Appendix 2-7 A

High Technology

BACKGROUND

This report is an appendix to the Economic Development Strategy of the City of Portland (Summer 2002). The original draft of the appendix was prepared by ECONorthwest for the Portland Development Commission. The purpose of that draft was to inform the discussions of the Industry Panel for High Technology, which met three times in May and June, 2002. The deliberations of that Panel led to several recommendations for modifications to the draft report. The recommended modifications have been incorporated into this appendix.[1] The appendix is organized as follows:

- **Description of the sector.** What businesses does the sector comprise?
- **National overview.** How big is the sector at the national level?
- **Portland: the Metro area and the City.** What are the characteristics of the sector locally?
- **Issues.** What are the obstacles and opportunities for the sector?
- **Strategies.** What actions should be taken by the City to encourage the growth of the sector?

DESCRIPTION OF THE SECTOR[2]

The term “high technology” means different things to different people, but in Portland it is most commonly meant to describe computer and computer-related industries. It includes makers of semiconductors, computer equipment, and wireless communications products, as well as services. Among the high tech service components are Internet service providers, software writers, data services, and designers of computer networks. PDC is interested in this sector because of its explosive growth over the past couple decades in the region, and its relatively high wages.

In this study, the high technology sector is the sum of four industry classifications under the NAICS system. Shown in Table 1, they are (1) computer and electronic product manufacturing, (2) software publishers, (3) computer system design services, and (4) information services and data processing.

---

[1] Thus, this appendix represents the Panel’s consensus about this sector. While the original report was prepared by ECONorthwest, not every view expressed in this appendix is necessarily the view of ECONorthwest.

[2] For a discussion of data sources and analysis methods as applied to all the sector analyses that were part of this report, see Appendix 2-7, Sector Analyses: Summary.

Table 1: Industries in the High Technology sector

NAICS:	
334	Computer & electronic product manufacturing
5112	Software publishers
5415	Computer systems design & related services
514	Information services & data processing services
SIC:	
357	Computer & office equipment
36	Electronic & other electric equipment
38	Instruments & related products
737	Computer programming, data processing, & other computer related services

Source: U.S. Economic Census.

Four SIC codes, also shown in Table 1, capture some of the same industries, but the overlap misses important elements. The old SIC system was designed in the 1930's—long before there were electronic computers, wireless phones, and the Internet. Thus, the SIC definition misses some key parts of the high technology sector while including companies that make things that should not qualify as high technology, such as common household appliances.

NATIONAL OVERVIEW

High technology was nearly a $660 billion industry in the United States in 1997. More than 3.4 million people worked in the sector and about one-in-ten were either self-employed or co-owners of small, non-employer businesses.

Table 2: High Technology sector in the United States, 1997

Description of High Tech Component	NAICS	Establishments	1997 Revenues (Thous. $)	Employees & Self Employed 1st Quarter	Annual Employee Payroll (Thous $)
Establishments with employees:					
Computer & electronic product mfg.	334	17,465	$438,209,195	1,698,529	$72,717,428
Software publishers	5112	12,090	61,699,420	266,380	18,386,784
Information & data processing services	514	14,895	41,937,212	349,517	13,251,834
Computer systems design & related services	5415	72,278	108,967,614	764,659	45,150,658
Establishments without employees:					
Computer & electronic product mfg.	334	7,346	$408,193	9,183	
Software publishers	5112	15,755	481,851	19,694	
Information & data processing services	514	42,489	1,076,405	53,111	
Computer systems design & related services	5415	206,234	6,728,053	257,793	
High Technology Sector Total		388,552	$659,507,943	3,418,866	$149,506,704

Source: U.S. Economic Census.

Rapid innovation, short product life cycles, and an environment where new small entrepreneurial businesses can compete and grow successfully against industry giants characterize the high technology sector. Thus, contrary to popular perception that it is an industry of large corporations, high technology, in fact, contains mostly small businesses (see Table 2). The sector has large numbers of establishments in each of its four components.

There is another popular misperception about high tech—that it is a sector of high employment growth. From 1990 to 2000, U.S. shipments by the computer and electronic components industries rose at double-digit rates.

The reality, in terms of employment, is quite different. In Table 3, we show that the number of paid employees in computer and instruments manufacturing fell at annual rates of 2.0 and 1.7% respectively—this in spite of 1990 being a recession year for the sector.[3] Employment in electronic equipment manufacturing rose, but barely. Overall, the manufacturing component of the sector fell by more than 207,000 employees in ten years. If we were to go back 20 years[4], we would find similar declines and in all three of the manufacturing SIC codes. Only the service component of the high-tech sector has grown at the national level.

