critical for all firms in the cluster. Other important primary activities include the effective marketing and management of products. On the service end, reliable customer support is crucial to a firm’s credibility in an industry.

The following SWOT chart summarizes the findings from the Diamond Model analysis:
Strengths, Weaknesses, Opportunities and Threats Analysis

<table>
<thead>
<tr>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td><strong>Weaknesses</strong></td>
</tr>
<tr>
<td>- Competitive salaries (relative to cost of living)</td>
<td>- Environment that does not support early adoption of new technologies</td>
</tr>
<tr>
<td>- Retention of skilled workers (less turnover than found on East/West Coasts)</td>
<td>Availability of venture capital has favored medical device industry and late-stage investments. In 2006, VCs have shifted in favor of early stage investments, particularly in IT (Source: Thomson Financial, PricewaterhouseCoopers and the National Venture Capital Association)</td>
</tr>
<tr>
<td>- Talent &amp; strong work ethic of workforce</td>
<td>- Lack of plan to support IT industry</td>
</tr>
<tr>
<td>- Diversity of technology companies</td>
<td>- State insurance as a requirement for marketing to state government</td>
</tr>
<tr>
<td>- Multiple associations, industry organizations and both formal and informal professional groups (IFCs)</td>
<td>- Sliding US dollars weakens material import capability</td>
</tr>
<tr>
<td>- National and international demand for products and services</td>
<td></td>
</tr>
<tr>
<td>- Transportation infrastructure (particularly air travel and cargo)</td>
<td></td>
</tr>
<tr>
<td>- High speed data networks</td>
<td></td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td><strong>Threats</strong></td>
</tr>
<tr>
<td>- New industry segments that emerge through new technologies</td>
<td>- Other regional economies with greater visibility in IT industry, e.g. Silicon Valley and Austin, TX.</td>
</tr>
<tr>
<td>- Ability of state’s cluster-based economic development approach to support the growth of the IT industry</td>
<td>- Overseas advantages (e.g. lower foreign labor costs, better infrastructure and global talent pool)</td>
</tr>
<tr>
<td>- Strong financial, biomedical, health-related, and bio-fuel industries will support growth and development of IT cluster</td>
<td>- Trend to outsourcing IT and resulting knowledge loss and potential loss of IT spin-offs</td>
</tr>
<tr>
<td>- Opportunity for technology &quot;intensive&quot; businesses to drive technology innovations and business growth</td>
<td>- Looming labor force shortage and changing skill requirements that are not met by MN educational marketplace</td>
</tr>
<tr>
<td></td>
<td>- Continuing trade and budget deficits adversely impact US economy</td>
</tr>
<tr>
<td></td>
<td>- Trade restrictions/tariffs and taxation on foreign sourced income.</td>
</tr>
</tbody>
</table>
Recommendations

Government can assist clusters by helping to provide factors of production (e.g., public goods such as education, roads, water and sewer systems) and address issues that impede cluster growth through policies and other means. Opportunities for public investment are to:

- **Increase access to capital** - some options include government grants, low-interest loans, investment guarantees to venture capital firms that invest in mid-stage companies based in the state, and equity investment credits for investors via private placement securities (e.g. Commonwealth of Pennsylvania’s $320 million capital investment fund).

- **Provide research and development (R&D) support** - some possible approaches are to foster collaborative work that can cause big technology breakthroughs, hatch start-up companies to commercialize such breakthroughs, and provide a ready source of engineering talent; provide firms with testing and technical expertise, provide space, mentoring, consulting, R&D support/incubators in software, microchips, telecommunications, and other technology businesses. (e.g., Ohio’s 10-year, $500 million R&D investment match pool or administer an open-source website for computer and IT-related issues and solutions. Consider setting up membership fees to finance site.

- **Ensure a qualified and available workforce** - maintaining our reputation as a state with a high-quality workforce and strong work ethic will require a coordinated and multi-pronged approach by businesses, educators, parents, and economic and workforce development leaders. It is clear that the promising jobs of the future require strong science, technology, engineering, and math (STEM) skills. Therefore, our public education system (P-16) needs to find a way to ensure that students graduate with the STEM skills and knowledge needed to prepare them for high-tech jobs of the future. We also need to have a more deliberate strategy for ensuring that all students enter the workforce with the softskills needed to succeed and advance in their careers. Moreover, the rapid pace of technology change requires businesses and individuals to continually update their skills through customized and individual training options. Minnesota’s aging workforce, pending “Boomer retirements, growing gap between minority and Caucasian student performance and graduation rates, and low rate of state immigration present a challenge to the state’s ability to provide enough future workers with the right skills needed by the computer-IT cluster. Minnesota’s projected slower workforce growth makes it important for the state to be an early adopter of technology as a means of increasing worker productivity. Greater flexibility in work arrangements (e.g., schedule, location, duties, etc.) is another means for addressing possible skill shortages.

