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Minnesota's Computer and Electronic Components Industry Group: A Review of Key Location Factors

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Table of Contents

Executive Summary 1

I. Introduction 3

II. Data Analysis 5

Employment and Employment Growth *5*

Industry Concentration *9*

Wages *11*

Detailed Industry Analyses *13*

III. Literature Review 27

Key Location Factors *27*

Geographical Clustering *28*

Spatial Division of Labor *29*

IV. Industry Interviews 31

Availability and Retention of Skilled Labor *31*

Industry Concentration and Business Community *32*

Taxes and Business Costs *32*

Transportation and Utilities *33*

Quality of Life *33*

Conclusion *33*

V. Minnesota's Competitive Assessment 35

Availability and Retention of Skilled Labor *36*

Industry Concentration and Business Community *38*

Taxes and Business Costs *39*

Transportation and Utilities *46*

Quality of life *47*

Conclusion *47*

Executive Summary

The computer and electronic components industry group is an important industry to Minnesota. Clients of the Analysis and Evaluation Office (AEO) of the Minnesota Department of Trade and Economic Development asked that AEO study the location issues faced by U.S. and Canadian businesses in the computer and electronic components industry group. This report summarizes Minnesota's relative strengths and weaknesses, and compares the state as an industry location with the Canadian provinces of Ontario and Quebec on the locational issues deemed most important in literature and by industry representatives.

The study consists of four sections: data analysis, a literature review, industry interviews and a competitive assessment of Minnesota's position relative to Ontario and Quebec. Each section is summarized below.

Data Analysis

The data indicates that Minnesota has a strong presence in the computer and electronic components industry group. This is especially true in the computer and data processing services industry (SIC 737) which saw employment increase by over 90 percent between 1988 and 1995. Although Minnesota's traditional computer industry, SIC 357, experienced a decrease in employment of almost 40 percent during the same period, Minnesota still ranked fourth in the United States in employment in this 3-digit industry. In addition, Minnesota's 1995 employment ranked highly in other industires including tenth in the electronic components and accessories industry (SIC 367).

Literature Review

A review of literature indicated that the following five categories are important to high technology companies like those found in the computer and electronic components industry group when considering expansion or relocation:

- Availability and Retention of Skilled Labor
- Industry Concentration and Business Community
- Taxes and Business Costs
- Transportation and Utilities
- Quality of Life

Results from the industry interviews and the competitive assessment sections of the report are analyzed in relation to the five categories.

Industry Interviews

Information obtained from interviews with Minnesota industry representatives was generally consistent with the literature findings. In particular, according to the interviewees, the availability and retention of skilled labor is the key location consideration for high technology industries like the computer and electronic components industry group.

Minnesota's Competitive Assessment

The results of the competitive assessment find that Minnesota's most obvious advantages in relation to Ontario and Quebec include Minnesota's large pool of skilled labor and its high concentration of computer and electronic components companies. Less distinct, yet still important advantages include Minnesota's central location in the United States and its educational system. Factors such as infrastructure, utilities and telecommunications, and quality of life are roughly equivalent among the locations.

The study also evaluated the taxes and business costs in Minnesota, Ontario and Quebec. Although variations in the definition of taxable income and apportionment of taxes make it difficult to compare taxes among the three areas, some distinctions are evident. For example, computer and electronic component businesses will likely have lower income taxes in Minnesota while payroll tax and sales tax liabilities will be similar.

Conclusion

Results from the data analysis, literature review, and industry interviews indicate that Minnesota is well positioned to compete with Ontario and Quebec in attracting businesses in the computer and electronic components industry group. Minnesota's long history of computer development and its position as one of several smaller computer and electronic components industry clusters in the nation have generated a foundation of skilled labor that businesses can tap into as they move, expand or relocate in the state.

Therefore, when targeting computer and electronic component industry group businesses, emphasis should be placed on Minnesota's large pool of skilled labor and the significant industry presence.

I. Introduction

The Department of Trade and Economic Development (DTED) has conducted several studies to better understand the state's manufacturing sector which enables the department to more effectively target economic development activities. Target industries for economic development efforts should have a significant impact on the state's economy. The most attractive target industries for Minnesota will have a high level of state employment, will be growing, pay high wages, and have a high employment concentration in the state relative to the nation (location quotient) which suggests the state offers competitive advantage for the industry.

This study expands on those analyses and closely examines one targeted industry group — the computer and electronic components industry group. Specifically, this study identifies the key location factors important to decision makers in the computer and electronic components industry group when they consider expanding or relocating, and provides a preliminary overview of Minnesota's position on these factors relative to the Canadian provinces of Ontario and Quebec. For this study, the computer and electronic components industry group includes the following Standard Industrial Classification (SIC) 3-digit industries:

- 357 Computer and Office Equipment
- 362 Electrical Industrial Apparatus
- 364 Electric Lighting and Wiring Equipment
- 366 Communications Equipment
- 367 Electronic Components and Accessories
- 737 Computer and Data Processing Services

The computer and electronic components industry group has a long and productive history in Minnesota dating back to World War II and includes prestigious industry names like IBM Corporation, Control Data Corp., and Cray Research. This aggregated industry group is representative of "high technology" industries which have been called the most important sources of strategically transformative products and processes in the U.S. economy.[1] Technical innovations produced by the computer and electronic components industry group can potentially alter an economy's mix of firms, industries, and jobs.

This study uses comparative data analysis to determine the current status of the industry group in Minnesota, a literature review to identify the location factors generally considered important to the industry group, and interviews with industry representatives to identify issues important when firms expand or relocate. The final section provides a preliminary discussion and broad overview of Minnesota's position relative to Quebec and Ontario using the key location factors identified. The effectiveness of the comparison on the factors varies considerably due to data availability which may result, in part, from the relative size of the computer and electronic components industry group in each location.

1 Luker, William Jr., and Donald Lyons. "Employment shifts in high technology industries 1988-96," *Monthly Labor Review*, U.S. Department of Labor, June 1997.

II. Data Analysis

It is important to understand Minnesota's computer and electronic components industry group to effectively compare Minnesota to other areas. This section examines the computer and electronic components industry group in Minnesota including employment levels, employment growth, industry concentration, wages, and the number of establishments. A general overview of the computer and electronic components industry group will be presented followed by specific information for each of the six individual 3-digit industries.

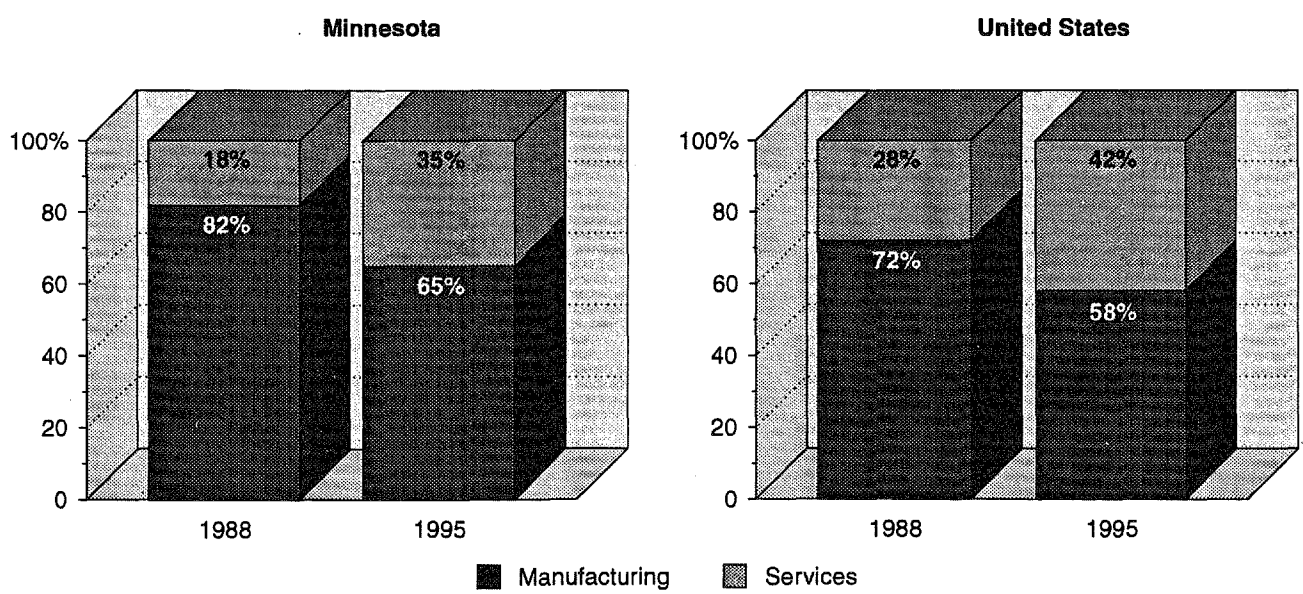
Employment and Employment Growth

The computer and electronic components industry group experienced a significant employment shift since 1988 with the service-oriented component increasing its presence relative to the manufacturing component as measured by employment levels. Five 3-digit industries constitute the manufacturing component of the industry group compared to only one 3-digit industry, the computer programming, data processing services sector (SIC 737) in the service component.

Figure 1 shows that the employment share accounted for by Minnesota's manufacturing component of the computer and electronic components industry group declined from 82 percent in 1988 to 65 percent in 1995. Conversely, Minnesota's services component of the industry group increased from 18 percent to 35 percent during the same period. Figure 1 also shows that the nation experienced a similar trend with the service component increasing from 28 percent of total industry group employment in 1988 to 42 percent in 1995.

Figure 1 also shows that the manufacturing component of the industry group continues to comprise a larger percentage of both Minnesota's and the nation's industry group.

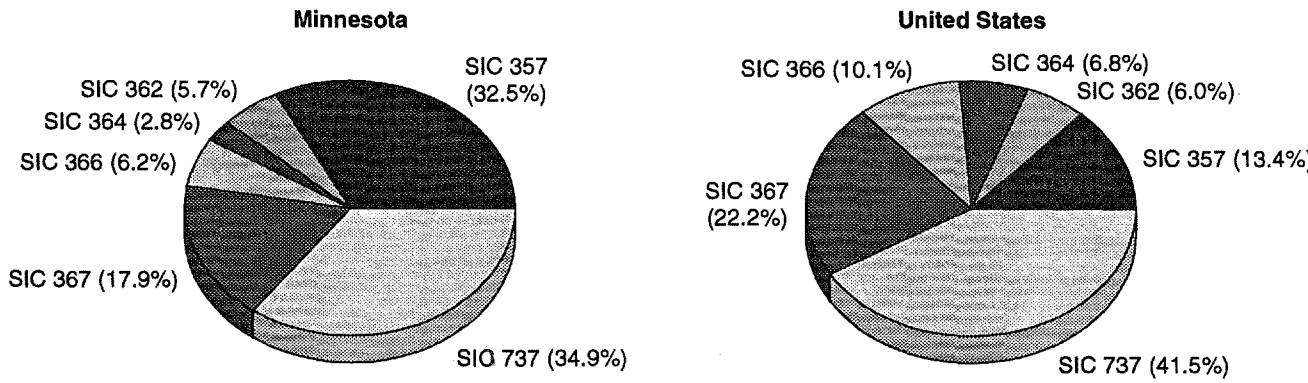
Figure 1: Components of the Computer and Electronic Components Industry Group As Measured by Employment, 1988 and 1995



Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

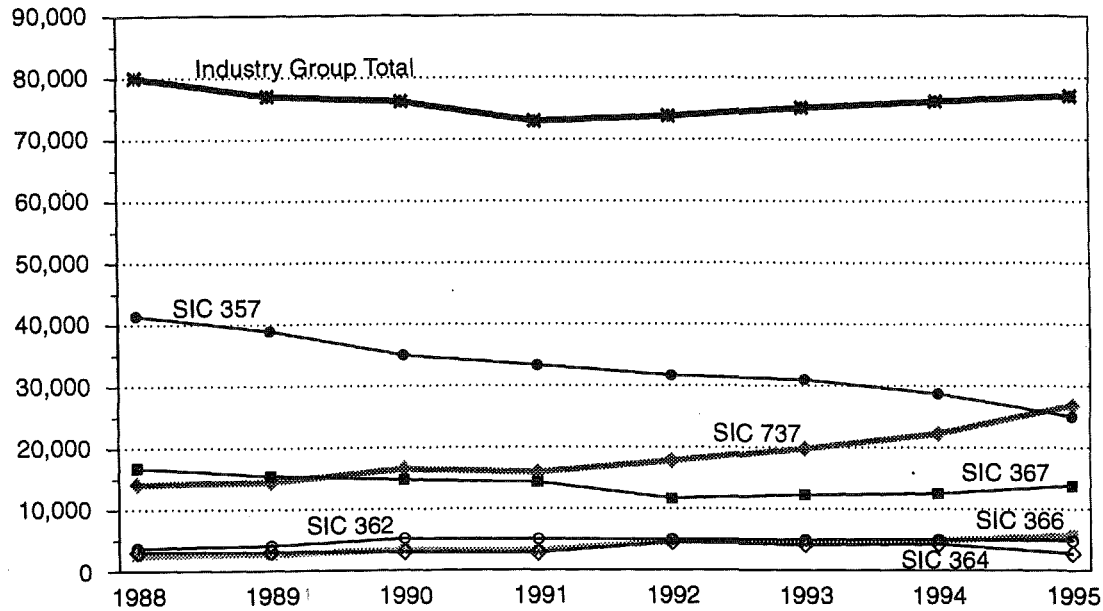
Figure 2 shows the employment distribution for the industry group for both Minnesota and the United States. As the figure shows, Minnesota's 1995 computer and electronic components industry group was dominated by the computer and electronic components industry (SIC 357), and the computer programming, data processing services industry (SIC 737), which employed approximately 33 percent and 35 percent of industry workers, respectively. The figure also shows that in both Minnesota and the United States, SIC 737 accounted for the largest percentage of industry group employment in 1995.