Table 3: High Technology sector trends in the United States

U.S. Covered Payroll Employment by SIC Code	1990	2000	10- Year Annual Growth Rate
Covered payroll employment by SIC code:			
357 - Computer & office equipment	439,349	357,246	-2.0%
36 - Electronic & other electric equipment	1,679,223	1,714,282	0.2%
38 - Instruments & related products	1,002,185	842,221	-1.7%
737 Computer programming, data & related	779,639	2,153,405	10.7%
National sector total	3,900,396	5,067,154	2.7%
US industry shipments:			
Computers & office equipment (MN 2000 $)	$65,419	$170,273	10.0%
Electronic components (MN 2000 $)	$62,565	$209,815	12.9%

Sources: Bureau of Labor Statistics. U.S. Census manufacturer shipments data via: http://www.census.gov/indicator/www/m3/hist adjusted to year 2000 dollars by ECONorthwest using the consumer price index.

Productivity explains the disparity between the growth rates in shipments and manufacturing employment. The sector's ability to innovate and offer consumers more products for less money has driven the rapid increase in industry sales. It simply takes less worker hours to produce a given amount of computer power today than it did a few years ago. This is why the sector can afford to pay good wages. But it also means that the industry can grow in sales without growing in employment.

While U.S. businesses as a whole saw productivity improve 0.9% a year during 1987- 1997, productivity in the computer and electronics industries grew at an astounding 7.3% annually.[5] The productivity growth rate is

[3] Clark, Don. *Chip Experts See Tough Times Ahead*. The San Francisco Chronicle. October 27, 1990. Page B-1.

[4] Due to changes made in 1988 in the way the U.S. Government classified industries, we were unable to develop 20-year trends for all sectors, although for high technology we would have been able to do so. For consistency, we chose the 1990 to 2000 period.

[5] Atrostic, B.A. and Gates, John. *U.S. Productivity & Electronic Business Processes in Manufacturing*. A paper presented at the IAOS Satellite Meeting on Statistics for the Information Industry. August 30-31. Tokyo, Japan.

multifactor, meaning that it is from the combined effects of improvements in equipment, manufacturing processes, and the quality of workers.

In 1980, the U.S. computer industry shipped $26 billion worth of products.[6] Adjusted for inflation that would be worth about $54 billion in 2000. Dollar sales since 1980 have been rising at an inflation-adjusted rate of 5.9%. In 1980, of course, mainframe computer manufacturers dominated the industry. They penetrated widely into commercial applications, but were highly inefficient by today's standards and impractical for home use. Personal computers were only just beginning to take hold in the market with Apple and Tandy (Radio Shack) being the principal suppliers in 1980. Since 1980, the extraordinary productivity gains of this sector have allowed companies to sell more products and services at steadily falling prices. Again, improved labor productivity is the principal reason the industry can deliver more for less. The result is that employment in manufacturing is not rising even though high technology product use is.

PORTLAND: THE METRO AREA AND THE CITY

GEOGRAPHIC DISTRIBUTION OF REGIONAL JOBS

In the first quarter of 1997 there were 48,596 workers in the high technology sector in the PMSA. While it is widely perceived to be a sector with a dozen or so big companies, in reality there were over 1,100 establishments with paid employees and 2,752 non-employer firms in 1997. The total payroll was nearly two billion dollars while the sector itself sold about $16.1 billion in goods and services.

Table 4: High Technology sector in the PMSA, 1997

Description of High Tech Component	NAICS	Establishments	1997 Revenues (Thous. $)	Employees & Self Employed 1st Quarter	Annual Employee Payroll (Thous $)
Establishments with employees:					
Computer & electronic product mfg.	334	230	$14,340,382	32,924	$1,345,018
Software publishers	5112	194	947,439	5,302	281,986
Information & data processing services*	514	104	159,316	1,496	52,370
Computer systems design & related services	5415	645	579,343	5,433	288,077
Establishments without employees:					
Computer & electronic product mfg.	334	82	$3,155	103	
Software publishers*	5112	199	6,016	249	
Information & data processing services	514	375	7,932	469	
Computer systems design & related services	5415	2,096	65,395	2,620	
High Technology Sector Total		3,925	$16,108,978	48,596	$1,967,451

* Estimated from higher-level data.
Source: U.S. Economic Census.

The high technology sector is concentrated in Washington County. In the City of Portland, as shown in Table 5, the sector's sales from establishments were far less than that of the PMSA. About 7,470 people were working in the sector and produced about $950 million worth of products in Portland.

[6] U.S. Computer Industry Avoids Economic Whirlpool. Washington Post. February 9, 1981.

Table 5: High Technology sector in the City of Portland, 1997

Description of High Tech Component	NAICS	Establishments	1997 Revenues (Thous. $)	Employees & Self Employed 1st Quarter	Annual Employee Payroll (Thous $)
Establishments with employees:					
Computer & electronic product mfg.	334	34	$537,648	2,886	$98,073
Software publishers	5112	47	147,262	1,188	52,863
Information & data processing services	514	45	83,904	724	25,013
Computer systems design & related services	5415	196	155,693	1,619	76,730
Establishments without employees:*					
Computer & electronic product mfg.	334	18	$646	23	
Software publishers	5112	95	2,786	119	
Information & data processing services	514	110	2,706	138	
Computer systems design & related services	5415	618	19,931	773	
High Technology Sector Total		1,163	$950,576	7,470	$252,679

* Estimated using data for Multnomah County.
Source: U.S. Economic Census and the Oregon Employment Department ES-202 data.

