



PUBLIC POLICY ADVISOR

High Technology Employment Trends in Michigan

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An important part of Michigan's economic development strategy has been to encourage the establishment and expansion of high technology firms. As Michigan government and business leaders grappled with the structural unemployment of the last recession, they encouraged the development of high technology and growth industries in an effort to replace some of the jobs lost in durable goods manufacturing industries. In the past decade new state programs have been launched and existing ones reoriented for this purpose.

Governor William G. Milliken began to move the state in this direction in 1981 with the establishment of the blue-ribbon High Technology Task Force. Out of this effort came the Centers of Excellence—the Industrial Technology Institute, the Michigan Molecular Institute, and the Molecular Biology Institute—and the venture capital program, which invests in new or emerging high-growth companies offering products and technologies that could help diversify the state's economy. The effort to create high technology jobs continues under Governor Blanchard with such programs as the Michigan Strategic Fund, which encourages public sector flexibility in addressing the varying financial needs of rapidly changing industries and technologies, and the Michigan Modernization Services and Manufacturing Services, which encourage the development of high tech jobs in the state by assisting small and medium-size manufacturers in the deployment of new technologies and development of human resources and by providing existing firms and prospective companies with development and retention services. Supporters of these efforts claim that technological modernization has been one of the most important factors in rekindling economic growth in Michigan.

The purpose of this paper is to report the changes in high tech employment from 1982 to 1988, comparing it to employment in general and examining wage levels. (The influence of the economic development programs described above is not assessed in this paper.) This is the first compilation of such data, and it will be of interest to all observers of the Michigan economic scene, particularly public policy makers and economic development planners.

DEFINITIONS

High technology industry has many meanings: To state and local economic development planners it means emerging growth industries that may solve the problem of high unemployment; to industry it means the manufacture of new products and new, often labor-saving, production processes; in political circles it is the economic edge that increases the ability to compete in world markets; and in academia and think tanks it refers to industries involving sophisticated research and development (R&D).

The definitions used in this analysis come from two sources. The first is *High Tech America*, a 1986 book by Ann Markusen, Peter Hall, and Amy Glasmeier, in which the term has an occupational basis: High technology industries are defined as manufacturing operations in which the proportion of engineers, engineering technicians, computer scientists, life scientists (as in biology and medicine), and mathematicians exceeds the average for all manufacturing firms. Conceptually, this definition reflects the

maticians exceeds the average for all manufacturing firms. Conceptually, this definition reflects the capacity of an industry to harness scientific and technical expertise in the development of new products and is closely linked to sophistication of product line and manufacturing process; it comes closest to encompassing the various connotations of *high tech*. It is assumed that an industry having a large proportion of such personnel is innovative. Evidence of innovation, in turn, implies the potential for growth. Using this definition, Markusen et al. classified 29 three-digit SIC¹ manufacturing sectors as high technology. These are shown in rank order of scientific and technical personnel employment in Exhibit 1.

Because we wanted to include more than manufacturing firms in our analysis, we used three additional definitions provided by an article in the November 1983 *Monthly Labor Review* (U.S. Department of Labor) entitled "High Technology Today and Tomorrow: A Small Slice of the Employment Pie," by Richard Riche, Daniel Hecker, and John Burgan. The definitions concern an industry's (1) utilization of scientific and technical workers, (2) expenditures for research and development, and (3) the nature of its product. Exhibit 2 lists 48 industries and shows under which definition(s) they fall.

An industry was included under the first definition if technology-oriented workers accounted for a proportion of total employment at least 1.5 times the average for all industries (only industries having more than 25,000 workers in the United States were included because those having fewer were likely to have so few in any one state as to be insignificant statistically); 48 industries qualified.

The other two definitions did not add any new industries to the list but provide a narrower definition of high technology industries. For purposes of this analysis these definitions can be ignored.

An industry was included under the second definition if its ratio of R&D expenditures to net sales was at least twice the average for all industries (only manufacturing industries were considered because few nonmanufacturing industries engage in considerable research and development). The six industries that qualified under this definition also qualified under the first.

An industry was included under the third definition if its proportion of technology-oriented workers relative to total employment was equal to or greater than the average for all manufacturing industries and the ratio of R&D expenditures was near or above the average for all industries. Twenty-eight industries qualified under this definition; all also qualified under the first.

In total, Riche et al. classified 48 three-digit industries as high technology, and we have used this list as the basis for our research. Included are 27 of the 29 manufacturing industries also defined by Markusen et al. as high technology (reclaimed rubber and railroad equipment were excluded), plus an additional 13 manufacturing industries, including motor vehicles and equipment (SIC 371).

1 The standard industrial code (SIC) is the system used by the federal government to group similar industries and industry sectors for data collection purposes. A two-digit code denotes a broad classification; for example, 20 is the code for construction and 30 is the code for manufacturing. Two-digit classifications may be broken down further into three-digit categories, such as 215 for nonresidential building and 337 for the manufacture of transportation equipment. Four-digit categories are a further refinement; examples are 2177 for concrete work and 3711 for the manufacture of motor vehicles and car bodies.