Figure 2: Employment Distribution for Computer and Electronic Components Industry Group, 1995



Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Figure 3: Number of Minnesota Employees By Industry, 1988-1995



Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 1: Employment and Employment Change in Minnesota's and U.S.'s Computer and Electronic Components Industry Group, 1988 to 1995

	Number of Employees in Minnesota		*Percent Change 1988-1995*	
SIC Code	*1988*	*1995*	*Minnesota*	*United States*
357	41,417	25,023	-39.6%	-24.8%
362	3,188	4,390	37.7	-12.7
364	2,531	2,182	-13.8	-10.2
366	2,043	4,806	135.2	-3.6
367	16,757	13,795	-17.7	-6.2
737	14,093	26,854	90.6	63.7
Total	**80,029**	**77,050**	**-3.7**	**9.0**

Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Despite a decline in overall industry group employment of almost 4 percent from 1988 to 1995, Minnesota's computer and electronic components industry group ranked twelfth in the nation for number of workers in 1995. As shown in Figure 3, employment levels for the six individual 3-digit industries showed variation during the period, however, total industry group employment remained relatively stable.

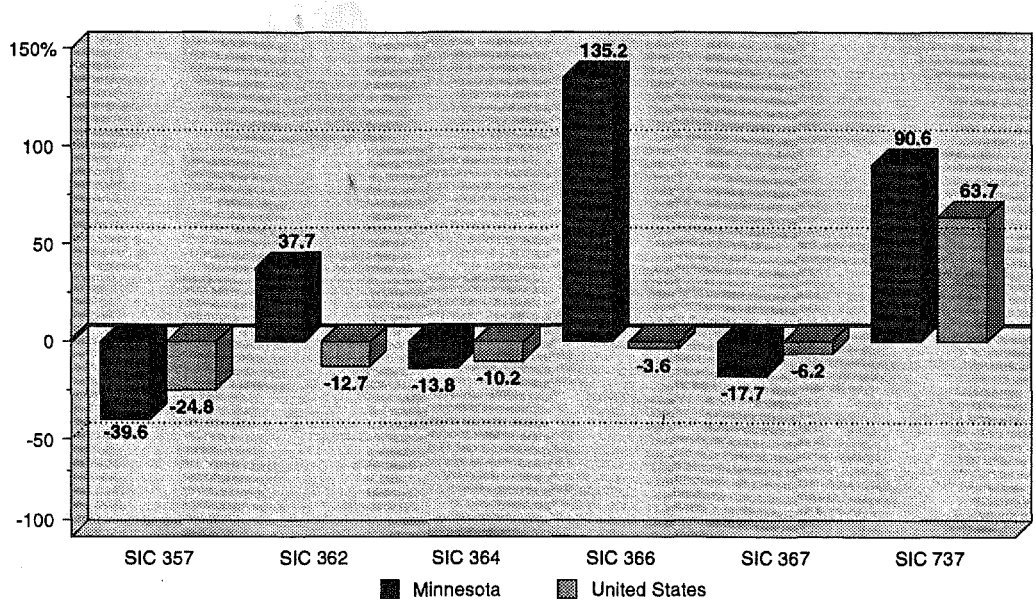
Table 1 shows that Minnesota's computer and electronic components industry group employed 77,050 people in 1995, an approximate 4 percent decline since 1988. Nationally, employment in the industry group increased by nearly 9 percent. Although both the nation and Minnesota experienced significant employment declines in the computer and office equipment industry (SIC 357), much of the decrease was offset by increases

in other industries. For example, the nation's increase was driven mainly by an employment increase of nearly 64 percent (421,900 workers) in the computer and data processing services industry (SIC 737). Minnesota's growth in employment in SIC 737 was nearly 91 percent, exceeding the national growth rate by nearly 50 percent.

Table 1 also shows that Minnesota experienced high percentage increases in employment in the electrical industrial apparatus industry (SIC 362) and the communication equipment industry (SIC 366). Overall, Minnesota experienced a decline in employment in three of the six 3-digit industries compared to a decline in employment in five of the six 3-digit industries nationally. Figure 4 shows the relative employment declines and increases of the six 3-digit industries from 1988 to 1995 for Minnesota and the United States.

A more detailed analyses of employment changes within each of the six 3-digit industries is presented in the *Detailed Industry Analyses* section on page 13.

Figure 4: Percent Change in Minnesota's and the U.S.'s Employment for the Computer and Electronic Components Industry Group, 1988 to 1995



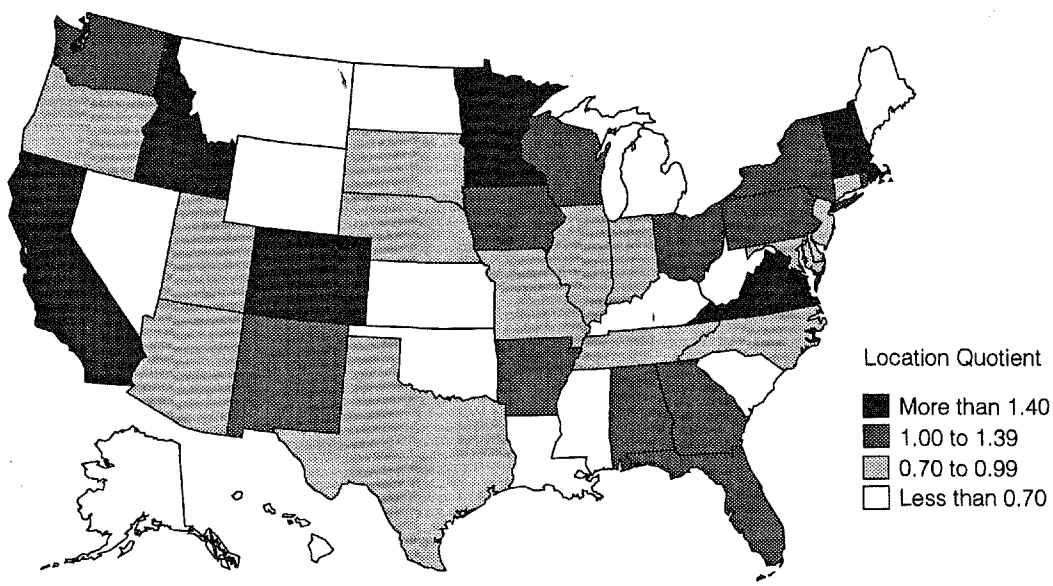
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Industry Concentration

Industry concentration is one indicator of an industry's strength in a geographic area, possibly suggesting a competitive advantage exists. Measures of industry concentration are commonly referred to as location quotients.[2] Concentrated industries are industries in which local share are larger than their shares in the U.S. industrial base. Location quotients greater than one indicate that the industry has an above-average employment concentration in the state and that products or services are likely exported to areas outside the state.

With a location quotient of 1.44, Minnesota's computer and electronic components industry group is about 44 percent more concentrated than the national average. Moreover, Minnesota is only one of eight states with location quotients greater than 1.40 for the industry group. Figure 5 shows location quotient ranges for the 50 states.

Figure 5: State Location Quotients for the Computer and Electronic Components Industry Group, 1995



Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

2 Location quotients are calculated by dividing the local share of an industry with the industry's share in the U.S. industrial base.

Table 2: Minnesota's Computer and Electronic Components Industry Group Location Quotients, 1988 and 1995

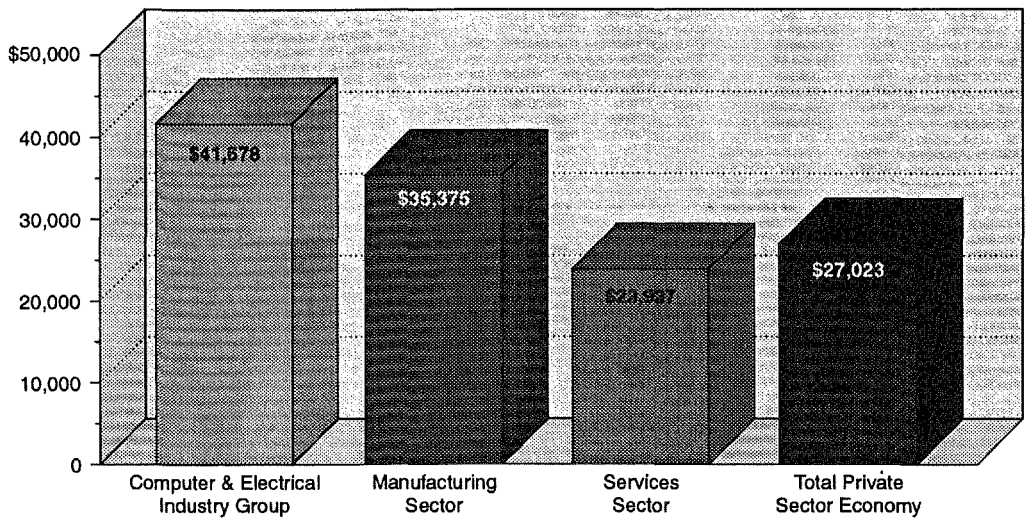
SIC Code	*1988*	*1995*
357	4.64	3.48
362	0.92	1.36
364	0.66	0.60
366	0.39	0.89
367	1.41	1.16
737	1.11	1.21
Industry Group Total	**1.73**	**1.44**

Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

As Table 2 shows, the location quotient within the industry group varied considerably from the industry group's total location quotient of 1.44. In fact, the high location quotient of the industry group is due principally to a very high quotient in SIC 357. Of the five other 3-digit industries, two were less concentrated in Minnesota than the national average and three were more concentrated in 1995.

Table 2 also shows that Minnesota's location quotient within the 3-digit industries have changed since 1988. Such fluctuations often occur as industry concentrations change when companies expand and contract in response to the dynamic market place. As industries become more and less concentrated, new resources and skills are developed to meet changing production demands. Overall, the industry concentration in Minnesota relative to the national average decreased from 1988 to 1995. Three of the 3-digit industries experienced an increase in concentration compared to the national average and three experienced a decrease during the time period.

Figure 6: Minnesota's Average Annual Salary for Selected Industrial Sectors, 1995



Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Wages

Wages paid by the computer and electronic components industry group are among the highest in the United States and reflect the high skill level demanded by the occupations. Figure 6 shows the average annual salary in 1995 for selected industrial sectors in Minnesota. In 1995, the average wage for Minnesota's workers in the computer and electronic components industry group was $41,678 which is approximately 54 percent higher than the average annual wage for all workers employed by the state's private sector.

As shown in Table 3, from 1988 to 1995 Minnesota's computer and electronic components industry group experienced an inflation-adjusted increase in wages of 5.5 percent compared to an approximate 12 percent increase nationally. Average wages for all Minnesota private sector employees increased by 3 percent during the same period.

Average wages in 1995 for each of the six 3-digit industries exceeded the state's average employee wage of $27,023. In addition, wage rates grew faster in Minnesota than in the United States in three of the six 3-digit industries between 1988 and 1995. More detailed analyses of the wages within each of the six 3-digit industries is presented in the *Detailed Industry Analyses* section.

Table 3: Average Wages and Percent Change in Minnesota and United States, 1988 and 1995

SIC Code	Minnesota Average Wages* 1988	Minnesota Average Wages* 1995	U.S. Average Wages* 1988	U.S. Average Wages* 1995	Percent Change 1988-1995 Minnesota	Percent Change 1988-1995 United States
357	$46,649	$47,848	$49,590	$53,907	2.6%	8.7%
362	31,085	35,529	33,876	33,212	14.3	-2.0
364	30,467	28,820	31,711	31,757	-5.4	0.1
366	27,483	37,814	42,068	45,991	37.6	9.3
367	28,174	31,240	35,980	40,209	10.9	11.8
737	37,274	44,033	44,478	50,996	18.1	14.7
Total	**39,509**	**41,678**	**41,148**	**46,100**	**5.5**	**12.0**

* All wages are in 1995 dollars.

Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 4: Average Hourly Wages for Production Workers in Minnesota and the United States, 1995

SIC Code	*Minnesota*	*United States*
357	$13.91	$13.27
362	13.41	11.59
364	15.62	12.08
366	12.50	14.84
367	10.61	11.38
Total	**12.56**	**12.19**

Source: *Annual Survey of Manufacturers 1995*, U.S. Department of Commerce.