- **Adopt supportive policies** - favorable public policy can be a key driver and communicate a state’s commitment to a cluster, thus providing long-term stability to investors. Some examples of supportive policies are procurement policies, setting of standards that favor the industry cluster, tax incentives (tax breaks and relocation assistance) or targeted exemptions, removing regulatory barriers, hiring legislative analysts and commissioning a report to identify key regulatory obstacles and proposals to address them.

- **Establish a state cluster vision** - do not underestimate the power of a clear and compelling vision from political and community leaders to promote and align cluster development activities. A well developed vision statement can also develop and promote our national or regional leadership in this area.
The table below summarizes findings and provides recommendations for public support of the computer-IT cluster. Findings and recommendations with the greatest opportunities for DEED action are highlighted in **bold italic**.

<table>
<thead>
<tr>
<th>Findings (S.W.O.T Analysis)</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor (Input) Condition Findings:</strong></td>
<td><strong>Work with industry and education to close gap between supply and demand for software engineers and technicians.</strong></td>
</tr>
<tr>
<td>1. Workforce talent and strong work ethic are key to why industries have started and stayed in Minnesota.</td>
<td><strong>Promote Minnesota Jobs Skills Partnership (MJSP) program to IT industry.</strong></td>
</tr>
<tr>
<td>2. Gap between supply and demand for software engineers and technicians.</td>
<td><strong>Increase STEM literacy.</strong></td>
</tr>
<tr>
<td>3. Rapid technology change means changes in high-tech workforce skills needed by cluster employers</td>
<td><strong>Clarify IT skills and competencies for K-12 and higher education.</strong></td>
</tr>
<tr>
<td>4. Many non-computer/IT occupations require workers to have high levels of technology literacy.</td>
<td><strong>Support development and growth of small core businesses.</strong></td>
</tr>
<tr>
<td>5. About half of core industries have less than 10 employees and 3% of businesses account for about 38% of core industry employment)</td>
<td><strong>Maintain and upgrade technology infrastructure to ensure competitive position.</strong></td>
</tr>
<tr>
<td>6. Technology (e.g., cable) infrastructure is critical to the clusters ability to develop and be globally competitive</td>
<td><strong>Investigate need for capital to grow smaller core industries into medium sized businesses.</strong></td>
</tr>
<tr>
<td>7. Electronic components can be purchased and easily transported from China or India, so are not a value added component of the core industry.</td>
<td></td>
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</table>

| Firm Strategy & Rivalry Findings: | **Support Customized Training and efforts to expedite content development.** |
| 8. Projected flat to declining job growth for core cluster over next 10 years. | **Establish an IT Industry Specialist position at DEED.** |
| 9. Rapid change in industry skills needed and skill gaps has resulted in many businesses internalizing training functions. | **Have DEED BSS specialize by key regional industry groups.** |
| 10. Increased R&D is needed to maintain and grow core cluster. Difficulty for smaller and medium-sized core businesses to finance R&D investments. | **Investigate methods to increase R&D support by the University of MN and MnSCU. Consider establishing an equity investment tax credit for investors in IT R&D, providing tax incentive for core industry R&D investments; establish a investment match pool fund similar to Ohio state; explore potential for incubator partnerships between public higher education institutions and IT industry.** |
| 11. State insurance requirements limit the interest of IT security businesses from applying for state contracts. | **Review state contract insurance requirements to see if this condition can be removed for IT security contracts or contracts in general.** |
| 12. Simplify tax law for small core businesses. | **Simplify tax law for small core businesses.** |

| Demand Condition Findings: | **Promote the twin cities as a IT leader.** |
| 13. Minnesota does not have a clear economic development vision or marketing strategy for this cluster | **Market how DEED’s SEED, FIRST, and potential TARGET initiatives inter-relate and strengthen regional competitiveness.** |

| Related & Supporting Industry Findings: | **Evaluate opportunities to increase cross fertilization of ideas and technology across industry segments (role for DEED IT Industry Specialist).** |
| 14. Multiple associations, industry organizations and both formal and informal professional groups (IFCs); however, there appears to be a gap in IFCs representing the interests of smaller high tech | |
15. Larger and medium cluster businesses view MHTA as an effective industry advocate.
16. Some IFCs reported struggling for members.
17. There are opportunities for local suppliers to support larger core manufacturing businesses.