The clustering pattern is typical of sectors where proximity to similar firms and workers is important. We see this pattern for high technology elsewhere in the country. For example, a recent study of the San Diego metropolitan area found that 47% of all the high tech firms were in just seven of the area's 131 Zip codes and that a third of all high tech employees lived in just ten of those Zip codes.[7] This need to cluster and locate near where employees live helps explain why Washington County has such a high concentration of high technology establishments while Clackamas County, despite having available land and other positive attributes, does not.

The geographic distribution of high tech jobs differs by subsector. Engineering-oriented workers prefer suburban communities where they can raise their families. Thus, high tech manufacturers and research facilities are often located in the suburbs. In the San Jose area, for example, most high tech establishments are located well outside of urban downtown, which at one point was in decline. Now Downtown San Jose has attracted creative content firms.[8] Pittsburgh is one of the only cities to capture a significant amount of high tech manufacturing within its urban core (a result of its topography, which creates a geographic constraint to suburban growth, and thus limits the availability of suburban industrial land).[9]

While manufacturing is in the suburbs, high tech content companies, such as those who make multimedia and Internet products, are typically concentrated in urban centers. For example, 62% of Toronto's multimedia firms are in the innermost municipality and 65% of New York metropolitan firms are in Manhattan. Because this sector of high technology is based on combining information and communications it still relies "heavily on interpersonal networks and strong backward linkages leading to agglomeration in urban centers."[10] They depend on "convergence and

[7] San Diego Regional Economic Development Corporation. *Where the Tech Workforce Lives.* January 2002.

[8] Pulcrano, Paul. *Who Built Downtown?* Metro This Week. February 25, 1999.

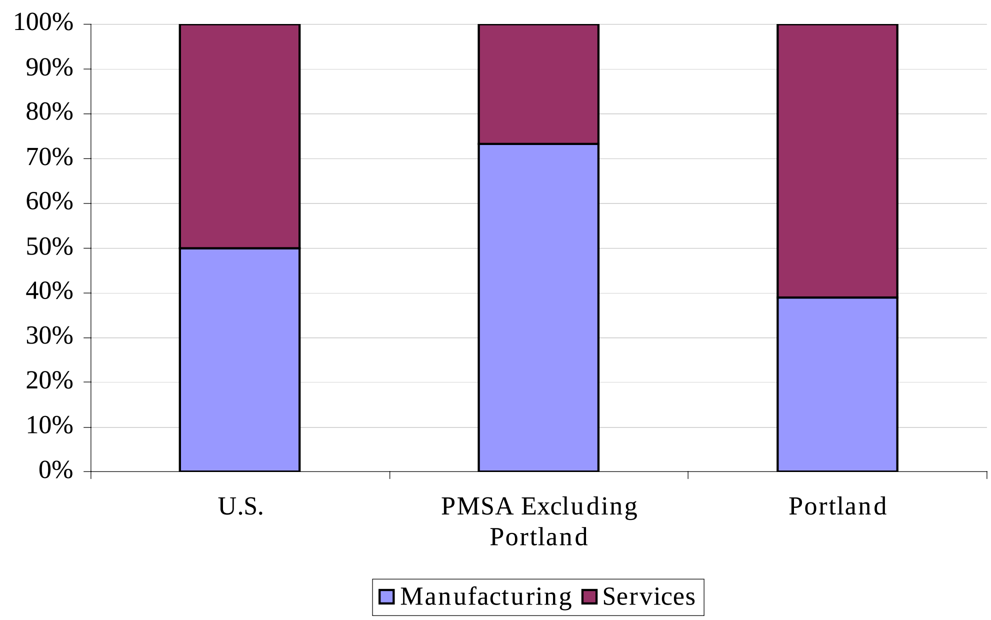
[9] Sunnucks, Mike. *Tech Sector has a Distinctly Urban Feel in Pittsburgh.* Pittsburgh Business Times. January 5, 2001.

[10] Brail, Shauna. *The Paradox of Technological Change: New Media in Old Urban Areas*. Department of Geography, the University of Toronto.

cooperation and collaboration and the confluence of technology and tools with creative content and infrastructure, you're naturally going to form clusters. And people who will be most competitive are companies that are in a cluster." Urban centers are natural areas for such businesses to locate because they generally employ young, single, creative professionals who prefer living in urban environments.[11]

This urban-suburban difference is evident in the Portland area. Data show that the share of people in the service (or "knowledge-based") portion of high technology is greater in Portland than in the rest of the PMSA. Figure 1 shows that, nationally, work in high technology was split nearly 50-50 between manufacturing and services. Jobs in the PMSA, excluding the City of Portland, were heavily skewed towards manufacturing (73%). In the City of Portland only 39% of the work was in manufacturing.

Figure 1: Service (or knowledge-based) versus manufacturing work in the High Technology sector, various areas in 1997



Source: U.S. Economic Census.