Another measure of earnings in an industry is the average wage per production worker.[3] Average wage per production worker reflects the wages earned by workers actively engaged in the manufacturing process and excludes such administrative staff as clerical and managers. Table 4 shows average hourly wages for Minnesota's manufacturing production workers in the five 3-digit manufacturing industries included in the computer and electronic components industry group in 1995.

Table 4 shows that the average wages for Minnesota's production workers in the computer and electronic components industry group was slightly higher than the U.S. average — $12.56 per hour compared to $12.19. Moreover, the state's average wage per production worker is greater than the nation's in three of the five 3-digit industries. Although worker productivity is important to determining wage levels, the type of product produced by the industry is also a determinant.

Some occupations important to the computer and electronic industries group pay even higher wages. Table 5 shows the Twin Cities' average wages for selected computer and electronic occupational categories in 1996. On average, software and electrical engineers earned the highest wages with the more technical or assembly oriented workers earning lower average wages.

Table 5: Average Hourly Wages for Selected Occupational Categories in the Twin Cities Metropolitan Area, 1996

Occupation	*Average Hourly Wage*	*Beginning Hourly Wage*	*Experienced Hourly Wage*
Programmer Analysts	$20.43	$14.47	$26.15
Database Design Analysts	22.54	14.16	29.03
Computer Programmers	16.80	11.82	22.84
Software Engineers	24.39	17.31	29.54
Electrical and Electronic Engineers	24.40	14.49	32.12
Electrical and Electronic Engineering Technicians and Technologists	15.57	8.95	21.47
Electrical and Electronic Equipment Assemblers	9.96	6.65	13.03
Electromechanical Equipment Assemblers	10.46	8.55	12.89

Note Beginning hourly wages are defined as those in the 10th percentile while experienced hourly wage represents the 90th percentile. In other words, 10 percent of workers earn the beginning hourly wage or less, and 90 percent earn the experienced hourly wage or less.

Source: *Minnesota Salary Survey 1996*, Minnesota Department of Economic Security.

3 Production workers includes individuals engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping (but not delivering), maintenance, repair, janitorial and guard services, product development, auxiliary production for plant's own use, record keeping, and other services closely associated with these production operations at the establishment. Employees above the working-supervisor level are excluded.

Detailed Industry Analyses

As noted previously, the performances of the six 3-digit industries within the computer and electronic components industry group varied. This section analyzes the employment levels, employment growth, wages and wage growth, and industry concentrations of both the 3-digit industries and the 4-digit industries. It should be noted that while information is provided for the 4-digit industries, this information is often less extensive than 3-digit industry information. This is due to the suppression of data by the Bureau of Labor Statistics to prevent disclosure of information on individual firms.[4] However, detailed information for 4-digit industries is generally available for the United States as a whole. Lastly, all references to wage changes from 1988 to 1995 are based on inflation-adjusted wages using real 1995 dollars for both years.

Computer and Office Equipment (SIC 357)

In 1995, 91 establishments employed 25,023 workers in Minnesota's computer and office equipment industry (SIC 357). Examples of Minnesota companies classified in this 3-digit industry include Ceridian Corp., Computing Devices International, Cray Research, and Innovex Inc. which produce such items as electronic computer equipment, disk drives, storage units, optical storage devices, terminals, and office machines. In 1995, Minnesota's SIC 357 had the greatest number of employees among all of Minnesota's 3-digit manufacturing industries and the fourth highest level of employment for SIC 357 in the nation.

Although this 3-digit industry experienced a decrease in employment in the state of nearly 40 percent between 1988 to 1995, Minnesota was not alone. Eight of the top ten employment states in this 3-digit industry experienced declines in employment during this period and the United States experienced a decrease of nearly 25 percent. Table 6 shows the employment and changes in employment from 1988 to 1995, and location quotients for the top ten employment states in SIC 357 in 1995.

Table 6: Employment, Change in Employment, and Location Quotient for Top Ten Employment States in SIC 357

State	1995 Employment	Change in Employment (1988 to 1995)	1995 Location Quotient
United States	349,978	-24.8%	—
California	84,700	-8.4	2.19
Texas	31,097	40.5	1.33
Massachusetts	25,944	-52.0	2.83
Minnesota	25,023	-39.6	3.49
New York	22,682	-52.9	0.97
North Carolina	21,682	10.7	2.07
Colorado	16,758	-17.3	3.05
Ohio	9,479	-22.4	0.59
Pennsylvania	9,071	-33.4	0.57
Florida	8,768	-47.4	0.48

Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

4 The Bureau of Labor Statistics withholds data for any industry at a specific geographic level: (1) which consists of fewer than three establishments; or (2) in which a single establishment represents 80 percent or more if the industry's employment. Suppressed information is signified with a 'd' in the tables.

As shown in Table 6, California employed more workers in this 3-digit industry than any other state and Texas had the highest growth rate of the top ten employment states. Texas' growth was driven by employment increases in a range of personal computer makers, most notably Dell Computer Corp. and Compaq Computer Corp. Table 7 shows that Minnesota's decline in employment was driven by a decline of over 55 percent (a loss of 18,389 workers) in the electronic computers industry (SIC 3571) and a decline of 45 percent (a loss of 2,049 workers) in the other computer equipment industry (SIC 3577). These decreases were partially offset by an increase of over 332 percent (a gain of 5,457 workers) in the computer storage devices industry (SIC 3572) during the same period. Minnesota's growth between 1988 and 1995 in SIC 3572 was ten times faster than the nation and was driven by growth in companies like Seagate Technology Inc. and Western Digital Corp. which specialize in the manufacture of such devices.

Table 7 also shows that the nation's 25 percent decline in employment was driven by decreases of 37 percent in SIC 3571, 25 percent in SIC 3578 and nearly 27 percent in SIC 3579 from 1988 to 1995. Decreases in military spending may explain some of the decline, especially as it relates to companies like Unisys Corp. which had large government contracts. Declines in military spending resulted in fewer contracts and may have transferred to a need for fewer employees.

Nationally, employment in the computer terminals industry (SIC 3575) increased by 10 percent and by approximately 32 percent in the computer storage devices industry (SIC 3572).

Minnesota's computer and office equipment industry's location quotient of 3.49 was the highest location quotient of the six 3-digit industries included in the industry group and reflects the significant concentration of the industry in Minnesota. Table 6 also shows that Minnesota had the highest location quotient among the top ten employment states in the SIC 357 industry. In fact, only South Dakota (6,722 workers) and New Hampshire (7,075 workers), two states with smaller economies than Minnesota, had higher location quotients in 1995.

The industry's location quotient results from a significant concentration within two 4-digit industries. Out of 14 states reporting employment in the computer storage devices industry (SIC 3572), Minnesota's location quotient of 8.55 was the second highest (only Colorado had a higher location quotient for this 4-digit industry). Minnesota's electronic computers industry (SIC 3571) had a location quotient of 3.81 indicating that Minnesota has a comparative advantage in this 4-digit industry compared to the national average. SIC 3579's location quotient of 0.51 was the lowest of the four 4-digit industries with available information (due to data privacy concerns specific data is not available for SIC 3575 and SIC 3578).

Table 7: Employment Summary for SIC 357, 1988 to 1995

SIC Code	Industry	Minnesota Employment 1988	Minnesota Employment 1995	Employment Change 1988 to 1995 Minnesota	Employment Change 1988 to 1995 United States
357	Computer and Electronic Components	41,417	25,023	-39.6%	-24.8%
3571	Electronic Computers	33,386	14,997	-55.1	-37.4
3572	Computer Storage Devices	1,643	7,100	332.1	31.5
3575	Computer Terminals	1,470	d	na	10.2
3577	Other Computer Equipment	4,553	2,504	-45.0	1.6
3578	Calculating and Accounting Machines, except electronic computers	d	d	na	-25.1
3579	Office Machines, not elsewhere classified	d	283	na	-26.8

Note: 'd' indicates that information was not disclosed and 'na' indicates that information was not available.
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 8: Wage Summary for SIC 357, 1988 to 1995

SIC Code	Industry	Minnesota Average Wage 1995	Minnesota Wage Change* 1988 to 1995	United States Average Wage 1995	United States Wage Change* 1988 to 1995
357	Computer and Electronic Components	$47,848	2.3%	$53,907	8.7%
3571	Electronic Computers	53,154	9.5	58,952	11.5
3572	Computer Storage Devices	40,256	3.3	52,489	30.3
3575	Computer Terminals	d	na	50,999	3.9
3577	Other Computer Equipment	39,574	8.7	45,270	1.3
3578	Calculating and Accounting Machines, except electronic computers	d	na	48,170	26.4
3579	Office Machines, not elsewhere classified	37,562	na	53,907	8.7

Note: 'd' indicates that information was not disclosed and 'na' indicates that information was not available.
* Changes in wages are inflation adjusted.
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

As shown in Table 8, Minnesota's workers in this 3-digit industry earned an average wage of $47,848 in 1995. This was the highest average wage of the six 3-digit industries included in the industry group and reflects an increase of 2.3 percent from 1988 to 1995 compared to an increase of 8.7 percent nationally. Minnesota's workers in SIC 357 earned wages approximately 77 percent higher than the average Minnesota employee in 1995.

The electronic computers industry's (SIC 3571) average wage of $53,154 was the highest average wage among the 4-digit industries and reflects an increase of 9.5 percent from 1988 to 1995. Minnesota workers in SIC 3577 also experienced an earnings increase of almost 9 percent during the same period and earned an average wage of $39,574 in 1995. Minnesota workers in SIC 3572 earned an average wage of $40,256 in 1995, an increase of 3.3 percent from 1988 while workers in SIC 3579 earned an average wage of $37,562 (due to data privacy, no 1988 wage information is available for this 4-digit industry).

Nationally, workers in SIC 357 earned an average wage of $53,907 in 1995. Among the 4-digit industries, workers in SIC 3571 earned the highest wage at $58,952 while workers in SIC 3579 earned the lowest average wage at $48,760. These wages represent increases of 11.5 percent and 3.9 percent from 1988 to 1995, respectively. The greatest wage increase for this 4-digit industry nationally was a 30.3 percent increase in wages for workers in SIC 3572.

Electrical Industrial Apparatus (SIC 362)

In 1995, Minnesota's 46 electrical industrial apparatus (SIC 362) manufacturing establishments employed 4,390 workers. Examples of Minnesota companies classified in this industry include Onan Corp., Rockwell International, and MTS Systems Corp. producing such items as electrical generators, servomotors, frequency converters, and invertors. From 1988 to 1995 Minnesota's SIC 362 experienced an increase in employment of nearly 38 percent (a gain of 1,202 workers), compared to a decrease of 12.7 percent nationally.

As shown in Table 9, Minnesota's overall employment increase in SIC 362 was driven by an increase of approximately 53 percent (a gain of 1,134 workers) in the motors and generators industry (SIC 3621). Data privacy concerns resulted in the suppression of detailed information for this 3-digit industry in Minnesota in both 1988 and 1995 thus limiting analysis of employment growth between 1988 and 1995 to only one 4-digit industry (SIC 3621). Because the two 4-digit industries with data available employed 98 percent of the industry's workers it is clear that the remaining 4-digit industries had little impact and employed just 59 of the 4,390 industry workers, less than 2 percent of total employment.

Nationally, all four 4-digit industries experienced declines in employment from 1988 to 1995. SIC 3625's decline of 15 percent was the greatest, followed by SIC 3621's decrease of 13 percent.

In 1995, the electrical industrial apparatus industry had a location quotient of 1.36 indicating that the state is 36 percent more concentrated than the national average. Due to data privacy concerns, location quotients can be calculated for only two of the four 4-digit industries in 1995. SIC 3621 had a location quotient of 2.02 and SIC 3629 had a location quotient of 5.33.

Table 9: Employment Summary for SIC 362, 1988 to 1995

SIC Code	Industry	Minnesota Employment 1988	Minnesota Employment 1995	Employment Change 1988 to 1995 Minnesota	Employment Change 1988 to 1995 United States
362	Electrical Industrial Apparatus	3,188	4,390	37.7%	-12.7%
3621	Motors and Generators	2,132	3,266	53.2	-13.0
3624	Carbon and Graphite Products	d	d	na	-4.6
3625	Relays and Industrial Controls	d	d	na	-15.1
3629	Electrical Industrial Apparatus, not elsewhere classified	d	1,065	na	-1.9

Note: 'd' indicates that information was not disclosed and 'na' indicates that information was not available.
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 10: Wage Summary for SIC 362, 1988 to 1995

SIC Code	Industry	Minnesota Average Wage 1995	Minnesota Wage Change* 1988 to 1995	United States Average Wage 1995	United States Wage Change* 1988 to 1995
362	Electrical Industrial Apparatus	$35,529	14.3%	$33,212	-2.0%
3621	Motors and Generators	36,766	17.4	30,196	-6.6
3624	Carbon and Graphite Products	d	na	37,203	4.8
3625	Relays and Industrial Controls	31,644	na	36,912	3.8
3629	Electrical Industrial Apparatus, not elsewhere classified	d	na	31,179	-9.4

Note: 'd' indicates that information was not disclosed and 'na' indicates that information was not available.
* Changes in wages are inflation adjusted.
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 10 shows that Minnesota's average wage for workers in this industry was $35,529 in 1995, an increase of 14.3 percent from 1988 to 1995 compared to a decrease of 2 percent nationally. Minnesota workers in SIC 3621 earned an average wage of $36,766 in 1995, an increase of 17.4 percent compared to a decrease of 6.6 percent nationally. Moreover, on average, Minnesota's workers in SIC 3621 earned wages nearly 18 percent higher than the national average wage for this 4-digit industry in 1995. Minnesota's workers in SIC 3625 also earned higher average wages compared to the national average.