EXHIBIT 1

29 High Tech Sectors and Their Occupational Mix

Rank	SIC ¹	Title	(a)	(b)	(c)	Total (a, b, and c)
			Engineering/ Technicians/ Computer Scientists	Life and Physical Scientists	Mathematics	
			Percentage of Total Employment			
		TOTAL MANUFACTURING	5.51	0.26	0.05	5.82
1	376	Space vehicles and guided missiles	40.90	0.21	0.08	41.19
2	357	Office computing machines	26.62	0.05	0.03	26.70
3	381	Engineering, laboratory instruments, and scientific instruments	25.67	0.73	0.05	26.45
4	366	Communications equipment	21.30	0.26	0.30	21.86
5	383	Optical instruments and lenses	18.73	1.03	0.04	19.80
6	286	Industrial organic chemicals	14.51	4.85	0.24	19.60
7	372	Aircraft and parts	17.95	0.24	0.34	18.53
8	283	Drugs	8.86	8.59	0.22	17.67
9	291	Petroleum refining	11.76	2.42	0.44	14.62
10	382	Measuring and controlling instruments	13.93	0.12	0.09	14.14
11	367	Electronic components and assembly	12.72	0.10	0.02	12.84
12	281	Industrial inorganic chemicals	9.46	3.14	0.05	12.65
13	282	Plastics and synthetic resins	9.38	1.81	0.17	11.36
14	351	Engines and turbines	10.16	0.48	0.01	10.65
15	348	Ordnance	9.37	0.99	0.06	10.42
16	289	Miscellaneous chemicals	6.35	3.70	0.05	10.10
17	386	Photographic equipment	8.67	0.80	0.01	9.48
18	362	Electric industrial apparatus	9.24	0.03	0.03	9.30
19	361	Electrical transmission equipment	8.55	0.03	0.01	8.59
20	353	Construction equipment	8.34	0.05	0.04	8.43
21	285	Paints and varnishes	3.22	4.97	0.01	8.20
22	303	Reclaimed rubber	5.26	2.27	0.00	7.53
23	356	General industrial machinery	7.21	0.04	0.02	7.27
24	374	Railroad equipment	6.58	0.08	0.09	6.75
25	365	Radio and TV receiving equipment	6.62	0.06	0.04	6.72
26	287	Agricultural chemicals	4.58	1.79	0.11	6.48
27	354	Metal working machinery	6.27	0.01	0.00	6.28
28	384	Medical and dental supplies	5.42	0.57	0.04	6.03
29	284	Soap	3.14	2.71	0.06	5.91

SOURCE: Ann R. Markusen, Peter Hall, and Amy Glasmeier, *High Tech America: The What, How, Where, and Why of the Sunrise Industries* (Boston: Allen & Unwin), 1986.

¹The standard industrial code (SIC) is the system used by the U.S. government to group similar industries and industrial sectors for data collection purposes.

EXHIBIT 2

High Technology Industries

SIC ¹	Industry	High-tech group ²		
		1	2	3
131	Crude petroleum and natural gas	X		
162	Heavy construction, except highway and street	X		
281	Industrial inorganic chemicals	X		X
282	Plastic materials and synthetics	X		X
283	Drugs	X	X	X
284	Soaps, cleaners, and toilet preparations	X		X
285	Paints and allied products	X		X
286	Industrial organic chemicals	X		X
287	Agricultural chemicals	X		X
289	Miscellaneous chemical products	X		X
291	Petroleum refining	X		X
301	Tires and inner tubes	X		
324	Cement, hydraulic	X		
348	Ordnance and accessories	X		X
351	Engines and turbines	X		X
352	Farm and garden machinery	X		
353	Construction, mining, and material handling machinery	X		
354	Metalworking machinery	X		
355	Special industry machinery, except metalworking	X		X
356	General industrial machinery	X		
357	Office, computing, and accounting machines	X	X	X
358	Refrigeration and service industry machinery	X		
361	Electric transmission and distribution equipment	X		X
362	Electrical industrial apparatus	X		X
363	Household appliances	X		
364	Electric lighting and wiring equipment	X		
365	Radio and TV receiving equipment	X		X
366	Communication equipment	X	X	X
367	Electronic components and accessories	X	X	X
369	Miscellaneous electrical machinery	X		X
371	Motor vehicles and equipment	X		
372	Aircraft and parts	X	X	X
376	Guided missiles and space vehicles	X	X	X
381	Engineering, laboratory, scientific, and research instruments	X		X
382	Measuring and controlling instruments	X		X
383	Optical instruments and lenses	X		X
384	Surgical, medical, and dental instruments	X		X
386	Photographic equipment and supplies	X		X
483	Radio and TV broadcasting	X		
489	Communication services	X		
491	Electric services	X		
493	Combination electric, gas and other utility services	X		
506	Wholesale trade, electrical goods	X		
508	Wholesale trade, machinery, equipment, and supplies	X		
737	Computer and data processing services	X		X
7391	Research and development laboratories	X		X
891	Engineering, architectural, and surveying services	X		
892	Noncommercial educational, scientific and research organizations	X		

SOURCE: Bureau of Labor Statistics, U.S. Department of Labor, "High Technology Today and Tomorrow: Small Slice of Employment," *Monthly Labor Review*, November 1983.

¹The standard industrial code (SIC) is the system used by the U.S. government to group similar industries and industrial sectors for data collection purposes.

²Group 1. Includes industries with a proportion of technology-oriented workers (engineers, life and physical scientists, mathematical specialists, engineering and science technicians and computer specialists) at least 1.5 times the average for all industries.