- Evaluate alignment between core industry support needs and IFC missions and outcomes and make recommendations based on findings (role for DEED IT Industry Specialist).
- Support Center for Strategic Information Technology and Security initiatives (Involvement of DEED staff in Apr '08 seminar).

1 Core industry (NAICS Code 334): Computer and electronic product manufacturing industry (i.e., computer and peripheral equipment manufacturing, communication equipment manufacturing, audio and video equipment manufacturing, semiconductor and electronic component manufacturing, navigational and control instruments manufacturing -- excluding electro-medical-- and magnetic and optical media manufacturing).
2 Secondary industries: Software publishers (NAICS 5112), software publishers (NAICS 5161), telecommunications (NAICS 517), internet service providers (NAICS 518), computer system design related services (NAICS 5415).
3 IT-intensive industries: financial/insurance, defense, medical devices, retail/services, information providers, and other industries that rely heavily on IT as part of their business.

Next Steps

The steps listed below provide a process for taking this report to the next stage of development. The process is modeled after the state of Pennsylvania, which has been very successful in their cluster initiatives. The key to Pennsylvania’s success and embodied in our recommended next steps is business leadership of cluster initiatives.

1) Conduct cluster analysis: a) define cluster, b) assess cluster strengths, weaknesses, opportunities, and threats, c) identify public support opportunities.
2) Identify and meet with key cluster leaders to share cluster analysis results and explore their interest in launching a joint, business-led effort to address cluster workforce and economic development priorities;
3) Convene cluster leaders and key public sector and community partners to prioritize cluster needs and define public support opportunities. Select top three cluster priorities and a cluster management team to define strategies, team roles, resource needs and progress/performance measures for each priority.
4) Have cluster management team or sub-teams prepare an action plan, with progress measures and resource needs, for each priority.
5) Obtain resources needed and implement action plan.
6) Provide periodic progress reports to stakeholders and assess the success of the actions to address cluster priorities. Also, report lessons learned throughout the project.
## Appendices

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<td>B</td>
<td>State’s Computer-IT Development Status by Economic Development Region</td>
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<td>D</td>
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<td>Industry Report (Secondary Industries) (<a href="http://www.economicmodeling.com">www.economicmodeling.com</a>)</td>
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<td>Career Cluster Report (<a href="http://www.economicmodeling.com">www.economicmodeling.com</a>)</td>
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APPENDIX A
COMPUTER-IT CLUSTER

Core Industry (334):
Hardware: Computers, Components, Peripherals, Semiconductors, Electronics

Secondary (5112, 5161, 517, 518-5415):
Software: Development and Pre-packaged Software, Open Source Technology
Services: Consulting, Systems Integration, Computer Programming Services, Data Preparation and Processing
Networking: Computer Networking, Cyber Security
Telecom: Satellite, Equipment, Services
Technology: GIS, GPS, Service-oriented architecture

Institutions for Collaboration (IFCs)
Trade Associations/Industry Groups:
Association of Information Technology Professionals (Northwest Chapter), The Collaborative, CTA, MN High Tech Association; MN Technology Inc, MN Nano, Tri-State Manufacturers Assoc., Informal Tech User Groups (e.g. Cisco, Microsoft or other platform specific applications)

Educational and Research Institutions:
MnSCU (Center for Strategic Information Technology & Security), University of MN (Institute of Technology, Center for Nanotechnology Application)

CLUSTER MAP

OTHER RELATED CLUSTERS/INDUSTRIES
Appendix B

State's Computer-IT Development Status by Economic Development Region

http://map.deed.state.mn.us/chameleon/DEED_dev2.phtml
Appendix C

Potential Institutions for Collaboration (IFC)

Trade Associations and Industry Groups

Association of Information Technology Professionals- Northwest Chapter: A not-for-profit professional association, the group is comprised of IT professionals in the Twin Cities. It strives to facilitate the sharing of IT knowledge and experience through conferences, publications, and idea exchange with industry peers at monthly meetings.