This finding is consistent with other research, which has found similar patterns of high technology specialization. One study noted "metropolitan areas that show high concentrations of high tech employment in one technology, like software, will show very low concentrations in hardware."[12]

The high technology manufacturers, as a whole, prefer suburban locations because they offer lower costs, open land, and settings that fit their image (as

---

[11] Kotkin, Joel. *Net Economy Creates New Silicon Valleys.* Industry Standard. February 14, 2001.

[12] Cortright, J. and Mayer, H. *High Technology Specialization: A Comparison of High Technology Centers*. Center on Urban and Metropolitan Policy. The Brookings Institution. January 2001.

being very different from old style manufacturing commonly found in the cities). Suburban locations also allow for ample parking, which makes it easier and safer for workers to commute late at night. Tri-Met, for instance, curtails bus service at night and ends it completely after midnight. By contrast, high technology businesses that deliver creative content tend to prefer urban locations because their employees typically value urban amenities and social diversity.[13]

The concentration of knowledge-based service firms in Portland may be a positive development for the city because national data show that the service component (other than data processing) pays more and is faster growing than high tech manufacturing. According to the 1997 Economic Census, paid service employees in high technology earned about $13,000 more a year than their counterparts in manufacturing. In the PMSA, the difference is about $10,000.

While services compose a much larger share of the high tech employment in the City of Portland than in the rest of the PMSA, the City has only 29% of all the software and related computer services jobs in the region.

A 1997 survey of Portland businesses indicated the following advantages to being located downtown:

- Proximity to professional or support services, clients, and business associates.
- Access to public transportation.
- Image, atmosphere, access to varied stores and restaurants.

The study also listed disadvantages that firms in and related to the services side of the high technology sector identified with downtown Portland. They include:

- The lack of affordable parking.
- Traffic congestion.
- Homeless population.
- Crime and drug activity.
- Rent is high.

One major study indicates that there is evidence of dispersion in high tech manufacturing—plants are either moving to lower cost areas in the U.S., or production is moving overseas. The services part of the sector, however, is

[13] Sommers, Paul and Carlson, Daniel. *Ten Steps to a High Tech Future: The New Economy in Metropolitan Seattle*. Center on Urban and Metropolitan Policy. The Brookings Institution. December 2000.

becoming more concentrated. Service activities benefit from geographic proximity. Quality of life and access to a pool of talented labor are two factors identified as important for growth in high technology services.[14]

Another subcategory of high technology, albeit imbedded in the four NAICS codes of the sector, is wireless communications technology. The PMSA has several important firms in this subcategory. Perhaps the most notable is TriQuint Semiconductor, whose 700 employees make sophisticated gallium arsenide circuits that are used in wireless devices.[15] The PMSA is home to several companies engaged in the software side of the business.

EMPLOYMENT TRENDS

High technology employment in the Oregon portion of the PMSA grew between 1990 and 2000 at a 5.8% rate—far above the national growth rate. Of the four components of the sector, only one (SIC 38) showed job losses. Back in 1980, the largest local company in that SIC code was Tektronix. With more than 24,000 workers at its peak, Tektronix was Oregon's biggest high technology employer. By 1990 they had 8,000 in the Portland area.[16] In 1999 their workforce in the Portland metropolitan area was down to 3,600[17] and it has declined further since then.

Table 6: High Technology sector trends in the PMSA (Oregon Portion)

Portland PMSA (Oregon Portion) Covered Payroll Employment by SIC Code	1990	2000	10- Year Annual Growth Rate
357 - Computer & office equipment	3,317	4,179	2.3%
36 - Electronic & other electric equipment	12,192	27,920	8.6%
38 - Instruments & related products	10,438	8,424	-2.1%
737 Computer programming, data & related	7,189	17,594	9.4%
Oregon sector total	33,136	58,117	5.8%

Source: Oregon Employment Department.

During the 1980s and 1990s, Intel gradually replaced Tektronix as a region's dominant high tech firm. Worldwide employment at Intel rose from 41,600 in 1995 to 86,100 in 2000 (15,500 of which worked at one of the eight Intel campuses in the Portland metropolitan area).[18] When we look at employment at the three next largest semiconductor companies with plants in the U.S., we see less employment growth. Taiwan Semiconductor, which owns the WaferTech plant in Clark County, saw its worldwide employment

---

[14] DeVol, Ross. *America's High Tech Economy*. Milken Institute. July 13, 1999. Pages 77 – 78.

[15] Oregon Communications Council. *Communications as a Cluster*. Presentation to the Portland Development Commission. November 8, 2001.

[16] Eisler, Gary. *High Tech Zigzags Through the Decade*. Oregon Business. February 1991. Page 42.

[17] Tektronix's Bold Move: Divide and Survive. Su-Jin Yin. *The Sunday Oregonian*. June 27, 1999. Page E-1.