Electrical Lighting and Wiring Equipment (SIC 364)

In 1995, there were 2,182 workers in 32 establishments in Minnesota's electrical lighting and wiring equipment industry (SIC 364). Examples of Minnesota companies classified in this industry include Sheldahl Inc. and Energy Solutions International. Companies in this 3-digit industry produce such items as current-carrying devices and electric lighting equipment. In 1995, Minnesota's SIC 362 had the lowest number of employees among the 3-digit industries included in Minnesota's computer and electronic components industry group.

Table 11 shows that overall this 3-digit industry experienced a decrease in employment of nearly 14 percent from 1988 to 1995, compared to a decrease of approximately 10 percent for the United States. Due to data privacy concerns, information was suppressed for two of the seven 4-digit industries in 1995 and for four of the seven 4-digit industries in 1988. However, available data shows that of the five 4-digit industries where data is available, 1995 employment totaled 2,181 workers, one less than the overall employment of 2,182 for the industry that year. This indicates that one of the remaining two 4-digit industries (SIC 3641 and SIC 3647) had no workers and the other had only one worker in 1995.

Between 1988 and 1995, Minnesota's commercial, industrial, and institutional electric lighting fixtures industry (SIC 3646) added 355 new jobs to total 428, an increase of more than 486 percent; the residential electric lighting fixtures industry sector (SIC 3645) lost 300 workers to total 33, a decline of 90 percent; and the current-carrying wiring devices industry (SIC 3643) lost 175 jobs to total 1,462, a decrease of nearly 11 percent.

Nationally, three of the seven 4-digit industries experienced employment increases from 1988 to 1995. Employment in SIC 3646 increased by approximately 27 percent, employment in SIC 3648 increased by more than 19 percent, and employment in SIC 3644 increased by nearly 12 percent. The largest decreases in employment nationally were in SIC 3645 which declined by 28 percent and SIC 3643 which declined by almost 22 percent.

The industry's location quotient decreased from 0.66 in 1988 to 0.60 in 1995, indicating a slight decline in concentration compared to the national average. In 1995, SIC 3643 had the industry's highest location quotient of 1.15, while SIC 3647 and SIC 3645 had the lowest location quotients of 0.06 and 0.08, respectively. SIC 3644 and SIC 3646 location quotients of 0.65 and 0.82, respectively, were closer to the industry's average.

Table 11: Employment Summary for SIC 364, 1988 to 1995

SIC Code	Industry	Minnesota Employment 1988	Minnesota Employment 1995	Employment Change 1988 to 1995 Minnesota	Employment Change 1988 to 1995 United States
364	Electrical Industrial Lighting and Wiring Equipment	2,531	2,182	-13.8%	-10.2%
3641	Electric Lamp Bulbs and Tubes	d	d	na	-16.7
3643	Current-carrying Wiring Devices	1,637	1,462	-10.7	-21.5
3644	Noncurrent-carrying Wiring Devices	d	237	na	11.7
3645	Residential Electric Lighting Fixtures	333	33	-90.1	-28.2
3646	Commercial, Industrial, and Institutional Electric Lighting Fixtures	73	428	486.3	26.5
3647	Vehicular Lighting Equipment	d	d	na	-0.9
3648	Electrical Industrial Apparatus, Lighting Equipment, not elsewhere classified	d	21	na	19.1

Note: 'd' indicates that information was not disclosed and 'na' indicates that information was not available.
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 12: Wage Summary for SIC 364, 1988 to 1995

SIC Code	Industry	Minnesota Average Wage 1995	Minnesota Wage Change* 1988 to 1995	United States Average Wage 1995	United States Wage Change* 1988 to 1995
364	Electrical Industrial Lighting and Wiring Equipment	$28,820	-5.4%	$31,757	0.1%
3641	Electric Lamp Bulbs and Tubes	d	na	36,531	2.8
3643	Current-carrying Wiring Devices	29,257	-6.6	32,429	1.5
3644	Noncurrent-carrying Wiring Devices	30,385	na	29,964	-4.1
3645	Residential Electric Lighting Fixtures	16,486	-47.7	23,859	-1.9
3646	Commercial, Industrial and Institutional Electric Lighting Fixtures	27,550	5.5	29,158	2.1
3647	Vehicular Lighting Equipment	d	na	39,778	-3.7
3648	Electrical Industrial Apparatus, Lighting Equipment not elsewhere classified	26,267	na	28,523	-3.6

Note: 'd' indicates that information was not disclosed and 'na' indicates that information was not available.
* Changes in wages are inflation adjusted.
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

In 1995, Minnesota's workers in this 3-digit industry earned the lowest average wage of the six 3-digit industries included in the industry group. Table 12 shows that the average wage for workers in this 3-digit industry was $28,820, a decrease of 5.4 percent from 1988 to 1995 compared to an increase of 0.1 percent nationally. Minnesota's decrease in wages was driven, in part, by a decrease in average wages of nearly 48 percent for workers in the residential electric lighting fixtures industry sector (SIC 3645). SIC 3645's average wage of $16,486 was also the lowest average wage of all 4-digit industries included in Minnesota's computer and electronic components industry group.

Nationally, the average wage for the 3-digit industry was $31,757, a decrease of less than one percent. Wages in three of the seven 4-digit industries increased by 3 percent or less while wages in the remaining four 4-digit industries decreased by 2 to 4 percent.

Workers in SIC 3644 experienced the largest decline nationally with wages decreasing by approximately 4 percent from 1988 to 1995. The average wage of the nation's workers in SIC 3647 was $39,778, the highest average wage of the SIC 367 industry. Similar to Minnesota, workers in SIC 3645 earned the industry's lowest average wage at $23,859, a decrease of 2 percent from 1988 to 1995.

Communication Equipment (SIC 366)

In 1995, Minnesota's communication equipment industry (SIC 366) employed 4,806 workers in 48 establishments. Examples of Minnesota companies in this 3-digit industry include ADC Telecommunications and E.F. Johnson Co. and products produced include wire telephone and telegraph equipment, modems and other communications interface equipment. From 1988 to 1995 this 3-digit industry experienced an increase in employment of more than 135 percent (a gain of 2,763 jobs), compared to a decrease of approximately 4 percent nationally.

As shown in Table 13, in 1995 the telephone and telegraph apparatus industry (SIC 3661) employed 2,540 workers, the radio and television broadcasting and communication equipment industry (SIC 3663) employed 1,424 workers and the communication equipment, not elsewhere classified industry (SIC 3669) employed 843 workers.

Due to data privacy concerns, specific information for 1988 is available for only one of the three 4-digit industries included in SIC 366. That 4-digit industry, the radio and television broadcasting and communication equipment industry (SIC 3663), experienced a decline in employment of nearly 6 percent (a loss of 83 jobs) from 1988 to 1995. Since SIC 3663 lost jobs during the period and given that SIC 3669 employed only 843 in 1995, it is clear that the majority of the job growth for this 4-digit industry occurred in SIC 3661, which employed over half of the 4-digit industry's workers in 1995.

In 1995, this 3-digit industry had a location quotient of 0.86 compared to its location quotient of 0.39 in 1988, indicating that the 3-digit industry is becoming more concentrated in Minnesota relative to the United States. In 1995, SIC 3661 had a location quotient of 1.10, SIC 3663 had a location quotient of 0.56 and SIC 3669 had a location quotient of 1.49.

Table 13: Employment Summary for SIC 366, 1988 to 1995

SIC Code	Industry	Minnesota Employment 1988	Minnesota Employment 1995	Employment Change 1988 to 1995 Minnesota	Employment Change 1988 to 1995 United States
366	Communication Equipment	2,043	4,806	135.2%	-3.6%
3661	Telephone and Telegraph Apparatus	d	2,540	na	-18.4
3663	Radio and Television Broadcasting and Communication Equipment	1,507	1,424	-5.5	8.8
3669	Communication Equipment, not elsewhere classified	d	843	na	24.0

Note: 'd' indicates that information was not disclosed and 'na' indicates that information was not available.
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 14: Wage Summary for SIC 366, 1988 to 1995

SIC Code	Industry	Minnesota Average Wage 1995	Minnesota Wage Change* 1988 to 1995	United States Average Wage 1995	United States Wage Change* 1988 to 1995
366	Communication Equipment	$37,814	37.6%	$45,991	9.3%
3661	Telephone and Telegraph Apparatus	41,433	na	49,684	13.9
3663	Radio and Television Broadcasting and Communication Equipment	31,954	23.7	44,150	5.8
3669	Communication Equipment, not elsewhere classified	36,766	na	39,239	15.0

Note: 'd' indicates that information was not disclosed and 'na' indicates that information was not available.
* Changes in wages are inflation adjusted.
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 14 shows that the average wage for Minnesota's workers in this 3-digit industry was $37,814 in 1995, an increase of nearly 38 percent from 1988 to 1995 compared to an increase of approximately 9 percent nationally. Due to the suppression of 1988 data, wage growth rates can only be calculated for workers in SIC 3663 who earned an average wage nearly 24 percent higher in 1995 compared to 1988. In 1995, SIC 3661's average wage of $41,433 was the highest of the 4-digit industries included in this 3-digit industry.

Nationally, workers in SIC 366 earned average wages of $45,991 in 1995, about 18 percent higher than Minnesota. Average wages for the three 4-digit industries were also higher nationally than in Minnesota with the average wage for SIC 3663 about 28 percent higher.

Electronic Components and Accessories (SIC 367)

In 1995, 13,795 workers were employed by 163 establishments in Minnesota's electronic components and accessories industry (SIC 367). Examples of Minnesota companies classified in this industry include Cypress Semiconductor Inc., Unisys Corp., Precision Diversified Industries Inc., and Advance Circuits Inc. Industry products include printed circuit boards, semiconductors and related devices, electronic capacitors, resistors, connectors, and transformers. In 1995, Minnesota's employment in SIC 367 ranked tenth in the nation.

Table 15 shows that overall, this 3-digit industry experienced a decrease in employment of nearly 18 percent from 1988 to 1995 driven by decreases of approximately 71 percent (a loss of 287 jobs) and 74 percent (a loss of 6,098 jobs) in the electronic connectors industry (SIC 3678) and in the electronic components, not elsewhere classified industry (SIC 3679), respectively.

Conversely, the printed circuit boards industry (SIC 3672) and the electronic coils, transformers, and other inductors industry (SIC 3677) experienced increases of 73 percent (a gain of 3,600 jobs) and 64 percent (a gain of 332 jobs), respectively. The semiconductors and related devices industry (SIC 3674) employed 2,128 workers in 1995, an increase of nearly 12 percent from 1988.

Nationally, employment in SIC 367 decreased by more than 6 percent from 1988 to 1995 with six of the eight 4-digit industries experiencing a decrease in employment. The greatest decrease was in the electron tube industry (SIC 3671) which saw a decline in employment of more than 51 percent. Other decreases include a decline of 20 percent in the electronic coils, transformers, and other inductors industry (SIC 3677) and a decline of nearly 19 percent in the electronic resistors industry sector (SIC 3676). Only two 4-digit industries experienced increases in employment nationally: SIC 3672 increased by about 36 percent and SIC 3678 increased by approximately 22 percent.

The electronic components and accessories industry had a location quotient of 1.16 in 1995, indicating that the state's 3-digit industry is about 16 percent more concentrated than the national average. Minnesota's SIC 3672 and SIC 3677 were more concentrated than the 3-digit industry in general with location quotients of 3.53 and 2.22, respectively, in 1995. The location quotients for the three remaining 4-digit industries with data available in 1995 were 0.34, 0.44 and 0.79 indicating that these 4-digit industries were less concentrated than SIC 367 as a whole.