Group 2. Includes industries with a ratio of R&D expenditures to net sales at least twice the average for all industries

Group 3. Includes manufacturing industries with a proportion of technology-oriented workers equal to or greater than the average for all manufacturing industries, and a ratio of R&D expenditures to sales close to or above the average for all industries. Two nonmanufacturing industries which provide technical support to high tech manufacturing industries are included.

PROFILE OF MICHIGAN HIGH TECH INDUSTRIES

For purposes of this report the 48 three-digit industries were further broken down into 104 four-digit sectors. These are listed in Appendix A with employment and average wages in each for 1982 and 1988 and growth rates from 1982 to 1988.

In Michigan in 1988, 605,822 workers were employed in high tech industries: 19.5 percent of total Michigan private employment. Michigan has 6.1 percent of the nation's high technology jobs but only 3.6 percent of private employment. If the motor vehicle industry is excluded from the definition, as it is by some, high technology accounts for only 10.5 percent of Michigan private employment and 3.3 percent of national high tech employment. In other words, if motor vehicle manufacturing is defined as a high technology industry, Michigan has more than its share of high tech jobs; if it is excluded, Michigan has less than its share. One problem Michigan has is that many high tech jobs are related to defense, and we have little defense business in this state. In 1989 only 2.5 percent of Michigan employment was dependent on defense, compared to 6.1 percent nationwide (see Appendix B).

From 1982 to 1988 employment in high technology industries in Michigan increased by 31,431 jobs or 5.8 percent. Nationwide, employment in these industries declined 1.8 percent. This does not mean that total high tech employment nationwide declined—it actually increased 12.5 percent. It means that the industries in which Michigan has significant employment declined or grew slowly nationwide. This is troubling, as it means that Michigan high tech employment is concentrated in slow-growth industries. (Refer to Exhibit 6 and discussion below.) Excluding motor vehicles (SIC 3711), high tech employment increased by 38,068 jobs or 14.3 percent. This compares with a 23.3 percent increase in total private employment in Michigan. The major reason that total employment increased faster than high tech employment is that the services sector, with few high tech jobs, was the fastest growing sector of the economy, while manufacturing, with the largest concentration of high tech jobs, was the slowest growing.

Total wages paid by Michigan high technology industries in 1988 was \$24 billion, a 48.1 percent increase from 1982. This compares with a 55.4 percent increase in total Michigan wages and salaries from 1982 to 1988. The average wage in Michigan high tech industries in 1988 was \$39,527, 62.2 percent above the average wage for all industries in Michigan (\$24,366). This substantial differential is accounted for in large part by the high wages paid by the motor vehicle sector. The average high tech wage nationwide in 1988 was \$32,498, 17.8 percent below the Michigan average.

There are 18 high technology sectors in Michigan that employ more than 5,000 workers (see Exhibit 3). The largest is motor vehicles (SIC 3711), employing 173,000 workers, which accounts for 48.6 percent of all U.S. employment in this sector. (Although some analysts question the inclusion of this sector—and motor vehicle parts and accessories—as high tech because some aspects of it clearly are not, it qualifies on the basis of employing an above-average proportion of technology-oriented workers; the industry has had to increase its use of new technology to compete in the more competitive world market.) Michigan has an above-average share of national employment—more than 3.6 percent—in 15 of the 18 sectors; electric services, aircraft engines and parts, and electronic components are the exceptions. There are 28 sectors in Michigan that have 5 percent or more of national employment (see Exhibit 4), but many are too small to provide a large number of jobs in Michigan. For example, Michigan accounts for 16.5 percent of all jobs in the metal working machinery sector, but this translates to only 767 jobs in the state. Also, few of these sectors are growing fast; only six recorded an employment gain of 20 percent or more from 1982 to 1988.

EXHIBIT 3

**Michigan High Technology Sectors
Employing 5,000 or More Workers, 1988**

SIC ¹	Sector	Michigan Employment	Percentage of U.S. Employment
3711	Motor vehicles	173,091	48.6%
3714	Motor vehicle parts and accessories	115,748	29.1
3544	Special dies, tools, jigs, and fixtures	78,227	19.0
8711	Engineering	27,295	4.9
4911	Electric services	15,307	3.4
5084	Industrial machinery and equipment (wholesale trade)	14,872	4.4
7373	Computer system design (services)	14,702	16.0
3545	Machine tool accessories	13,019	23.0
2834	Pharmaceutical preparations	11,647	6.2
3694	Engine electrical equipment	9,053	13.0
5085	Industrial supplies (wholesale trade)	7,166	5.2
3541	Machine tools, metal cutting	6,454	13.1
3724	Aircraft engines and parts	5,598	3.6
3585	Refrigeration and heating equipment	5,565	4.3
3795	Tanks	5,534	32.7
3535	Conveyers and equipment	5,294	15.3
3571	Electronic components	5,247	1.7
8071	Medical sales (services)	5,180	4.8

SOURCE: Calculated by PSC from: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Wages Annual Averages*, 1982 and 1988.

¹The standard industrial code (SIC) is the system used by the U.S. government to group similar industries and industrial sectors for data collection purposes.

The fastest growing high technology sectors in Michigan from 1982 to 1988 are shown in Exhibit 5. Jobs in these 22 sectors total only 127,000—21 percent of all Michigan high technology employment and 4 percent of private employment. Only six employ 5,000 or more workers: tools, dies, and jigs; engineering; industrial machinery and equipment; engine electrical equipment; industrial supplies; and medical laboratories. It also is of interest that the majority of the 22 sectors are growing at below-average rates nationally.