The Collaborative: It is the largest membership organization in Minnesota that serves growing and emerging companies, entrepreneurs, investors, and executives. The organization provides programs, relevant publications, and services for its membership.

The Communications Technology Association of Minnesota (CTA): Partnering with business, government, technology, education, and information resources, the CTA seeks to accelerate business strategy and technology innovation. Membership is made up of communications, information technology, knowledge management, and business professionals.

Internet Technical Group (ITG): A technical group of the Human Factors and Ergonomics Society, ITG is a collection of professionals from industry, academia, and government organizations who share an interest in Internet technologies and “related behavioral phenomena.” Its goal is to encourage coordinated collaboration of its membership and also enable the quick exchange of research, ideas, and technical innovations.

Minnesota High Tech Association: The group advocates on behalf of the state’s technology-based economy to promote growth, sustainability, and global competitiveness.

Minnesota Information Professional Society (MnIPS): A volunteer-run organization for IT professionals in the Twin Cities metro area, MnIPS seeks to further develop the IT profession and meet the needs of those in the field. The organization offers networking opportunities, joint meetings and alliances with peer professional groups, and educational training through monthly presentations and annual seminars.

Minnesota Technology, Inc: An organization that focuses on business consulting and services. It promotes economic growth for private firms and the state by working with technology and manufacturing companies to find competitive advantages.

MN Nano: This is a private sector led coalition of industry, higher educational institutions, government entities, service providers, and investors spanning the entire state. The group is focused on establishing Minnesota as a leader in nano-science and engineering through innovative nanotechnology application. It advocates increasing investment in nano-scale education, research, development, and commercialization. The areas of application include advanced materials, sensors, electronics, agriculture, food science, biotech, and biomedical technology.
**Tri-State Manufacturers Association:** An organization of manufacturers focused on growth and success of its members and their communities, it covers west-central Minnesota and eastern North Dakota and South Dakota. Member companies work in industries including, but not limited to, accounting services, welding, machine manufacturing, and wood products.

**Educational and Research Institutions**

**Center for Strategic Information Technology and Security (MnSCU):** Part of MnSCU’s Centers of Excellence, the organization operates as a joint venture between Metropolitan State University, Inver Hills Community College, and Minneapolis Community and Technical College. The mission is to create and maintain competitive information and communication systems by helping individuals and organizations acquire the necessary knowledge and skills.

**Minnesota State Colleges and University System (MnSCU):** Separate from the University of Minnesota, MnSCU comprises 32 colleges and universities, which includes 25 two-year colleges and 7 state universities. The member schools offer a wide variety of degrees in the areas of computer and information technologies.

**University of Minnesota (Twin Cities and satellite campuses):** The university system provides the skilled labor force necessary to support high tech companies in the state.

- **The Institute of Technology (University of Minnesota):** IT’s 12 departments and 24 research centers bring together the university’s programs in engineering, mining, architecture, and chemistry. Along with offering undergraduate and graduate degrees in many high-tech fields, the Twin Cities campus also has modern electrical engineering/computer science and biomedical engineering facilities utilized for education, research, and development.

- **Center for Nanotechnology Application (CNA) – University of Minnesota:** The CNA is involved in three major activities- Seeding interdisciplinary research projects in nano that will go on to attract external support; organizing workshops, speaker series, and short courses that bring together diverse sets of researchers; and disseminating information about current nano-related research to faculty groups, the University, and private industry.
## Appendix D Value Chain

### Value Chain
**Computer-Information Technology Cluster**

<table>
<thead>
<tr>
<th><strong>Infrastructure</strong></th>
<th><strong>Human Resource Management</strong></th>
<th><strong>Technology Development</strong></th>
<th><strong>Procurement</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings and grounds</td>
<td>In-house hiring and training of workforce</td>
<td>Computer-aided design and modeling</td>
<td>Procurement of materials, raw materials, including metals, plastics, etc., partially finished parts, components</td>
</tr>
<tr>
<td>- Accounting and Legal</td>
<td>- Teaching relationships with this workforce and professional services contract work</td>
<td>- In-house R&amp;D, R&amp;D projects with higher education institutions and other collaborative partners</td>
<td>- Raw material, partially finished, and supplies to produce products</td>
</tr>
</tbody>
</table>

### Support Activities

- Recruitment and training of specific skills
- Facility capabilities
- Raw materials, partially finished components, and supplies to produce products