Table 15: Employment Summary for SIC 367, 1988 to 1995

SIC Code	Industry	Minnesota Employment 1988	Minnesota Employment 1995	Employment Change 1988 to 1995 Minnesota	Employment Change 1988 to 1995 United States
367	Electronic Components and Accessories	16,757	13,795	-17.7%	-6.2%
3671	Electron Tubes	628	d	na	-51.5
3672	Printed Circuit Boards	4,910	8,810	73.3	35.6
3674	Semiconductors and Related Devices	1,905	2,128	11.7	-10.3
3675	Electronic Capacitors	d	d	na	-11.6
3676	Electronic Resistors	d	d	na	-18.8
3677	Electronic Coils, Transformers, and Other Inductors	515	847	64.5	-20.5
3678	Electronic Connectors	406	119	-70.7	21.5
3679	Electronic Components, not elsewhere classified	8,288	2,190	-73.6	-6.2

Note: 'd' indicates that information was not disclosed and 'na' indicates that information was not available.
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 16: Wage Summary for SIC 367, 1988 to 1995

SIC Code	Industry	Minnesota Average Wage 1995	Minnesota Wage Change* 1988 to 1995	United States Average Wage 1995	United States Wage Change* 1988 to 1995
367	Electronic Components and Accessories	$31,240	10.9%	$40,209	11.8%
3671	Electron Tubes	d	na	40,884	13.2
3672	Printed Circuit Boards	30,609	10.4	29,503	-0.9
3674	Semiconductors and Related Devices	42,247	22.1	53,796	24.6
3675	Electronic Capacitors	d	na	27,237	4.8
3676	Electronic Resistors	d	na	25,839	3.0
3677	Electronic Coils, Transformers, and Other Inductors	21,797	-8.6	22,374	-2.3
3678	Electronic Connectors	35,215	24.0	31,222	-0.6
3679	Electronic Components, not elsewhere classified	26,448	-4.0	32,610	2.3

Note: 'd' indicates that information was not disclosed and 'na' indicates that information was not available.
* Changes in wages are inflation adjusted.
Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 16 shows that contrary to the decline in employment levels, average wages for Minnesota's workers in this 3-digit industry increased by almost 11 percent to $31,240 in 1995. This increase was mainly driven by wage increases of 22 percent and 24 percent in the semiconductor and related devices industry (SIC 3674) and in the electronic conductors industry (SIC 3678), respectively. In 1995, workers in SIC 3674 earned an average wage of $42,247 and workers in SIC 3678 earned an average wage of $35,215. The average wage of $21,797, a decrease of approximately 9 percent from 1988 to 1995, for workers in the electronic coils, transformers, and other inductors industry (SIC 3677) was the lowest average wage of the five 4-digit industries for which information was available.

Between 1988 and 1995 the nation's average wages for this 3-digit industry increased by approximately 12 percent to $40,209. SIC 3674's average wage of $53,796 was highest average wage of the 4-digit industries included in SIC 367 and reflects an increase of approximately 25 percent from 1998. Workers in SIC 3671 earned an average wage of $40,884, an increase of more than 13 percent from 1988 to 1995. Workers in three of the eight remaining 4-digit industries experienced wage increases of five percent or less while workers in the last three 4-digit industries experienced wage decreases of approximately 2 percent or less.

Computer Programming, Data Processing, and Other Computer Related Services (SIC 737)

In 1995, there were 26,854 workers in 2,258 establishments in Minnesota's computer programming, data processing, and other computer related services industry (SIC 737). Examples of Minnesota companies classified in this 3-digit industry include Analysts International, Best Consulting, Dataserv Inc., FBS Information Service Inc., and Lawson Software. These companies offer computer programming services like software design and analysis, and custom software and training. Some companies in this 3-digit industry also offer prepackaged software, processing services, system integration and network services, and leasing and rental of computer time.

This 3-digit industry's employment of nearly 27,000 workers in 1995 reflects a growth rate of over 90 percent since 1988. Table 17 shows that employment growth in this 3-digit industry was driven by increases of nearly 202 percent (a gain of 3,275 workers) in the computer programming industry (SIC 7371), an increase of over 355 percent (a gain of 4,424 workers) in the other computer related services industry (SIC 7379), and an increase of approximately 484 percent (a gain of 2,831 workers) in the computer integrated systems design industry (SIC 7373). Three 4-digit industries also experienced employment increases during the period while SIC 7375 and 7376 experienced decreases in employment of 66 percent and 58 percent, respectively, from 1988 to 1995.

Nationally, employment increased by nearly 64 percent from 1988 to 1995. This increase was driven by an increase of nearly 138 percent in SIC 7379, an increase of nearly 106 percent in SIC 7372, and an increase of approximately 102 percent in SIC 7371. Four other 4-digit industries also experienced increases in employment and two experienced decreases nationally.

The location quotient for this 3-digit industry was 1.21 in 1995 indicating that the industry was about 21 percent more concentrated in Minnesota than the national average. Among the 4-digit industries, SIC 7378's location quotient of 1.77 was the highest. SIC 7375 had the lowest location quotient of 0.42 with the remaining 4-digit industries having location quotients ranging from 0.87 to 1.61 in 1995.

Table 17: Employment Summary for SIC 737, 1988 to 1995

SIC Code	Industry	Minnesota Employment 1988	Minnesota Employment 1995	Employment Change 1988 to 1995 Minnesota	Employment Change 1988 to 1995 United States
737	Computer Programming, Data Processing, and Other Computer Related Services	14,093	26,854	90.6%	63.7%
7371	Computer Programming	1,624	4,899	201.7	102.2
7372	Prepackaged Software	1,248	3,181	154.9	105.6
7373	Computer Integrated Systems Design	585	3,416	483.9	40.4
7374	Computer Processing and Data Preparation and Processing Services	5,206	6,584	26.5	20.8
7375	Information Retrieval Services	1,425	486	-65.9	47.2
7376	Computer Facilities Management Services	1,588	664	-58.2	-2.6
7377	Computer Rental and Leasing	138	214	55.1	-19.5
7378	Computer Maintenance and Repair	1,034	1,741	68.4	56.6
7379	Computer Related Services, not elsewhere classified	1,245	5,669	355.3	137.7

Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

Table 18: Wage Summary for SIC 737, 1988 to 1995

SIC Code	Industry	Minnesota Average Wage 1995	Minnesota Wage Change* 1988 to 1995	United States Average Wage 1995	United States Wage Change* 1988 to 1995
737	Computer Programming, Data Processing, and Other Computer Related Services	$44,033	18.1%	$50,996	14.7%
7371	Computer Programming	48,876	7.6	53,187	9.5
7372	Prepackaged Software	44,582	8.2	64,464	20.9
7373	Computer Integrated Systems Design	48,317	12.0	55,144	12.2
7374	Computer Processing and Data Preparation and Processing Services	34,900	16.1	39,585	13.9
7375	Information Retrieval Services	31,625	9.6	42,902	11.8
7376	Computer Facilities Management Services	45,834	28.6	48,392	19.6
7377	Computer Rental and Leasing	72,663	10.4	54,982	-1.0
7378	Computer Maintenance and Repair	37,758	-30.0	38,378	-9.2
7379	Computer Related Services, not elsewhere classified	49,265	10.0	51,996	4.1

* Changes in wages are inflation adjusted.

Source: Unpublished data 1997, U.S. Department of Labor, Bureau of Labor Statistics.

As shown in Table 18, average wages for Minnesota's workers in this industry were $44,033 in 1995, an increase of approximately 18 percent from 1988. Minnesota's workers in the computer rental and leasing industry (SIC 7377) earned the highest wages among the 4-digit industries with average wages of $72,663 in 1995, an increase of about 10 percent from 1988. Workers in three other 4-digit industries earned average wages higher than the industry's average. The only 4-digit industry included in SIC 737 to experience a decline in real wages from 1988 to 1995 was the computer maintenance and repair industry (SIC 7378) which saw wages decrease by 30 percent from 1988 to 1995.

Nationally, workers in this 3-digit industry earned an average wage of $50,996, an increase of nearly 15 percent from 1988 to 1995. The 3-digit industry increase was driven, in part, by an approximate 20 percent increase in average wages for SIC 7376 and an approximate 21 percent increase in average wages for SIC 7372. The average wage of $64,464 for workers in SIC 7372 was the highest average wage of the 4-digit industries included in SIC 737 nationally.

III. Literature Review

Hundreds of articles have been written analyzing the factors that are important for industry site location. The literature review component of this study discusses findings from a review of articles relative to the key factors important to companies in the computer and electronic components industry group when they consider relocation, moving or expansion. Generally, industries included in the computer and electronic components industry group are classified as high technology,[5] although not all companies nor employees included under the six SIC codes used in this study are necessarily high technology.[6]

The main emphasis of this section is identification of location factors; however, geographical clustering and spatial division of labor represent two issues related to the identification of location factors that are often included in discussions of high technology industry. Empirical evidence shows that high technology companies cluster in a few areas of the country. Understanding the clustering process facilitates the identification of location factors for the high technology industry. Similarly, the growing tendency for high technology companies to split the research and development components of production from the manufacturing components impacts location decisions. Therefore, a discussion of both geographical clustering and spatial division of labor is included.

Key Location Factors

Studies indicate that high technology firms are drawn to factors that help attract and maintain a skilled work force. Specifically, surveys and case studies show that high technology firms tend to be "footloose" in terms of traditional locations factors (such as market access and transportation), and that location decisions are primarily driven by a firm's ability to obtain and retain individuals with specific technical, scientific, and engineering skills.[7]

For example, a Joint Economic Committee Staff Study (1982) on the "Location of High Technology Firms and Regional Economic Development," asked high technology respondents to indicate the significance of various factors on location decision both at the regional level and within a region. Eight of the most important regional location determinants and five of the most important within-region determinants related either directly or indirectly to the ability of the firm to attract and retain a highly skilled work force.[8]

5 High technology refers to a group of knowledge-intensive manufacturing (and services) industries actively engaged in development of new products and processes. Research and development are important to such industries and a high proportion of the workforce have professional and technical occupations (Lynn E. Browne, "Can High Tech Save the Great Lake States?" *New England Economic Review*, Nov./Dec. 1983).

6 High technology workers generally refers to worker in the following occupational categories: computer specialists, engineers, mathematical specialists, life and physical scientists, operations and systems analysts, and engineering and science technicians (Herzog, Schlottmann and Johnson 1986).

7 Herzog, Henry W. Jr. and Alan M. Schlottmann. "Metropolitan Dimensions of High Technology Location in the U.S.: Worker Mobility and Residence Choice," *Industry Location and Public Policy*, 1991.

8 Herzog, Henry W. Jr., Alan M. Schlottmann and Donald L. Johnson. "High Technology Jobs and Worker Mobility." *Journal of Regional Science*, Vol. 26, No. 3, 1986.

In addition to the availability and retention of skilled workers, research also indicates that high technology workers are more mobile overall than "other" workers, and place greater value on transportation access when considering relocations. High technology workers are distinguished from other workers by their preference for large metropolitan areas which may be related to the alternative employment needs of dual-career couples.[9]

In summary, besides the availability and retention of skilled workers, studies indicate that the following factors are important when determining the location of a high technology plant: transportation availability, educational resources, quality of life, market access, business climate, taxes, utilities, access to venture capital, and site and community characteristics. This study condenses these factors into the following groups:

- Availability and Retention of Skilled Labor
- Industry Concentration and Business Community
- Taxes and Business Costs
- Transportation and Utilities
- Quality of Life

A preliminary discussion and broad overview of Minnesota's relative strengths on each item and a comparison with Canada is presented in Section V.

Geographical Clustering

The literature indicates that the high technology industry is geographically clustered usually developing around a science base which is strong on knowledge specific to the clustering industries.[10] Consequently, high technology companies tend to cluster in locations resulting in some areas having little or no presence.[11] The largest concentrations of high technology industry in the United States are located in California's Silicon Valley, Boston's Highway 128, and the Research Triangle of North Carolina. Such clusters have generally been influenced by defense spending, proximity to research institutions, and preferences of company executives. Investment by state and local governments and other financing has also encouraged development. For example, the state of North Carolina and local counties have spent $35 million on facilities for Research Triangle Park and venture capital has contributed significantly to growth in the Silicon Valley area.

Whatever the initial circumstances that led to the siting of the new high technology complexes, their growth is undoubtedly attributable to and supported by agglomerative forces.[12] Such conditions generally provide an environment where new firms are frequently formed from employees "spinning off" of older companies to found competitors.[13]

Minnesota represents one of several smaller computer and electronic components industry clusters throughout the nation. Minnesota's initial concentration of computer businesses was driven by the preferences of company executives, with defense spending and government contracts contributing to the continued growth and

9 Herzog, Henry W. Jr. and Alan M. Schlottmann. "Metropolitan Dimensions of High Technology Location in the U.S.: Worker Mobility and Residence Choice," *Industry Location and Public Policy*, 1991.

10 Baptista, Rui. "Research Round Up: Industrial Clusters and Technological Innovation," *Business Strategy Review*, 1996, Vol. 7 No. 2 pp 59-64.

11 Peter Hall and Ann R. Markusen, "High Technology and Regional-Urban Policy" in Peter Hall and Ann Markusen, eds. Silicon Landscapes (Boston: Allen and Unwin, 1985).