Of the fastest growing high technology industries nationally, Michigan has an above-average share of national employment in only eight sectors: motor vehicles and accessories (29.1 percent); tools, dies, and jigs (19 percent); household vacuum cleaners (11.8 percent); engine electrical equipment (13 percent); vehicular lighting equipment (6.2 percent); medical laboratories (4.8 percent); refrigeration and heating equipment (4.3 percent); and measuring controls and devices (4.1 percent). Only five of these sectors employed 5,000 or more workers in Michigan. (See Exhibit 6.)

High technology industries have a reputation for paying high wages. As shown in Exhibit 7 this is true in a number of sectors, but some pay very low wages. Many of the former are related to vehicle production; these sectors are heavily unionized and have benefited from the bargaining prowess of the United Auto Workers.

Michigan is a high-wage state, so it is not surprising that this state has a small share of national employment in all of the low-paying sectors. Many low-wage sectors use high technology processes but

EXHIBIT 4

Michigan High Technology Industries Comprising
More Than 5 percent of U.S. Employment, 1988

SIC ¹	Sector ²	Percentage of U.S. Employment	Total Michigan Employment	Percentage Change in Employment, 1982-88
3711	Motor vehicles	48.6%	173,091	-1.4%
3795	Tanks	32.7	5,534	NA
3714	Motor vehicle parts and accessories	29.1	115,493	7.2
3545	Machine tool accessories	23.0	13,019	-25.0
3544	Special dies, tools, jigs, and fixtures	19.0	28,227	27.0
3549	Metal working machinery	16.5	767	3.2
7373	Computer system design (services)	16.0	14,702	NA
3535	Conveyers and equipment	15.3	5,294	21.5
3541	Machine tools, metal cutting	13.1	6,454	-32.3
3694	Engine electrical equipment	13.0	9,053	25.1
3635	Household vacuum cleaners	11.8	1,436	113.7
3567	Industrial furnaces and ovens	10.1	1,719	14.1
3542	Machine tools, metal forming	9.6	1,800	-11.2
3632	Household refrigerators and freezers	9.2	2,668	0.5
2841	Soap and other detergents	8.2	3,586	-16.0
3569	General industrial machinery	7.0	2,617	1.1
3536	Hoists, cranes, and monorails	6.6	596	-7.3
2851	Paints and allied products	6.3	4,021	31.7
3519	Internal combustion engines	6.2	4,242	-65.1
3647	Vehicle lighting equipment	6.2	1,126	NA
2834	Pharmaceutical preparations	6.2	11,647	-13.5
3547	Rolling mill machinery	6.0	315	-11.5
2899	Chemical preparations	6.0	2,684	-18.1
3568	Power transmission equipment	5.9	1,070	4.6
3537	Industrial trucks and tractors	5.4	1,455	-54.5
2821	Plastics and resins	5.2	4,317	14.1
5085	Industrial supplies (wholesale trade)	5.2	7,166	37.8
3826	Analytical instruments	5.1	1,348	NA

SOURCE: Calculated by PSC from: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Wages Annual Averages*, 1982 and 1988.

¹The standard industrial code (SIC) is the system used by the U.S. government to group similar industries and industrial sectors for data collection purposes.

²Manufacturing unless otherwise indicated in parentheses.

employ low-skilled workers for assembly jobs, and many assembly operations have moved to Mexico, Taiwan, or other countries to take advantage of the low labor costs.

EXHIBIT 5

Fastest Growing High Technology Industries,
Michigan, 1982-88

SIC ¹	Sector ²	Percentage Employment Growth, Michigan, 1982-88	Total Michigan Employment, 1988	Percentage Employment Growth, U.S., 1982-88
3643	Current carrying wire devices	590.7%	2,072	3.1%
3829	Measuring and control devices	282.1	1,926	82.3
1389	Oil and gas field services (mining)	121.7	1,377	-46.5
3635	Household vacuum cleaners	113.7	1,436	40.9
3677	Electric coils and transformers	96.4	269	2.1
3625	Relays and industrial controls	75.0	2,273	4.3
3841	Surgical and medical instruments	61.9	887	27.6
5084	Industrial machinery and equipment	59.4	14,872	4.3
3674	Semiconductors	53.9	845	15.2
3614	Engine electrical equipment	52.1	9,053	25.1
3823	Process control instruments	48.5	1,443	-2.2
5085	Industrial supplies	37.8	7,166	9.6
1623	Wastes, sewer, utility construction	34.2	4,625	9.9
5065	Electronic parts and equipment (wholesale trade)	33.9	4,508	95.8
3621	Motors and generators	32.8	2,310	-17.4
8711	Engineering (services)	32.5	27,295	-2.3
2851	Paints and allied products	31.7	4,021	5.0
3842	Surgical appliances and supplies	30.9	2,039	23.5
8071	Medical laboratories (services)	29.3	5,180	50.1
5087	Service establishment equipment (wholesale trade)	27.4	2,610	33.5
4833	TV broadcasting (communications)	27.3	2,219	-2.9
3544	Tools, dies, and jigs	27.0	28,227	19.2
	Total Michigan (high tech)	5.8%	126,653	12.5%

SOURCE: Calculated by PSC from: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Wages Annual Averages*, 1982 and 1988.

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²Manufacturing unless otherwise indicated in parentheses.