[18] Former Timber Town Faces Issues of Growth. Weld Royal. *Industry Week*. July 16, 2001.

rise from 3,412 in 1995 to 14,636 in 2000. The number three company, Texas Instruments cut its total employment from 60,375 to 42,481. Applied Materials went from 10,537 workers to 16,263.[19] So, in net, the next three largest after Intel saw their workforce level decline.

Table 7 shows that the best paying high technology jobs are outside the City. In Portland we estimate (using SIC industry definitions and covered employment data) that the sector had 9,786 paid employees in 2000 earning an annual average of $59,775. Workers outside of Portland made an average of $84,911. We believe that the concentration of research occupations in Washington County is one reason why the average pay is higher outside the City.

Payroll Data in SIC Defined High Tech Sector	2000
Average Employment:	
PMSA	66,464
City of Portland*	9,786
Average Annual Wage:	
PMSA	$78,466
City of Portland*	$59,775

Table 7: High Technology sector employment and wages, PMSA and Portland, 2000

Sources: Oregon Employment Department and Washington Economic Security Department ES 202 tapes for 2000.
* Estimated by ECONorthwest.

Table 8 lists the top ten high technology sector employers in the Portland-Vancouver PMSA. Intel stands out as the largest single employer with 12,000 followed by a number of firms with employment between 200 and 2,000. Among the ten largest regional employers, only two are located in Portland (Wacker and Precision Interconnect). Also, only two firms, representing just 13% of the employment in Table 8, are firms headquartered in the PMSA. The rest are out-of-state companies.

[19] Based on employment totals from the annual reports of Intel, Taiwan Semiconductor, Texas Instruments, and Applied Materials. Companies were ranked according to their market capitalization (total value of their common stock) on February 20, 2002.

Table 8: Largest High Technology manufacturing sector employers in 2002

Top 10 Employers in 2002	Employees	Year Begun	Main Business
Intel	12,000	1976	microcomputer components
Tektronix	2,000	1946	test & measurement devices
Hewlett-Packard	1,900	1979	printers
SEH America	1,700	1979	silicon wafers
Wacker Siltronic	1,600	1978	silicon wafers
Maxim Integrated Products	1,500	1984	Integrated circuits
InFocus Corp.	1,235	1986	projection equipment
Xerox	1,200	2000	printers
Precision Interconnect	1,050	1975	electronic cables
LSI Logic	1,000	1995	microcomputer components

Sources: Portland Metropolitan Chamber of Commerce, Largest Employers of the Portland Vancouver Metropolitan Area 2002 edition. ECONorthwest deleted Cypress Semiconductor from the Chamberís list because a search indicated that their employment level was less than reported in the 2002 edition.

Twenty years ago only eight firms in the high technology sector had at least 200 workers. In 1982, Tektronix was by far the biggest in the local industry. As can be seen in Table 9, they had 16,000 employees. Of the top eight in 1982, two closed and only three had more employees in 1992.

Table 9: Largest sector employers in 1982 and their employment in 2002

Firms That Employed 200 or More in 1982	Employees in 1982	Employees in 2002	Current Status
Tektronix	16,000	2,000	operating
Intel	3,000	12,000	operating
Floating Point Systems	1,100	-	closed
Wacker Siltronic	650	1,600	operating
Hewlett-Packard	580	1,900	operating
Electro Scientific Inds.	500	420	operating
Code-A-Phone	275	-	closed
Sidereal Corp.	260	under 5	operating (new ownership)

Sources: Portland Metropolitan Chamber of Commerce, Largest Employers of the Portland Vancouver Metropolitan Area (1982-1983) and the 2002 edition.

Table 10 compares Portland's high tech employment to 106 other metropolitan areas across the United States using an analysis of the 1997 Economic Census,[20].

[20] There were 106 areas that we were able to estimate. Others metro areas, because they had one large dominant company, had withheld employment data for one or more high tech components and their statistics could not be calculated. Most were small PMSAs. However, two are know to have large high technology sectors and they are Nassau and Suffolk Counties in New York, and Atlanta, which is the high tech center of the southeast.

Table 10: Leading metropolitan areas of High Technology sector employment, 1997

Rank	Metropolitan Area	Employees
1	San Jose, CA	212,249
2	Washington, DC-MD-VA-WV	138,662
3	Boston, MA-NH	133,745
4	Chicago, IL	125,604
5	Dallas, TX	107,722
6	Los Angeles-Long Beach, CA	102,613
7	Orange County, CA	70,268
8	Minneapolis-St. Paul, MN-WI	66,738
9	Philadelphia, PA-NJ	65,551
10	Phoenix-Mesa, AZ	56,051
11	Seattle-Bellevue-Everett, WA	55,897
12	New York, NY	55,782
13	Austin-San Marcos, TX	49,521
14	Oakland, CA	48,159
15	San Diego, CA	47,296
16	San Francisco, CA	46,366
17	**Portland-Vancouver, OR-WA**	**45,155**
18	Detroit, MI	43,733
19	Raleigh-Durham-Chapel Hill, NC	40,153
20	Houston, TX	36,908

Sources: ECONorthwest analysis of Bureau of Labor Statistics and 1997 Economic Census data.
Note: the U.S. Census, due to individual establishment confidentiality, did not disclose data for the entire sector for Nassau and Suffolk Counties in New York, and the Atlanta metropolitan areas. ECONorthwest believes all three of them have larger high technology sectors than the Portland PMSA.