### Inbound Logistics

| - - Recruit for talent - Specific skills |
| - - Facility capabilities |
| - - Raw materials, partially finished components, and supplies to produce products |

### Operations

| - - Facilitate Mgmt. |
| - - Operations |
| - - Board Communications, Managers |

### Outbound Logistics

| - - Storage, warehousing for critical components |
| - - Shipping (on-the-road and air) |

### Marketing & Sales

| - - Product sales |
| - - Web marketing & sales |
| - - Print advertising |
| - - Relations - community, public, higher education |
| - - Sales promotion |
| - - Group sales |
| - - Brand management |
| - - Licensed merchandise |
| - - Publications |
| - - Product tie-ins/bundling |

### Service

| - - Please, online, customer, service support |
Appendix E

CORE COMPUTER MANUFACTURING INDUSTRY REPORT

Appendix F

Secondary Computer-IT Industry Report

Appendix G

Information Technology Career Cluster Report
Appendix H

HIGHER EDUCATION CONCENTRATION

Computer/IT Programs in Minnesota Higher Education System

APPENDIX I

INFORMATION TECHNOLOGY/COMPUTER SECURITY BUSINESS INTERVIEWS

Diamond categories:

**Factor (Input) Conditions** (HR, Capital, Physical infrastructure, Scientific and technology infrastructure, Administrative systems (e.g., permitting and approvals), Availability of information, Available natural resources, public education and post secondary training assets).

**Related & Supporting Industries** (Access to suppliers and firms in related fields, presence of clusters)

**Demand Conditions** (Local and global demand)

**Firm Strategy & Rivalry** (Regs and norms that encourage investment and productivity, conditions for competition)

**Basic Industry Information:**

When was your company founded?

Where was your company founded?

What IT products do you sell or services do you provide?

Do you have operations out of the state? If “yes,” in what locations?

How many employees work for your company? If the company has operations outside of Minnesota, ask “About what percent of your company’s employees work in Minnesota?”

If not an IT business:

What aspects of your business are dependent on high tech (sales, marketing, R&D, etc)?

About what percent of total employees do these areas represent? If the company has operations outside of Minnesota ask “About what percent of your company’s IT-dependent employees work in Minnesota?”

What IT operations, such as headquarters, R&D, sales, manufacturing, are located in Minnesota?

**Geographic Considerations:**

Why did your company locate in the region?

What keeps your company in the region?

**Factor Inputs**

**Infrastructure:**

What types of infrastructure (roads, rail, air, utilities, telecommunication infrastructure) are important to your business and industry?

**Workforce:**

Have you had any challenges finding skilled workers?

If yes, what challenges have you had (skill challenges, motivation/soft skill challenges)?
If yes, what is your company doing to overcome workforce shortages or employee skill gaps?

**Training:**

Are local educational and training institutions fulfilling your new and incumbent workforce development needs?

If "yes," what are their strengths and weaknesses?
If "no," why not?

**Finances:**

Does your company have access to the capital needed to grow/expand? If no, ask "What challenges is your company facing in getting needed capital?"

**Related & Supporting Industries:**

Who are your key suppliers?

Where are they (key suppliers) located?

What businesses in your area do you work with or that rely on your IT products and services?

How could local and state government support the growth of your company?

Is your company a part of any industry organization or local chamber of commerce or other professional or economic development organization? If "yes," what organizations are you involved in?

**Demand Conditions:**

Who are your primary customers?

What percent of your demand is local, regional, national and international?

**Strategy and Rivalry:**

What percent of resources (i.e., employees or $) do you devote to IT research and development?

Where are your competitors located? (local, regional, national, international)?

What competitive pressures does your company face?

What government rules, laws and actions most limit the growth of your business?

What factors or attributes are most responsible for your company's success?

Where do you see new markets developing?

In ten years, where will your company be (or What will be the future for the IT industry and your company in ten years)?
Appendix J

References and Resources


Economic Modeling Specialists, Inc. www.economicmodeling.com (Subscription licensed to Minnesota State Colleges & Universities, see additional references in the industry and career cluster reports)


Appendix K

Acknowledgements - The Computer-IT Cluster Team would like to acknowledge the contributions of the following firms and individuals:

Ayrshire Electronics, Inc.

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Darrel Gubrud, President, MN Nano

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Don Lewis, Center for Strategic Information and Security, Metropolitan State University

Pradeep Kotamraju, Minnesota State Colleges and Universities

Bruce Steuernagel, Minnesota State Colleges and Universities