CONCLUSION

High technology industries, even as broadly defined for this paper, provide a relatively small proportion of jobs in this state. Between 1982 and 1988, high technology provided only about 5 percent of the increase in total private employment in Michigan. For the foreseeable future the bulk of employment expansion is expected to occur in services and trade, which are not high technology fields. High technology jobs pay higher wages, however, and are the type of jobs we should be trying to create in Michigan; one reason state and local revenue growth is slowing is that low-wage jobs, which are being created in large numbers in Michigan, generate relatively low income, sales, and property tax revenue.

The research on where high technology firms locate is encouraging for this state: It indicates that the accessibility of sites to both transportation networks and business service complexes, the existence of such amenities as a good climate and a range of educational options, and the presence of major headquarter

EXHIBIT 6

U.S. High Technology Sectors Recording
Growth of 15 percent or more, 1982-88

SIC ¹	Sector ²	Employment Growth, 1982-88	Michigan Employment, 1988	Michigan Employment as Percentage of U.S.
5065	Electronic parts and equipment (wholesale trade)	95.8%	4,508	1.8%
7370	Computer and data processing (services)	83.6	26,294	4.0
3829	Measuring controls and devices	82.3	1,926	4.1
3760	Guided missiles, space vehicles and parts	61.2	-0-	-0-
8071	Medical laboratories (services)	50.1	5,180	4.8
3635	Household vacuum cleaners	40.9	1,436	11.8
3647	Vehicular lighting equipment	38.5	1,126	6.2
5087	Service establishment equipment (wholesale trade)	33.5	2,610	3.1
8710	Engineering and architectural services (services)	28.1	31,851	5.6
3841	Surgical and medical instruments	27.6	887	0.9
3694	Engine electrical equipment	25.0	9,053	13.0
2843	Surface active agents	24.0	208	3.1
3842	Surgical appliances and supplies	23.5	2,039	2.4
2891	Adhesives and sealants	22.8	689	2.8
3714	Motor vehicle parts and accessories	22.5	115,748	29.1
3544	Tools, dies, and jigs	19.2	28,227	19.0
3585	Refrigeration and heating equipment	17.6	5,565	4.3
5088	Transportation equipment and supplies (wholesale trade)	16.9	327	0.8
3728	Aircraft parts and equipment	16.1	5,598	0.5
3721	Aircraft	15.7	277	0.1
3674	Semiconductors	15.2	845	0.3
3822	Environmental controls	15.2	1,132	2.3

SOURCE: Calculated by PSC from: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Wages Annual Averages*, 1982 and 1988.

¹The standard industrial code (SIC) is the system used by the U.S. government to group similar industries and industrial sectors for data collection purposes.

²Manufacturing unless otherwise indicated in parentheses.

companies, are more important than traditional factors such as wage rates, unionization, and cost of living.² This means that targeted, well-planned efforts to attract these types of firms have a chance to be successful. High technology industries, however, are unlikely ever to provide enough jobs to replace the thousands of manufacturing jobs that have disappeared in the last decade, but public and private efforts to make Michigan attractive to new businesses should target those sectors that will employ the most workers at the highest wages.

2 Ann Markusen, Peter Hall, and Amy Glasmeier. *High Tech America: The What, How, Where, and Why of the Sunrise Industries* (Boston: Allen & Unwin, 1986).

EXHIBIT 7

**Ten Highest and Ten Lowest Paying High Technology Industries
Michigan, 1988**

SIC ¹	Sector	Average Annual Wages	Michigan Employment	Michigan Employment as Percentage of U.S.
HIGHEST PAYING				
4899	Communication services	\$51,023	487	1.8%
3711	Motor vehicles	50,020	173,091	48.6
3519	Internal combustion engines	44,667	4,242	6.2
3521	Farm machinery and equipment	44,497	1,790	2.4
4911	Electric services	44,006	15,307	3.4
4711	Motor vehicle parts and accessories	40,640	115,748	29.1
3694	Engine electrical equipment	40,417	9,053	13.0
2891	Adhesives and sealants	39,239	689	2.8
1311	Crude petroleum and natural gas	39,119	1,218	0.6
3647	Vehicular lighting equipment	38,711	1,126	6.2
2834	Pharmaceutical preparations	38,570	11,647	6.2
LOWEST PAYING				
3861	Photo equipment and supplies	22,307	384	0.3
5087	Service establishment equipment	22,239	2,610	3.1
4832	Radio broadcasting	22,180	3,638	3.1
3643	Current-carrying wire devices	21,627	2,072	2.6
5083	Farm and garden machinery	21,325	2,693	2.3
7374	Data processing	19,780	3,549	1.9
3677	Electronic coils and transformers	17,591	269	1.1
3652	Pre-recorded records and tapes	17,438	160	0.7
3679	Electronic components	16,546	1,816	1.3
8732	Commercial nonphysical research	14,419	2,334	2.6
	All high technology industries	\$39,341	477,043	5.1%
	Michigan (private)	\$24,366	3,141,600	-

SOURCE: Calculated by PSC from: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Wages Annual Averages*, 1982 and 1988.

¹The standard industrial code (SIC) is the system used by the U.S. government to group similar industries and industrial sectors for data collection purposes.