The Portland PMSA ranked 17th in high technology employment. The top ranking metropolitan area is no surprise—San Jose, California, the home of Silicon Valley. Number two is the Washington D.C. area. While there are few electronic manufacturing firms there, Washington has a very high concentration of businesses in NAICS code 5415 (computer systems design and related services). Over half of the country's Internet traffic passes through firms based in the Washington D.C. metropolitan area.[21]

Table 11 shows the Portland-Vancouver PMSA ranked 17th in terms of its location quotient, which indicates the concentration of high technology workers in the PMSA, relative to its total employment in the region. Notably, the PMSA ranks fourth in the nation in revenues per paid employee. This may be an indication that the PMSA has a more highly productive workforce and this bodes well for the future of the sector.

We said, "may be" rather than "is," because revenue per worker is affected by factors other than labor productivity. It could be that plants in the PMSA produce more final stage products (as opposed to unfinished products) so that the unit sales prices average higher than in other metropolitan areas.

[21] DeVol, Ross. *America's High Tech Economy*. Milken Institute. July 13, 1999. Page 68.

Secondly, Portland's high technology manufacturing plants are comparatively new and, thus, they are comparatively more efficient—but this an edge that can erode over time as new plants are built elsewhere. Finally it is a practice at some major plants in the PMSA to contract out work for operating and maintaining equipment to outside firms that are not classified under the high technology NAICS codes – which will inflate revenue per employee figures.

Table 11: National ranking of the PMSA High Technology sector, 1997

Sector Measure	Rank Out of 106 Metro Areas
Number of paid employees	17
Annual revenues	9
Location quotient versus nation	17
Revenues per paid employee	4

Sources: ECONorthwest analysis of Bureau of Labor Statistics and 1997 Economic Census data.

Table 12 further illustrates the productivity of high tech workers in the PMSA, who generated $331,488 in revenues each compared to $192,903 nationally. Portland had 14% of the PMSAs employees, but only six percent of the sector's revenues. On the other hand, Portland has more than twice the percentage of workers who are self employed in the sector.

Table 12: Sector statistics

	1997
1997 Sector revenues per worker:	
United States	$192,903
Portland-Vancouver PMSA	$331,488
City of Portland	$127,252
Portland's share of:	
The sector's employees in the PMSA	14%
The sector's payroll in the PMSA	13%
The sector's revenues in the PMSA	6%
Location quotients (paid employees):	
PMSA versus the US	1.88
Portland versus the PMSA	0.36
% of sector workers in non-employee firms:	
City of Portland	14%
Rest of the PMSA	6%
United States	10%
National sector accounting ratios:	
Pre-tax profit to sales	5.0%
Net fixed assets to total assets	28.7%
Sales to total assets	1.59

Sources: U.S. Bureau of Labor Statistics, U.S. Economic Census, and ECONorthwest.

Table 13 reports the economic impacts associated with a $1 million increase in output (or sales) for typical firms in each of the four industries that compose the sector. For example, if a manufacturer of computer and office equipment increased its sales by $1 million, we estimate total output in the Portland area (five county Oregon portion) would increase by $1.98 million. Total regional employment would increase by 12 with the average income per job at $51,917. For the typical firm in this industry, about 35% of the output is made for export outside of the five-county region.

Table 13: Gross Economic Impacts Associated with $1 Million Increase in Industry Output

Industrial Sector	Total Change in Regional Output	Total Change in Regional Employment	Labor Income per New Job	Percent of Output Made for Export
Computer and office equip.	1,980,000	12	51,917	35%
Electronic and other electric equipment	1,680,000	10	46,505	54%
Instruments and related products	1,910,000	16	44,516	47%
Computer programming, data processing	1,840,000	20	47,602	37%

Source: ECONorthwest using IMPLAN input-Output model for a five county region (Multnomah, Washington, Clackamas, Columbia, and Yamhill).

In summary:

- Within the PMSA, a disproportionate number of the jobs in high technology are outside the City, especially in the manufacturing and related research sub-sectors.
- Self-employed and high technology service jobs make up a larger share of the high technology employment inside the City of Portland than in the PMSA.
- Contrary to the widely held belief, the number of high technology manufacturing jobs in the country has been falling for the last 20 years, although in the PMSA it has been growing.
- All of the growth in employment seen in high technology nationally is the result of the service component—which is also the component that dominates the high tech sector inside the City of Portland. High technology service jobs (other than information services and data processing) pay considerably more than high tech manufacturing jobs.
- The PMSA's high technology workforce produces more revenue per employee than all but four other metropolitan areas in the country. This is an indication of strong labor productivity, although the young age of the industry's plants in the PMSA and the high valued products they manufacture also contribute to the favorable revenue-per-employee ratio.