12 Ibid.

13 Markusen, Ann. *Profit Cycles, Oligopoly, and Regional Development.* The MIT Press, Cambridge, Massachusetts, 1987.

expansion of the industry in the state. As World War II drew to a close, the U.S. Navy decided to continue funding research and development into electrical computing and cryptologic devices it had initially funded as part of the war effort. One of the initial recipients of this funding was Electronic Research Associates (ERA) in St. Paul, Minnesota, a company founded by engineers who had participated in the wartime Navy project. This group, led by William Norris and Seymour Cray, built some of the first special purpose computers for the military through the late 1940's and early 1950's.

During the 1960's, Control Data Corp., a descendant of ERA and a Minnesota-based company, used government contract work to fund research and developed commercial spin-offs from that work. In doing so, Control Data Corp. became the established leader in high performance, large-scale computers. Today, virtually all early mainframe computers can trace their roots through Minnesota. Since the 1940's, the computer and electronic components industry in Minnesota has grown to employ thousands of people and includes many of the most famous names in the industry: IBM Corp., Sperry Univac/Unisys, Honeywell, and Cray Research. Minnesota-based companies like Analysts International and Lawson Software can also trace their origins back to ERA.

Minnesota's economy benefits from the clustering of computer companies through the critical role played by established corporations in the stimulation of high technology by initiating new product development, allowing the initiation of venture projects, developing supply agreements, and other strategic alliances. As a result of the market shift toward microprocessor-based personal computers, Minnesota companies have suffered due to their heavy dependence on the mainframe business; however, Minnesota's strong industry presence in computer-related industries will sustain it as a major factor in the industry throughout the foreseeable future.

Spatial Division of Labor

Many studies of the location factors important to high technology industry fail to distinguish between the manufacturing aspects of high technology industries and the research and development sectors.[14] Thus, such studies may not address or recognize the idea that the high technology industry is creating a spatial division of labor in which firms segment the more technical aspects of manufacturing from those of production and assembly. Such firms may seek out labor markets where the type of skill and labor relations needed to support different elements of production are found.[15]

The uncoupling of production from research and development allows companies to move production to areas where labor costs, or other production costs, are lower. For example, Cypress Semiconductor Corp. and Seagate Technology maintain complex manufacturing operations in Minnesota but ship their high-value components to Southeast Asian countries for further labor-intensive processing and packaging. This segmentation of the manufacturing process is an important part of the industry's development and evolution.

Minnesota's well trained, highly educated workforce will likely enable the state to remain a bastion of research and development and a source of customized software development. However, the lower costs of labor in other areas will likely persist and encourage the transfer of certain low-skill, low-wage production and assembly processes to lower cost areas in other states and countries.

IV. Industry Interviews

The findings from the data analysis and literature review sections make it clear that Minnesota has a strong presence in the computer and electronic components industry. While data show trends, discussions with industry officials help reveal the reasons for Minnesota's performance and aids in understanding the decisions to move, expand or relocate. These interviews included representatives from both computer and electronic component manufacturing companies, as well as firms specializing in software development and were designed to identify those factors in which Minnesota may have a comparative advantage.

The information obtained from the interviews was generally consistent with the literature findings that the availability and retention of skilled labor is the key location consideration for high technology industries like the computer and electronic components industry. The five areas identified in Section III will be used as the basis for the presentation of the information from the interviews. These areas are: availability and retention of skilled labor, industry concentration and business community, taxes and business costs, transportation and utilities, and quality of life.

Availability and Retention of Skilled Labor

The interviews strongly supported the research findings discussed in Section III that labor issues are critically important to high technology industries like the computer and electronic components industry group. By the year 2000, Lawson Software will consolidate three metro locations into a single St. Paul facility. According to Peter Patton, Ph.D., Chief Technologist with Lawson Software, the most important factor in Lawson's decision to stay in Minnesota is access to a skilled labor pool. According to Dr. Patton, Lawson never considered moving out of Minnesota and views the large pool of skilled labor as one of Minnesota's most important assets related to the computer industry. In fact, as stated by Dr. Patton, "Lawson's growth is sustainable only because of alumni of Cray, Unisys, and Control Data in the area." Lawson has hired several former Cray Research, Unisys Corp., and Control Data Corp. individuals for senior management positions. Such individuals reflect the strong, skilled labor force available in the state for the computer industry.

The importance of Minnesota's skilled labor pool was supported by other industry officials. According to William Schlemmer, Director of Business Strategy for the Recording Heads Division of Seagate Technology, it is important to be located in an area that has a lot of engineering talent and a strong education base. Daniel Seebart, director of operations at Onan's Fridley, Minnesota plant, also mentioned the importance of Minnesota's skilled labor pool and high quality trade schools in the area. James Weir, vice president of finance at Cypress Semiconductor (Minnesota) Inc., stated that generally, the most important locational consideration for the semiconductor industry is the need for high caliber engineering talent.

A strong relationship between Minnesota's businesses and education facilities was mentioned as an important factor when doing business in Minnesota. Minnesota's manufacturing businesses rely on the state's technical colleges and universities for recruitment of the skilled workers. For example, Onan has worked with local vocational-technical schools to develop training programs that are designed to meet the changing needs of the electronics industry.

14 Maleki, Edward J. "Industrial Location and Corporate Organization in High Technology Industries." *Economic Geography* Vol. 61 1985.
15 Glasmeier, Amy K. "High-tech industries and the regional division of labor". *Industrial Relations*, v. 25 1986 pp. 197-211.

Industry Concentration and Business Community

Nearly all those interviewed indicated that the large number of high technology companies in the area is a strong asset for the state's computer and electronic components industry group. Mr. Schlemmer noted that the presence of a large number of high technology companies is important in making the location more populated with high technology individuals, which raises the overall business climate.

BEST Consulting also benefits from the large number of high technology firms in Minnesota. As a technical consulting firm, BEST provides services to other businesses and needs to be near companies that have technical requirements. According to James Swartzlander, manager with BEST Consulting, Minnesota's good business climate and the presence of many high technology companies that might utilize its services were the most important factors in BEST's decision to expand to Minnesota. Mr. Swartzlander also stated that Minnesota's tight labor market is slightly problematic and that BEST has had to increasingly look outside the area to recruit qualified individuals.

Several individuals interviewed stressed the importance of being near other high technology companies. Such proximity is beneficial for suppliers and recipients of goods and services related to the computer and electronic industries. Lawson often refers customers who want to modify Lawson's prepackaged software or who want more customized software packages to other local computer consulting firms.

For companies like Seagate and Cypress, it was also less costly to expand at their current locations than to undertake greenfield expansions which can be very expensive. Both Cypress and Seagate also benefited from the long history of the computer industry in Minnesota and entered the local markets through acquisitions or purchase of buildings from Control Data.

The availability of venture capital was cited by Lawson as an issue generally reviewed by companies in the software industry when considering moving, relocating or expanding. Dr. Patton stated that the Twin Cities area is a good place for people or companies seeking venture capital.

Taxes and Business Costs

Some individuals interviewed expressed concerns over the high cost of business in Minnesota, although they also recognized that the high costs were offset by the good education system and high quality of life, both of which are supported in part by business taxes. However, as James Weir of Cypress found, Minnesota's business costs are competitive with other states.

When Cypress considered expansion, Mr. Weir conducted a financial comparison between Minnesota, Texas, and Mississippi. According to Mr. Weir, Minnesota was lower in terms of cost largely due to the fact that Minnesota does not levy taxes on personal property.

William Schlemmer of Seagate also mentioned the high cost of labor in Minnesota, as did Dan Seebart of Onan. Both acknowledge that the high costs were related to high skills and Mr. Schlemmer also mentioned that Minnesota's labor costs for production personnel were higher than overseas markets.

Workers' compensation insurance was cited as one aspect of the high cost of doing business in Minnesota. Mr. Weir stated that the costs associated with workers compensation are higher at Cypresses' Minnesota plant than at its Texas plant, which has a higher incidence of worker injury.

Transportation and Utilities

The interviews also supported the idea that high technology companies generally produce items for which transportation costs are a small proportion of total costs. According to the individuals interviewed, the issue of transportation relates more to being near an airport to transport customers and employees to and from the worksite than to highways and rail transport.

Onan's representative also finds Minnesota's central location and large number of local suppliers and distributors to be cost-saving features. The good supply and distribution base enables companies like Onan to stay abreast of up-to-date developments and have easy access to new products.

James Weir also mentioned that Minnesota's energy costs were comparatively low and that manufacturing companies often require large amounts of energy and water during the production process.

Quality of Life

In each interview, the quality of life was mentioned as an important asset in terms of either attracting or retaining skilled workers. The cultural amenities and recreational opportunities available in the Twin Cities area and throughout the state are very important to the workers in these industries.

The interviews also indicated that Minnesota's high quality of life may become more important as competition for skilled workers intensifies. James Swartzlander observed that because of the tight labor market and low unemployment levels it is important to have a high quality of life to attract new workers. Mr. Swartzlander also stated that BEST Consulting likes the size of the Twin Cities area and considers the traffic congestion of larger metropolitan areas somewhat unappealing. Onan's representative stated that in their consideration to consolidate engineering and manufacturing they simply assumed that the engineers would not want to leave the Twin Cities. As he said, "it's sometimes hard to get skilled workers to move here, but once they are here they never want to leave." Many interviewees also stressed importance of the work ethic and overall high productivity of Minnesota's workforce.

It should be noted that each individual interviewed cited Minnesota's winter season as a possible deterrent to attracting skilled workers to the area.

Conclusion

Whether a computing consulting firm, a semiconductor manufacturer, or a maker of electronic components, the overall consensus of the computer and electronic components industry group representatives was that the depth and availability of skilled workers is Minnesota's greatest asset for the industry. The high concentration of computer and electronic component companies in the area was repeatedly mentioned as an important location factor for the industry. Other factors mentioned by those interviewed included the high quality of life in the area, the central location of the state within the U.S. market, and availability of venture capital. Section V below assesses Minnesota's position in the five location factors and provides a preliminary comparison between Minnesota and Canada.

V. Minnesota's Competitive Assessment

The computer and electronic components industry group is a dynamic global industry with potential for significant growth and innovation. In its drive to increase production and attract new computer and electronic components companies to the state, Minnesota is in direct competition with other states and countries throughout the world. Minnesota's ability to compete with and attract business from the Canadian provinces of Ontario and Quebec depends, in part, on how well Minnesota compares to Canada on the following five location factors identified in Section III:

- Availability and Retention of Skilled Labor
- Industry Concentration and Business Community
- Taxes and Business Costs
- Transportation and Utilities
- Quality of Life

The following provides a preliminary discussion and broad overview of Minnesota's position on each of the location factors and compares Minnesota to the Canadian provinces of Ontario and Quebec where data availability allows.[16]

A few cautionary notes must be made prior to undertaking the comparative assessment. Canada's national statistical agency, Statistics Canada, uses an industry code system similar to the standard industrial classification (SIC) code system used in the United States; however, the two systems are not identical, making precise industry comparisons difficult. Like the U.S. system, Canada's classification system groups industries into 2-digit codes which are divided into more detailed 3- and 4-digit industries. Similar to the United States, Canada's computer and electronic components industry group is a mixture of industries.

Canada's electrical and electronic products industry (SIC 33) and its computer and related services industry (SIC 772) most closely match the six 3-digit industries determined to represent Minnesota's computer and electronic components industry group.

While national level information is available for most 3-digit industries in Canada, provincial level information is only available at the 2-digit level. Consequently, for comparison purposes, data for Quebec and Ontario's SIC 77 is used with the understanding that this classification includes a wide array of business services like advertising, employment agencies, accounting and architecture in addition to computer and related services. To alleviate the difficulty associated with the limited availability of provincial level data, Table 19 shows Minnesota's employment for the computer and electronic components industry group (using SIC 737) and for the computer and electronic component and business services industries (using SIC 73). For more accurate comparisons, the latter employment category should be used, with the recognition that the industry includes employment for industries not in the computer and electronic components industry group.

16 The level of detail according to Canadian province varies substantially.

Table 19: Computer and Electronic Component Industry Group: Worker and Labor Market Summary

	Employment in 1995	*Employment Change 1988-1995*
Manufacturing Component		
Minnesota	50,196	23.9 percent decrease in employment (39.6 percent decrease for SIC 357 and 2.7 percent increase for non SIC 357)
Ontario	72,000	26.5 percent decrease in employment
Quebec	33,100	17.3 percent decrease in employment
Services Component		
Minnesota SIC 737	26,854	90.6 percent increase in employment
Minnesota SIC 73	132,469	56.2 percent increase in business services employment
Ontario SIC 77	282,200	6.6 percent increase in business services employment
Quebec SIC 77	144,400	1.2 percent increase in business services employment

Sources: Unpublished data from the Bureau of Labor Statistics; *Annual Estimates of Employment, Earnings and Hours 1984-1996*, Statistics Canada.

Availability and Retention of Skilled Labor

The literature review and industry interviews both reveal that availability of skilled labor is the most important location factor for the computer and electronic components industry group. Minnesota and most Canadian provinces are all highly-developed, industrialized areas, supported by high-skilled, well-educated work forces. With its concentration of computer personnel, Minnesota is well-positioned to compete with both Ontario and Quebec in the high technology arena. Efforts to attract computer and electronic firms should emphasize Minnesota's skilled and well-educated labor pool above other location factors. Specific factors related to the availability and retention of skilled workers including labor markets and education, are summarized in Tables 19 and 20. Each of these issues is discussed below.