APPENDIX A

High Technology Industries,
Michigan and United States Employment and Wages, 1982 and 1988

SIC ^a	Sector	1982		1988		Michigan as Percentage of U.S.	% Change in Michigan Employment, 1982-88	% Change in U.S. Employment, 1982-88	1988	
		Michigan Employment	Total Michigan Wages (000)	Michigan Employment	Total Michigan Wages (000)				Michigan Average Annual Earnings	U.S. Average Annual Earnings
	MANUFACTURING									
1311	Crude Petroleum and Natural Gas	N	N	1,218	\$47,647	0.6%	-	-26.6%	\$39,119	\$44,071
1381	Drilling oil and gas	1,957	\$49,934	1,026	24,486	2.0	-47.6%	-63.6	23,865	26,661
1382	Oil and gas exploration service	1,292	26,737	886	21,407	3.4	-31.4	-51.9	24,161	33,432
1389	Oil and gas field service	621	13,651	1,377	33,342	1.1	121.7	-46.5	24,214	24,938
1623	Water, sewer, and utility construction	3,446	85,427	4,625	153,210	2.1	34.2	9.9	33,126	26,297
1629	Heavy construction	11,570	358,449	3,383	111,548	1.4%	-70.8	-32.6	32,973	28,323
2819	Industrial inorganic chemicals	1,756	44,219	1,845	64,858	2.0	5.1	-15.5	35,153	36,633
2821	Plastics and resins	3,775	110,029	4,317	155,642	5.2	14.4	9.2	36,053	38,070
2834	Pharmaceutical preparations	10,258	292,525	11,647	449,222	6.2	13.5	12.1	38,570	37,733
2841	Soap and other	4,270	97,153	3,586	121,648	8.2	-16.0	0.5	33,923	37,756
2842	Polishes and sanitation	651	15,435	574	17,771	1.6	-11.8	10.5	30,960	29,756
2843	Surface active agents	N	N	208	6,277	3.1	-	24.0	30,178	32,937
2844	Toilet preparations	N	N	141	3,762	0.2	-	10.7	26,681	29,550
2851	Paints and allied products	3,054	80,222	4,021	145,343	6.3	31.7	5.0	36,146	29,697
2865	Cyclic crude chemicals	44	1,051	362	11,416	1.2	722.7	-12.8	31,536	44,069
2891	Adhesives and sealants	1,240	27,928	689	27,036	2.8	-44.4	22.8	39,239	30,704
2899	Chemical preparations	3,277	79,632	2,684	89,418	6.0	-18.1	11.6	33,315	32,335
2911	Petroleum refining	2,012	47,331	1,754	43,565	1.4	-12.8	-25.5	24,838	43,153
3011	Tires and inner tubes	1,646	49,656	N	N	-	-	-14.8	-	36,306
3241	Cement, hydraulic	1,286	37,448	1,131	41,784	5.8	-12.1	-29.6	36,944	33,674
3519	Internal combustion engines	12,142	352,254	4,242	189,477	6.2	-65.1	-10.8	44,667	34,714
3521	Farm machinery and equipment	N	N	1,790	79,649	2.4	-	-28.2	44,497	28,415
3531	Construction machinery	3,293	87,007	1,315	33,707	1.6	-60.1	-20.0	25,633	33,157
3532	Mining machinery	680	15,455	138	3,785	0.8	-79.7	-47.6	27,428	28,652
3535	Conveyors and equipment	4,358	114,278	5,294	196,638	15.3	21.5	12.8	37,144	28,303
3536	Hoists, cranes, and monorails	643	14,480	596	18,134	6.6	-7.3	-35.5	30,426	25,989
3537	Industrial trucks and tractors	3,200	76,079	1,455	37,468	5.4	-54.5	-3.8	25,751	25,174
3541	Machine tools, metal cutting	9,536	296,279	6,454	235,090	13.1	-32.3	-26.7	36,425	29,507
3542	Machine tools, metal forming	2,026	45,942	1,800	56,902	9.6	-11.2	-10.7	31,612	29,123
3544	Tools, dies, and jigs	22,219	602,136	28,227	1,016,139	19.0	27.0	19.2	35,999	29,685
3545	Machine tool accessories	17,367	421,677	13,019	405,059	23.0	-25.0	-4.3	31,113	27,040