ISSUES

Through their discussions, as well as research completed prior to the meetings, Panelists identified a number of obstacles and opportunities that face the high technology sector in Portland. We organize these issues under six headings that cover the location factors that are important to businesses: building space, workforce, access to markets, business environment, business formation and acceleration, and quality of life. Not all of these factors are key issues for this sector, so we do not discuss them all. For details on the importance of these factors to businesses in general, see Appendices 2-3, 2-3A, 2-3B, and 2-3C.

To summarize the key issues for the sector, we note the following:

- Access to high-quality local talent and superior schools is a major concern of both the manufacturing and services component of high technology in the PMSA.
- Firms in manufacturing are also concerned about the availability of land. The City of Portland lacks the contiguous acreage of industrial land needed to attract a large high technology manufacturer.
- The City also lacks the resident labor force and agglomeration of high-tech manufacturing establishments within the City limits.

- The City of Portland would gain more by having direct growth in high technology knowledge-based jobs. Not only are the wages higher than in manufacturing, but the workers for this part of the sector are apt to prefer living in the City—especially those in the creative content fields.

BUILDING SPACE

One anecdote from reliable sources is of one of the leading high technology manufacturing firms in the country. They came to Washington County looking for a place to build a large plant. The company already had many workers in the PMSA providing support services to other manufacturers and was attracted to Oregon by the critical mass of high technology companies here, lower cost of living, and other qualities of the region. The company was unable to find a contiguous parcel of land adequate for placing a manufacturing plant the size they had needed. The closest alternative was in Clackamas County, but that was too far from the firm's customers. They chose not to locate their plant in the Portland area.

The knowledge-based industry is an efficient user of downtown buildings—they can occupy many configurations of offices, warehouses, or light manufacturing. The only major renovation requirement would be to bring in high bandwidth data lines. Many downtown buildings with low occupancy rates have fiber optic lines at the street level or into the building. The Pearl District revitalization is a primary example of these dynamics. The surge in demand for downtown office space during the dot.com bubble of 2000-2001 is evidence that much of the infrastructure within the City is attractive to this industry segment.

WORKFORCE

There is a broad consensus that for the sector to thrive, the State must produce more high quality science and engineering graduates. "In the New Economy, the key engines of growth—technology and research-based companies and industries—are fueled by a large and high-caliber scientific and engineering workforce. So growing or attracting a high-quality, scientific workforce is critical to continued economic growth in states. These workers allow state economies to boost innovation and technological change (in both new products and production processes), and in so doing create higher value added and higher-wage jobs."[22]

The growth of high tech in Washington County came about in spite of the State's weak academic credentials. At its root was Tektronix, which at one point was Oregon's largest manufacturer. "The success of Tektronix triggered the assemblage of a critical mass of skilled workers and infused the region with its own business culture."[23] The company trained and valued employees

[22] Atkinson, R., Court, R., Ward, J. *The State New Economy Index*. Progressive Policy Institute. Page 32.

[23] Cortright, Joseph and Heike, Mayer. *The Ecology of the Silicon Forest.* March 2000. Page 17.

who took research and engineering risks. Tektronix board members persuaded Intel officials to locate a facility in Oregon. And in the 1980's and 1990's, when Tektronix downsized, many of its extremely talented workers were laid-off. Because as one contact told us "once people are here in the region, they tended to stay"[24] the layoffs at Tektronix ironically stimulated ex-employees to either form or join new high tech firms in the area. As one report noted, "you find Tek alumni in almost every company."[25] The question for the next 20 years is—What does Oregon do now for homegrown talent? It is a widely recognized industry concern, in particular those with close ties to Oregon.

Oregon's university system is considered by many to be mediocre. Only three of Oregon's 25 National Merit Scholarship winners in 1999 went to an in-state college. Technology degrees produced by Oregon schools dropped 25% from 1990 to 1996, ranking the State 48th nationally.[26]

The paucity of local science and engineering graduates has affected the mix of high technology establishments in the PMSA. Establishments owned by out-of-state and foreign corporations dominate the sector. They staffed their operations with scientists and engineers that came here from outside Oregon, while the great majority of their production workers are Oregonians. Intel, for instance, recruits 80% of its engineers from outside the state.[27]

This is problematic on two long-term development fronts. First, the lack of high caliber Oregon graduates in science and engineering means that there are fewer people to start-up successful new firms—a feature that is prevalent for this sector in other parts of the country. Secondly, because of this, a large proportion of facilities in the PMSA are run from out-of-state and they are more vulnerable to closure or relocation than locally owned ones. Ties to the local community are weak.

Others argue that proximity is not the most important issue and that high tech firms routinely recruit graduates from other states and countries, even for their operations in Silicon Valley. However, interviews with local firms indicate that continuing education is very important for both technical and managerial employees. Local firms expressed dissatisfaction with the quality of higher education in the PMSA for continuing education.[28]

The poor quality of K-12 public schools is also a concern. As noted earlier, engineers and scientists see suburban areas as good places to live and raise

---

[24] Cortright, Joseph and Heike, Mayer. *Regional Connections – Portland's Knowledge Based Economy.* February 2000. Page 15.