Labor Market

Comparing labor characteristics of the computer and electronic components industry group of Minnesota, Ontario and Quebec is difficult due to variations in data availability and industry classifications. As noted above, Canada does not have a classification system identical to the SIC code system used in the United States. Canada's computer and related services (SIC 772) is more directly comparable to Minnesota SIC 737, however, because 3-digit information is not available for Canadian provinces, the broader category SIC 77 is used for provincial comparisons.

Table 19 shows 1995 employment and employment change for the three locations' manufacturing and service components of the computer and electronic components industry group. All three areas experienced employment declines in the manufacturing component and increases in the services component during the period. Minnesota's manufacturing component of the computer and electronic components industry group experienced a decline of nearly 24 percent compared to a 26.5 percent decline and 17.3 percent decline in Ontario and Quebec, respectively.

Employment in Minnesota's business services industry (SIC 73) increased by 56.2 percent between 1988 and 1995 compared to a 6.6 percent increase in Ontario and 1.2 percent increase in Quebec. Minnesota's business services industry employment was driven by an increase of nearly 91 percent in the computer and data processing services industry (SIC 737). As noted earlier, 3-digit information was not available for Ontario and Quebec.

As noted in Section II, Minnesota's computer and electronic components industry group employed 77,050 workers in 1995. More broadly, the Minnesota Department of Economic Security (MDES) estimates Minnesota's labor force totals 2.6 million, with 1.6 million of these people located in the Twin Cities metropolitan area. MDES also projects an increase in employment of nearly 60 percent for computer and mathematical scientists by the year 2005.

In 1995, Canada's computer and electronic components industry employed 750,300 workers — an approximate 6.7 percent decrease from 1988 to 1995. During this period, the manufacturing component of Canada's computer and electronics industry experienced a decrease in employment of approximately 24 percent, while employment in the services component increased by approximately 15.6 percent. Combined, Ontario and Quebec accounted for nearly 71 percent, 531,700 workers, of Canada's employment in SIC 33 and SIC 77.

In June 1997, Minnesota's unemployment rate was 3.6 percent, a record low level of unemployment for the month of June. Canada's unemployment rate was higher than Minnesota's, and there was significant variation in unemployment rates among Canada's provinces. For example, the June 1997 unemployment rate in Alberta was 5.6 percent, 8.5 percent in British Columbia, 6.8 percent in Manitoba, 8.5 percent in Ontario, 11.2 percent in Quebec, and 6.0 percent in Saskatchewan.

Minnesota's low unemployment rate indicates a highly competitive labor market and a strong economy, an observation substantiated by industry interviews. This may prove to be a disincentive for companies seeking highly skilled, technical labor, but also reflects an attractive overall economic setting.

Education

Although Minnesota has less enrollment in colleges and universities than Ontario, technical college enrollment is very similar. Table 20 provides a summary of the number of universities and enrollment levels for the three areas. Minnesota has 98 institutions of higher education, including 11 public four-year, 43 public two-year, 35 private four-year, and 9 private two-year institutions.

Table 20: Summary of Education Data

	Number of Colleges and Universities	*Enrollment in Colleges and Universities*	*Technical Enrollment*
Minnesota	98	124,388 in 1995	103,038 in 1995
Ontario	44	318,661 in 1996	136,128 in 1996
Quebec	142	493,730 in 1995	120,459 in 1995

Sources: Minnesota Higher Education Services Office, Ontario Ministry of Education and Training, and Quebec Ministry of Education.

According to the Minnesota Higher Education Services Office, in 1995 there were 124,388 students enrolled in Minnesota's colleges and universities and 103,038 enrolled in community and technical colleges. In 1995, the National Research Council ranked 15 of the University of Minnesota's graduate programs in the top 20 in the country. Graduates of the University of Minnesota's Institute of Technology have founded more than 1,000 companies including Minnesota-based *Fortune 500* companies like Control Data Corp, Medtronic Inc., and Cray Research. Minnesota also has the second highest graduation rate among all states. In 1993, 89 percent of the state's students who were in ninth grade in 1989 graduated, far above the national figure of 71 percent.

Each Canadian province assumes responsibility for higher education with each system reflecting the specific regional concerns and historical and cultural heritage. In 1993, an estimated 551,300 students in Canada were studying at the college level and 867,300 were at the university level.

In 1996, Ontario's 44 colleges and universities had 318,661 students enrolled. Quebec's 142 colleges and universities had 493,730 students enrolled in 1995. There were 136,128 students enrolled in Ontario technical schools in 1996 and 120,459 in Quebec's technical schools in 1995.

Industry Concentration and Business Community

Minnesota's strengths in the areas of industry concentration and general business community are competitive advantages for the state. The role of Minnesota as the business center of the Upper Midwest is demonstrated by the presence of many large corporations with significant operations in the state. Ford Motor Company, IBM Corp., Boise Cascade, and Unisys Corp. are just a few of the dozens of *Fortune 500* companies located in Minnesota. Additionally, 15 *Fortune 500* corporate headquarters are found in the state. Together, these companies employ thousands of Minnesotans.

The business leadership of the Twin Cities, whether involved in high technology manufacturing or service industries, has traditionally assumed its "corporate social responsibility" to contribute to the economic development of the area and to improve the quality of life in the Twin Cities area.[17] Minnesota's wealth of successful companies across a variety of industries is an indicator of its strong economy and dynamic healthy business environment. Minnesota is also home to hundreds of computer and electronic firms.

17 Millere, Roger and Marcel Cote. *Growing the Next Silicon Valley*, D.C. Heath and Company, 1987.

The Twin Cities is also home to a thriving venture capital environment. Venture capitalists seek investment opportunities in niches that have large growth potential but are presently too small to attract entries by large technology-based firms. According to an article in the May 27, 1996 issue of *Fortune* magazine, "there are few places on the globe where so much cash is chasing so many creative ideas." The article also stated that Minneapolis-St. Paul has more publicly traded companies than any other metropolitan area in the United States. According to the Price Waterhouse National Venture Capital survey released in May 1997, 20 Minnesota-based companies received $42.6 million during the first quarter of 1997. Software and information industries received $13.8 million and the computer and peripherals industry received $7 million.

Canada also has a sophisticated business community that includes specialized companies with high degrees of mechanization, computerization, and technology. A large part of Canada's manufacturing industry could be characterized as high technology, with regard to both the manufacturing process and products. The high technology industry is very strong in Toronto, Markham, Mississauga, and Kitchener/Waterloo. Ontario's electronics and electrical products industries produce a wide range of goods, from computers, to instrumentation controls, robots, and household appliances.

Canada is the eighth-largest trading nation among the industrialized market economies and an active partner in international investment. In 1995, approximately 55 percent of all imports for Canada's computer and electronics industry and over 82 percent of exports were to the United States. Ontario is Canada's leading manufacturing province, producing 52 percent of Canada's manufactured goods and 80 percent of its manufactured exports. Since most of the country's exports were to the United States, Canadian businesses may be interested in a U.S. facility to reduce production, shipping, and transportation costs.

Major computer hardware and peripheral vendor firms active in Canada include: Apple, Compaq Computer Corp., Convex Computer Canada, Ltd., Control Data Corp., Cray Research, Dell Computer Corp., Sun Microsystems of Canada, Inc., Texas Instruments, and Unisys Corp. Software developing firms and computer services companies in Canada include: Axion Spatial Imaging, CEL Software, Harrison Muirhead Systems Inc., INSTAR Corporation, and Myrias Computer Technologies Inc. A large percentage of Canada's software products companies are export oriented from their inception with the largest market being the United States. Minnesota is well-positioned to serve as a relocation or expansion point for Canadian companies that wish to establish a presence in the United States.

Taxes and Business Costs

The difficult task of determining the relative impact of taxes on a business' location decision is made even more problematic when the regions under consideration are in separate countries. The difficulty stems in part from variations in definition of taxable income, differences in apportionment of taxes, and the variety of tax rates used from city to city. Another complication is the fact that Canada provides universal health care coverage for their citizens which is generally financed through payroll taxes which are imbedded in the taxes paid by employers and employees. These important differences should be kept in mind when undertaking comparisons. The information provided in this study represents an overview of the taxes in each area. Actual taxes paid will depend on a variety of factors. The information included below is designed to serve as a guide to some of the individual and business taxes in Minnesota and Canada.

Personal Income Taxes

Minnesota's personal income tax generally conforms to the federal income tax with some exceptions. For example, the state adds non-Minnesota state and municipal bond expenses to taxpayer income while subtracting some dependent education expenses and the income of elderly and disabled, up to specified limits. In addition, unlike many states, Minnesota's income tax brackets are indexed. Indexing adjusts the tax brackets to prevent residents from being pushed into a higher rate bracket due to inflation. Table 21 shows Minnesota's and the United States' 1997 tax rates.

In Canada, a personal income tax is levied by federal and all provincial governments. Like the United States, the Canadian system differentiates between residents and non-residents of Canada. Non-residents are only subject to tax on their Canadian-source income. Dividends earned by residents are subject to special treatment to ensure that the distribution is not taxed twice. In addition, while three-quarters of capital gains are included as income, gains from the sale of a taxpayer's principal residence are entirely tax-free. Moreover, individuals in Canada are entitled to a $500,000 cumulative lifetime capital gains exemption. Table 22 shows the 1997 personal income tax rates for Canada.

Table 21: Minnesota and United States Personal Income Tax Rates (Joint), 1997

Minnesota		*United States*	
Taxable Income	*Tax Rate*	*Taxable Income*	*Tax Rate*
$1 - $24,140	6.0%	$0 - $41,200	15.0%
$24,141 - $95,920	8.0	$41,201 - $99,600	28.0
over $95,920	8.5	$99,601 - $151,750	31.0
		$151,751 - $271,050	36.0
		over $271,050	39.6

Sources: Minnesota Department of Revenue, U.S. Internal Revenue Service.

Table 22: Canadian Federal Personal Income Tax Rates, 1997

Taxable Income	*Tax Rate*
$0 - $6,455	0.0%
$6,456 - $29,590	17.0
$29.591 - $59,180	26.0
over $59,180	29.6

Source: *Tax Facts and Figures, 1997*, Coopers & Lybrand Canada.

Table 23: Provincial Personal Income Tax Rates as a Percentage of Federal Tax, 1997

Province	*Rate*	*Province*	*Rate*
Alberta	45.5%	Nova Scotia	58.5%
British Columbia	51.0	Ontario	48.0
Manitoba	52.0	Prince Edward Island	59.5
New Brunswick	63.0	Saskatchewan	50.0
Newfoundland	69.0	Yukon Territory	50.0
Northwest Territories	45.0		

Source: *Tax Facts and Figures, 1997*, Coopers & Lybrand Canada.

Table 24: Quebec Personal Income Tax Rates, 1997

Taxable Income	*Tax Rate*
$0 - $7,000	16.0%
$7,001 - $14,000	19.0
$14.001 - $23,000	21.0
$23,001 - $50,000	23.0
over $50,000	24.0

Source: *Tax Facts and Figures, 1997*, Coopers & Lybrand Canada.

For all provinces except Quebec, the provincial income tax is calculated as a percentage of federal income tax. Provincial rates varied between 45 percent and 69 percent in 1997. Some provinces also impose surtaxes on high amounts of provincial tax. Table 23 shows the provincial taxes for all provinces except Quebec.

Residents of Quebec are entitled to a federal tax abatement of 16.5% of basic federal tax (after deducting personal and dividend tax credits), but must pay Quebec income tax at the 1997 rates indicated in Table 24.

Table 25 shows the combined federal and provincial personal income tax rates by province.

These rates reflect the top marginal rate in each province and represent the rate of tax on the next dollar of income in the highest tax bracket. Quebec and Ontario rank third and fifth, respectively, in terms of combined federal and provincial personal income taxes in Canada.

The combined U.S. and Minnesota personal income tax rates are lower than the rates imposed by Ontario and Quebec, especially for middle and upper income earners. However, the treatment of capital gains and the use of tax credits by Canada may result in competitive Canadian personal income tax rates for some taxpayers.

Table 25: Combined Federal & Provincial Personal Income Tax Rates, 1997

Province	*Rate*	*Province*	*Rate*
Alberta	46.07%	Nova Scotia	49.98%
British Columbia	54.17	Ontario	51.78
Manitoba	50.40	Prince Edward Island	50.30
New Brunswick	51.05	Quebec	52.94
Newfoundland	53.33	Saskatchewan	51.94
Northwest Territories	44.37	Yukon Territory	46.55

Source: *Tax Facts and Figures, 1997*, Coopers & Lybrand Canada.

Corporate Income Taxes

Canada's provinces and territories levy taxes on corporate income that generally ranges from 9 to 17 percent. Federal tax rates in Canada were 22.1 percent for manufacturers and 29.1 percent for non-manufacturing companies in 1997. Unlike state taxes in the United States, provincial income taxes are not deductible in computing income for federal tax purposes in Canada. Canada also imposes a surtax on corporate income tax of 4 percent.