SIC ^a	Sector	1982		1988			1988		1988	
		Michigan Employment	Total Michigan Wages (000)	Michigan Employment	Total Michigan Wages (000)	Michigan as Percentage of U.S.	% Change in Michigan Employment, 1982-88	% Change in U.S. Employment, 1982-88	Michigan Average Annual Earnings	U.S. Average Annual Earnings
3546	Power-driven handtools	692	19,136	153	4,433	0.7	-77.9	-9.2	28,974	25,010
3547	Rolling mill machinery	356	7,881	315	8,145	6.0	-11.5	-32.7	25,857	30,528
3549	Metalworking machinery	743	17,362	767	26,701	16.5	3.2	-62.0	34,812	28,776
3561	Pumps	1,744	41,722	872	24,712	3.3	-50.0	-31.9	28,339	28,782
3562	Ball and roller bearings	1,718	41,302	1,512	51,574	3.6	-12.0	-12.8	34,110	29,732
3564	Blowers and fans	1,356	31,781	871	23,102	2.8	-35.8	-15.8	26,524	24,511
3566	Speed changing, drives and gears	N	N	532	16,102	3.5	-	-	30,267	30,195
3567	Industrial furnaces and ovens	1,507	38,949	1,719	57,697	10.1	14.1	-6.0	33,564	27,896
3568	Power transmission equipment	1,023	24,083	1,070	32,959	5.9	4.6	-9.6	30,803	26,780
3569	General industrial machinery	2,588	70,612	2,617	77,081	7.0	1.1	-22.6	29,454	28,776
3571	Electronic computers	1,856	45,914	5,247	184,985	1.7	182.7	-24.3	35,255	41,061
3585	Refrigeration and heating equipment	5,193	109,018	5,565	145,634	4.3	7.2	17.6	26,170	26,247
3612	Transformer, except electrical	500	10,347	416	10,276	0.8	-16.8	4.3	24,702	24,158
3613	Switchgear and switchboards	1,860	44,641	1,037	25,584	2.1	-44.2	-27.9	24,671	26,942
3621	Motors and generators	1,740	31,368	2,310	54,472	2.5	32.8	-17.4	23,581	25,103
3623	Welding apparatus, electrical	2,038	60,204	2,156	80,190	12.3	5.8	1.6	37,194	30,973
3624	Carbon and graphite products	501	12,016	N	N	-	-	-18.3	27,554	-
3625	Relays and industrial controls	1,299	28,419	2,273	62,583	3.3	75.0	4.3	27,533	27,604
3632	Household refrigerators and freezers	2,655	49,442	2,668	67,063	9.2	0.5	11.1	25,136	27,828
3635	Household vacuum cleaners	672	8,818	1,436	36,150	11.8	113.7	40.9	25,174	24,064
3643	Current-carrying wire devices	300	4,087	2,072	44,812	2.6	590.7	3.1	21,627	24,790
3647	Vehicular lighting equipment	N	N	1,126	43,589	6.2	-	38.5	38,711	32,057
3651	Household audio and video equipment	1,003	20,674	1,053	24,905	1.7	5.0	-15.2	23,651	27,626
3652	Prerecorded records and tapes	302	5,609	160	2,790	0.7	-47.0	2.6	17,438	31,747
3662	Radio and TV communications equipment	1,581	27,896	X	X	-	-	-73.4	-	32,395
3674	Semiconductors	549	13,120	845	22,316	0.3	53.9	15.2	26,409	33,504
3677	Electric coils and transformers	137	1,834	269	4,732	1.1	96.4	2.1	17,591	17,778
3679	Electronic components	2,860	49,172	1,816	30,048	1.3	-36.5	-33.9	16,546	24,750
3694	Engine electrical equipment	5,953	182,518	9,053	365,894	13.0	52.1	25.1	40,417	27,880

3711	Motor vehicles	175,609	5,761,248	173,091	8,658,081	48.6	-1.4	10.4	50,020	44,972
3714	Motor vehicle parts and accessories	107,993	3,101,408	115,748	4,703,980	29.1	7.2	22.5	40,640	32,488
3721	Aircraft	N	N	277	9,741	0.1	-	15.7	35,166	36,916
3724	Aircraft engines and parts	3,833	93,676	5,598	166,661	3.6	46.0	3.1	29,772	36,190
3728	Aircraft parts and equipment	N	N	808	25,307	0.5	-	16.1	31,321	32,210
3795	Tanks	N	N	5,534	210,343	32.7	-	-1.9	38,009	36,037
3811	Engineering and scientific instruments	4,791	103,924	X	X	-	-	-	-	-
3822	Environmental controls	6,676	164,171	1,132	25,635	2.3	-83.0	15.2	22,646	25,190
3823	Process control instruments	972	21,489	1,443	42,708	2.5	48.5	-2.2	29,597	29,319
3825	Instruments/electricity	840	15,418	987	29,635	0.9	17.5	2.0	30,025	33,070
3826	Analytical instruments			1,348	32,748	5.1			24,294	31,165
3829	Measuring and controlling devices	504	12,578	1,926	54,150	4.1	282.1	82.3	28,115	28,546
3841	Surgical and medical instruments	548	11,166	887	28,183	0.9	61.9	27.6	31,773	27,991
3842	Surgical appliances and supplies	1,558	28,411	2,039	53,443	2.4	30.9	23.5	26,210	26,099
3843	Dental equipment and supplies	653	13,138	571	16,306	4.0	-12.6	-9.7	28,557	25,130
3861	Photographic equipment and supplies	722	13,753	384	8,566	0.3	-46.8	-20.4	22,307	38,918
COMMUNICATIONS										
4832	Radio broadcasting	3,975	72,682	3,638	80,692	3.1	-8.5	8.9	22,180	20,708
4833	TV broadcasting	1,743	42,715	2,219	78,068	2.0	27.3	-2.9	35,182	36,808
4899	Communication services	N	N	487	24,848	1.8	-	-75.8	51,023	33,830
4911	Electric services	16,027	492,451	15,307	673,600	3.4	-4.5	7.2	44,006	36,466
WHOLESALE TRADE										
5063	Electrical apparatus and equipment	5,077	110,469	4,936	155,140	2.6	-2.8%	-20.9	31,430	29,868
5064	Electrical appliances, TV and radios	4,364	101,655	2,056	71,802	3.1	-52.9	-8.9	34,923	30,822
5065	Electronic parts and equipment	3,366	75,529	4,508	148,890	1.8	33.9	95.8	33,028	33,983
5082	Construction and mining machinery	1,216	27,125	1,339	45,030	1.6	10.1	2.9	33,630	30,038
5083	Farm and garden machinery	3,927	69,720	2,693	57,428	2.3	-31.4	-22.1	21,325	21,493
5084	Industrial machinery and equipment	9,330	228,171	14,872	506,947	4.4	59.4	4.3	34,087	31,196
5085	Industrial supplies	5,202	119,008	7,166	230,667	5.2	37.8	9.6	32,189	28,071
5087	Service establishment equipment	2,048	35,699	2,610	58,045	3.1	27.4	33.5	22,239	12,999
5088	Transportation equipment and supplies	312	6,287	327	8,113	0.8	4.8	16.9	24,810	34,341
SERVICES										
7371	Computer programming	3,562	83,191	2,949	107,140	2.5	-17.2	7.8	36,331	37,720
7372	Prepackaged software	b	b	2,388	90,101	2.7	-	-	37,731	41,390