As shown in Table 26, Ontario's general corporate income rate for manufacturers was 13.5 percent and Quebec's was 8.9 percent in 1997. Minnesota's 1997 corporate income tax was 9.8 percent. In Minnesota, there is no tax on net value (capital value tax), and local governments may not levy additional income taxes. Also, a corporate income tax credit is allowed for expenses related to research and development. Businesses in Minnesota are also subject to federal corporate income taxes that are levied on a graduated scale that cannot exceed 35 percent.

Like businesses in other states, Minnesota businesses must determine what portion of their net income (i.e., taxable income) is attributable to Minnesota using a formula known as the apportionment formula. The formula weighs the company's property, payroll, and sales at the following weights: property and payroll each at 15 percent and sales at 70 percent. Minnesota's apportionment formula encourages sales outside the state and investment in property and employees by weighing the apportionment sales factor more heavily. More importantly, this apportionment formula benefits businesses with national and international markets, and significantly minimizes the corporate income that is taxable in Minnesota. The lower the taxable income, the lower the effective tax rate.

Table 26: Canadian Federal and Provincial Corporate Income Tax Rates, 1997

	Other Corporations		*Small Canadian Controlled Active Business Income*	
	Manufacturing	*Non-Manufacturing*	*Manufacturing*	*Non-Manufacturing*
Federal Rates	22.12%	29.12%	13.12%	13.12%
Alberta	14.50	15.50	6.00	6.00
British Columbia	16.50	16.50	9.00	9.00
Manitoba	17.00	17.00	9.00	9.00
Ontario	13.50	15.50	9.50	9.50
Quebec	8.90	8.90	5.75	5.75
Saskatchewan	17.00	17.00	8.00	8.00

Source: KPMG, Canada.

Table 27: Effective Corporate Income Tax Rates for Selected Canadian Provinces, 1995

Alberta	44.3%
British Columbia	45.3
Manitoba	45.8
Ontario	44.3
Quebec	37.7
Saskatchewan	38.8 - 45.8
Minnesota	41.4

Source: *North American Corporate Income Tax Comparison*, October 1995, Industry Canada.

In 1995, Industry Canada conducted a study of North American corporate income tax rates. According to the study, Minnesota's corporate income tax rate (including federal and state taxes) were similar to those of the selected provinces. The effective corporate income tax rates during 1995 for the selected Canadian provinces and Minnesota are detailed in Table 27.

The effective tax rates for all seven areas ranged between 37.7 percent and 45.8 percent. Minnesota's rate was lower than four or possibly five of the six provinces depending on the rate used in Saskatchewan. Because state taxes are deductible in computing income for federal tax purposes in Minnesota, businesses may experience lower corporate income taxes in the state compared to Quebec and Ontario.

Payroll Taxes

Payroll taxes consist of both discretionary benefits like health and dental insurance, paid vacations, and holidays and statutory benefits like social security and workers compensation. Although some general comparisons of payroll taxes are possible, direct comparisons are difficult due to the variety of services associated with each benefits category.

According to a study released in March 1997 by the U.S. Bureau of Labor Statistics, total benefits accounted for approximately 29 percent of total compensation for employees in the Midwest states of the United States. These benefits include paid leave such as vacation and holiday pay, health insurance payments, retirement and savings, and other legally required benefits like social security, Medicare, and unemployment insurance. Table 28 shows the percentage distribution of compensation for Midwest states.

Table 28: Distribution of Employee Compensation for Midwest States, 1997

Wages and salaries	71.1%
Total Benefits	28.9
Paid Leave	6.2
Supplemental pay	3.9
Insurance	6.5
Retirement and savings	3.4
Legally required benefits	8.7
Other benefits	0.2
Total Compensation	100.0

Source: *Employer Costs for Employee Compensation*, March 1997, U.S. Bureau of Labor Statistics.

As shown in the table, benefits related to insurance; retirement and savings; and legally required benefits like social security, unemployment, and workers compensation account for 18.6 percent of the total compensation for employees in the Midwest. As discussed below, legally required payroll taxes in Canada accounted for 14 percent of total payroll in Quebec and 11.7 percent of total payroll in Ontario in 1993. In Minnesota and other states, legally required benefits account for only 8.7 percent.

Payroll taxes in Canada consist of four components: unemployment insurance (UI) premiums, Canada/Quebec Pension Plan (C/QPP) contributions, workers compensation (WC) premiums, and the provincial health/post-secondary education (H/E) tax that is imposed by Quebec, Manitoba, Ontario, and Newfoundland. Canada's UI and C/QPP components are taxes on both the employers and the employees, whereas the other two components are taxes on the employers only. British Columbia does not impose a payroll tax on health or post-secondary education, but it is one of only two provinces in Canada (Alberta being the other) that charge health insurance premiums. These premiums are not considered a payroll tax since employers are not legislated to pay them, but rather do so on a voluntary basis (or through collective bargaining agreements).

A recent study by Statistics Canada found that payroll taxes have increased substantially in Canada over the last 30 years. The study found that in 1993 the average payroll tax per employee in Canada was $3,273. Table 29 shows the effective payroll tax rates for selected provinces in 1993 from this study. In contrast, Minnesota has seen dramatic reductions in workers' compensation rates (down 23 percent) and unemployment insurance (down 18 percent) during the 1990s.

The study also compared Canada to other countries and found that in 1993 payroll taxes comprised 5.9 percent of Canada's Gross Domestic Product (GDP) and 8.7 percent of the United States GDP.

A more recent study by KPMG Canada[18] included a comparison of statutory benefits and wage based taxes as a percent of gross payroll in 42 international cities. According to this study, statutory benefits and wage based taxes accounted for approximately 10 percent of the gross payroll in Minneapolis, 9 percent in Toronto, 9.5 percent in Ottawa, 12 percent in Montreal, and approximately 12.5 percent in Quebec City. Based on the results of the KPMG study, Minneapolis is competitive with Toronto and Ottawa and may posses an advantage over both Montreal and Quebec City.

When attempting to attract business expansion into the state, emphasizing Minnesota's efforts to reduce payroll taxes may be advantageous, as such efforts are reflective of the supportive relationship between government and industry.

Table 29: Effective Payroll Taxes for Selected Canadian Provinces, 1993

Alberta	9.4%
British Columbia	9.5
Manitoba	11.9
Ontario	11.7
Quebec	14.0
Saskatchewan	9.7

Source: *The Evolution of Payroll Taxes in Canada: 1961-1993*, February 1996, Zhengxi Lin, Garnett Picol, and Charles Beach, Statistic Canada.

18 *The Competitive Alternative: A Comparison of the Business Costs in Canada, Europe and the United States*, 1997, KPMG Canada and Prospectus Inc.

Sales Taxes

Canada's Goods and Services Tax (GST) replaced the Federal Sales Tax in 1991. The majority of goods and services sold or provided in Canada are subject to the GST currently at 7 percent. In addition to the GST, sales in Canada are usually subject to provincial sales taxes. Ontario levies a provincial sales tax of 8 percent on most purchases of goods and services and transactions in Quebec are subject to a 7.5 percent provincial sales tax. The GST and Quebec tax are value-added taxes that allow businesses to obtain a full rebate of all federal and Quebec provincial taxes paid. In Ontario, purchases of any equipment or inputs used in the production of goods are exempt from the provincial sales tax.

Minnesota levies a retail sales tax of 6.5 percent and the federal government does not impose a sales tax. Minnesota manufacturers are exempt from sales taxes for equipment and manufacturing inputs.

There does not appear to be a clear sales tax advantage for manufacturers in either Minnesota or Canada. However, general consumers who are not eligible for tax rebates in Canada may experience significantly lower sales tax burdens in Minnesota than in either Ontario or Quebec.

Property Taxes

Because the property tax rates vary from municipality to municipality, this analysis does not include a comparison of Minnesota and provincial property tax rates. However, below is a background of the property tax systems for each area.

Unlike most states, Minnesota exempts machinery and equipment from property tax. Real estate, or land and buildings is the basis for the local property tax in Minnesota and most "personal" property, such as inventory, machinery, equipment, and computers, is exempt. As mentioned in the industry interviews section, this exemption can truly lower costs for companies with large investments in personal property and make Minnesota a low cost state. Canada also exempts machinery and equipment from property tax and does not impose taxes on inventories.

Most municipalities in Canada levy property taxes on real property including land, commercial buildings, and residential property with rates varying from city to city. Although the means of calculating property taxes is complex and different than Minnesota, it appears that property taxes in Canada are generally lower than in Minnesota. However, business owners in Montreal are subject to a separate "business tax" on the assessed value of the business which may result in higher taxes.

Transportation and Utilities

Minnesota and Canada are both served by well-developed infrastructures and sophisticated air travel and telecommunications. Minnesota's only real comparative advantage in terms of transportation is related to its central location in the United States which makes it much easier to penetrate the rest of the U.S. market.

The need to move customers, employees, and goods makes the geographic location of Minnesota in the center of the country an attractive place for businesses serving markets nationwide and in Canada. The Minneapolis-St. Paul International Airport is among the largest air traffic hubs in the United States, with hundreds of flights leaving daily for a variety of domestic and international destinations. Non-stop and one-stop flights are available to such international destinations as London, Paris, Amsterdam, Frankfurt, and Tokyo. Although Minneapolis-St. Paul International Airport is a major hub for Northwest Airlines, travelers may utilize a variety of carriers. There are nine major airlines and 12 commuter-regional airlines that carry more that 23 million passengers through Minneapolis-St. Paul International Airport annually.

Those businesses that use overland transportation rely on Minnesota's and the Twin Cities' extensive, high-quality highway system. The state has more than 129,000 miles of paved road and several major interstate highways. Interstate 94 provides quick access from points east and west while Interstate 35 provides easy access from the north and south. Interstate 494/694 loops around the metropolitan area, helping make travel to anywhere in or around the Twin Cities relatively problem free.

There are more than 186,000 miles of surfaced roads in Canada providing reasonable access to major Canadian and U.S. cities. Railways are one of the main forms of freight transport in Canada. The Canadian National Railway and the Canadian Pacific Railway operate most national rail freight services. Two major airlines, Air Canada and Canadian Airlines International, serve both domestic and international routes from major Canadian cities. Other airlines also offer scheduled services in regional markets. About 860 licensed domestic air carriers provide scheduled and charter services throughout the country.

Minnesota, Quebec, and Ontario all benefit from reasonably priced utilities and a well-developed telecommunications infrastructure.

Quality of life

Quality of life is an issue related to ability of firms to attract and retain skilled workers and can be a highly subjective notion. As competition for skilled workers intensifies, the overall quality of life may become more important in attracting and retaining skilled workers.

Minnesota and the Twin Cities have long been recognized as a state and area that offer a high quality of life to its residents. Employers and employees may enjoy nationally renowned health care and educational systems, low cost housing, low crime rates, abundant cultural activities, and thousands of acres of public parks. For example, Minnesota has 66 state parks and 2 recreational areas containing more than 200,000 acres. Minnesota also has a healthy population. Health care costs in Minneapolis-St. Paul are 15 percent lower than the national average.

Canada is also home to a vast array of cultural and recreational activities. International cities like Vancouver, Montreal, and Toronto offer high quality theater, opera, and other cultural amenities. Canada's climate is characterized by its diversity, and temperature and precipitation differ from region to region and season to season. The coast of British Columbia has the most temperate climate in Canada while the vast central plains have cold winters and hot summers.

Both Minnesota and Canada appear to offer a multitude of attractions related to quality of life. While Minnesota cannot claim superiority, promoting its many cultural and environmental amenities is important in its efforts to attract new business to the state.

Conclusion

Minnesota has several competitive advantages in comparison with Canada. The most obvious advantages include Minnesota's large pool of skilled labor and its high concentration of computer and electronic components companies. It is only in terms of unemployment rate that Minnesota may be at a disadvantage, although this is unlikely to be a significant problem in the short term since a low rate of unemployment also reflects the overall strength of Minnesota's economy. Less distinct, yet still important advantages include Minnesota's central location in the United States and its educational system. Factors such as infrastructure, utilities and telecommunications, and quality of life are similar among the locations. With respect to taxes, it is difficult to draw conclusions due to the variation in definitions of taxable income, differences in apportionment of taxes, and the variety of tax rates used from city to city. Nonetheless, it does appear that businesses may experience slightly lower tax burdens in Minnesota than in either Ontario or Quebec.

Generally, when targeting computer and electronic component industry businesses, emphasis should be placed on Minnesota's large pool of skilled labor and the significant industry presence which contribute to a business environment conducive to future growth. Canada's computer and electronic components industry presence provides fertile ground for attracting companies to Minnesota. Efforts to attract Canadian expansions should focus on U.S. companies that have located plants in Canada as well as Canadian firms that are active exporters to the United States. Minnesota's strengths on the five location factors will be highly attractive to businesses in the computer and electronic components industry group looking to expand to the United States.