SIC ^a	Sector	1982		1988		Michigan as Percentage of U.S.	% Change in Michigan Employment, 1982-88	% Change in U.S. Employment, 1982-88	1988	
		Michigan Employment	Total Michigan Wages (000)	Michigan Employment	Total Michigan Wages (000)				Michigan Average Annual Earnings	U.S. Average Annual Earnings
7373	Computer system design	b	b	14,702	514,063	16.0	-	-	34,966	38,168
7374	Data processing	3,656	75,233	3,549	70,198	1.9	-2.9	-6.1	19,780	26,976
7375	Information retrieval			702	18,161	1.8			25,870	29,779
7379	Computer related services	1,324	35,841	1,361	43,688	1.9	2.8	38.3	32,100	38,786
7391	Research and development labs	5,831	136,098	X	X	-	-	-		
8071	Medical labs	4,007	73,049	5,180	121,641	4.8	29.3	50.1	23,483	25,310
8072	Dental labs	1,278	20,315	1,486	28,695	3.7	16.3	2.7	19,310	18,479
8711	Engineering	20,603	561,470	27,295	1,019,368	4.9	32.5	-2.3	37,346	35,383
8712	Architectural	c	c	3,589	124,699	3.0	-	-	34,745	33,318
8731	Commercial physical research	c	c	4,850	183,217	2.2	-	-	37,777	38,822
8732	Commercial nonphysical research	c	c	2,334	33,653	2.6	-	-	14,419	22,111
8733	Noncommercial research organizations	2,499	46,627	2,918	77,863	2.1	16.8	23.8	26,684	27,672
8734	Testing Labs	N	N	1,010	24,223	1.7			23,983	24,247
	Other	2,864	61,615	1,224	33,231	0.5	-57.3	-21.0	27,150	20,065
	Total high technology employment and wages	574,391	\$16,194,054	607,978	\$24,031,426	6.0	5.8	-1.8	\$39,527	\$32,498
	Total Michigan private employment and wages	2,556,137	\$48,250,817	3,151,600	\$76,791,963	3.6	23.3	19.0 ^d	\$24,366	\$21,649

SOURCE: Calculated by PSC from: U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Wages Annual Averages*, 1982 and 1988.

N = Not disclosed

X = Reclassified

^aThe standard industrial code (SIC) is the system used by the U.S. government to group similar industries and industrial sectors for data collection purposes.

^bIncluded in 7371

^cClassified elsewhere

^dU.S. employment

APPENDIX B

Defense and Employment, by State, 1989

State	Defense- Dependent Employment (excluding National Guard and Reserves)	Defense- Dependent Employment as Percentage of State Employment	State	Defense- Dependent Employment (excluding National Guard and Reserves)	Defense- Dependent Employment as Percentage of State Employment
Alabama	94,785	5.3%	Nebraska	32,059	4.1
Alaska	38,443	16.3	Nevada	21,581	3.8
Arizona	85,380	5.3	New Hampshire	22,067	3.7
Arkansas	36,528	3.5	New Jersey	137,546	3.6
California	905,018	6.6	New Mexico	42,213	6.5
Colorado	102,811	6.4	New York	246,865	3.0
Connecticut	91,351	5.4	North Carolina	177,889	5.4
Delaware	15,303	4.4	North Dakota	18,044	5.7
Florida	256,035	4.4	Ohio	171,971	3.4
Georgia	185,628	6.2	Oklahoma	87,012	6.1
Hawaii	87,046	17.0	Oregon	22,791	1.6
Idaho	13,521	2.9	Pennsylvania	185,529	3.3
Illinois	164,509	2.9	Rhode Island	21,963	4.4
Indiana	91,658	3.3	South Carolina	106,292	6.6
Iowa	23,623	1.6	South Dakota	13,818	4.0
Kansas	70,894	5.7	Tennessee	61,529	2.7
Kentucky	83,527	5.1	Texas	409,364	5.2
Louisiana	79,346	4.5	Utah	50,344	6.7
Maine	33,585	5.7	Vermont	6,966	2.4
Maryland	169,586	7.0	Virginia	365,973	12.1
Massachusetts	133,776	4.4	Washington	159,184	6.9
Michigan	105,221	2.5	West Virginia	12,398	1.8
Minnesota	52,418	2.3	Wisconsin	46,673	1.9
Mississippi	63,601	5.9	Wyoming	9,548	4.3
Missouri	124,969	5.1			
Montana	11,221	2.9	United States	7,179,685	6.1%

SOURCE: Defense Budget Project, published in *Governing Magazine*.

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