[25] *Op.Cit.*, page 14.

[26] Hernandez, Romel. *Universities Hold Back Oregon's Future*. Sunday Oregonian. January 23, 2000.

[27] Royal, Weld. *World-Class Communities – Portland's Juggling Act.* Industry Week. July 16, 2001.

[28] Cortright, Joseph and Mayer, Heike. *Regional Connections, Portland's Knowledge-Based Economy*. February 2000. Page 11.

their children. Good schools are a critical amenity. School districts in the PMSA are planning on reducing the number of school days to below 165 a school year, which on a calendar basis is about a month less school than most districts in the rest of the country. Together with larger class sizes, it is a quality of life issue that works against the recruitment of high technology professionals.

For the self employed, who have children, which are common in the high paid service end of the sector in Portland, the short school year translates directly into fewer working hours, lower incomes, and less incentives to live in Portland. This issue was brought up in one of our interviews with a Portland based professional.

A good example of the importance of K-12 education in deciding where to locate high tech research comes from a quote from Dr. Julius Krevans, who was the Chancellor of UCSF. He said that through focus groups the number one issue in deciding where to locate a new research campus was surprisingly the quality of K-12 education. "I think that entities such as ours, which hold themselves out as being strong advocates for a strong infrastructure for the economy of the region, have to be passionate advocates for the quality of K-12 education." Referring to the Bay Area high tech industry, he said "I have absolutely no comfort that just having a nice climate and a pleasant environment is sufficient to preserve a leadership role in a knowledge-based economy."[29]

ACCESS TO MARKETS

For the City of Portland, the prospects of attracting manufacturing firms or their suppliers are low. The City lacks close proximity to existing high technology manufacturing plants and their workers. Washington's County's lower occupancy, local tax, and parking costs will continue to be attractive to the sector's manufacturers. Likewise for software companies, with products that are more algorithmic and less creative in nature, the higher costs would also discourage a central city location.

High tech service firms whose work depends greatly on creative content also face higher costs in the City, but there are two important aspects of their business that could work to the City's advantage. First, many of the creative content companies work in teams with freelancers and other companies. They have frequent face-to-face contacts with clients and suppliers. Their largest cost item is employee time. Locating in the center of Portland serves to minimize employee time on travel while maximizing networking opportunities. Thus, being inside the City saves them money, enhances their product quality, and improves their efficiency. Second, being clustered near downtown and centrally located for clients facilitates marketing. For these firms, revenues are likely to be higher inside Portland than in the suburbs.

[29] Bay Area Economic Forum. *Why the Bay Area is the Global Technology Leader and How to keep it That Way*. City of San Jose. Spring 2001. Page 5.

For firms that sell prepackaged software internationally, the suburban enclave model may be appropriate, but for the multimedia firm making animated interactive software for schools, for example, the urban setting is a better choice.

BUSINESS ENVIRONMENT

PERMITTING AND COST OF DOING BUSINESS

Businesses value stable, predictable, and cooperative government. This is especially the case for emerging companies and the self-employed because they usually lack the sophistication of bigger businesses. In interviews, respondents noted that the City of Portland needs a more predictable political and regulatory climate.

One large firm indicated that it preferred Washington County because the County government was easier to work with than Portland city government. In their limited experience operating in Portland that said there were too many conflicting interests, which made their investment decisions unpredictable.

A smaller firm in the creative content area said, “Working with the City government to get building permits has been a bad experience.” Repeating something heard many times before from small firms, we were asked to suggest that the City government simplify the processes for doing business with them and to adopt a more entrepreneurial attitude.

Finally, Panelists believe operating costs and taxes are high in the City and parking is a problem. Emerging companies have to be cost effective, thus they tend to locate outside the City.

REGIONAL COOPERATION

Panelists noted that City leaders needed to recognize the importance of a sector located primarily outside the City borders. While most of the high tech employment in the area is located outside of the City, the sector benefits the City. High-tech companies hire lawyers, accountants, and creative service companies from the inside the City. Moreover, some of the workers in the high tech companies live in the City. The companies bring in jobs, production, and infrastructure. A 1998 study commissioned by Intel reported that the company’s Washington County operations generated about 3,000 jobs in Multnomah and Clackamas counties[30].

In the view of Panelists, local governments need to educate the public and gain support for public policy that will help the technology industry. Panelists believe few City policies draw people to the region and keep them here. Portland public policy does not engage in the discussion about needs of

[30] See ECONorthwest. October 1998. *Economic Impacts of Intel's Oregon Operations.* Prepared for the Intel Corporation.

companies. The City needs to acknowledge the importance of manufacturing facilities and operations in the region and the role and importance of the high tech ecosystem.

In 1999, Washington County and Intel agreed to Strategic Investment Program (SIP) that essentially capped property taxes on capital investment to the first $100 million. No representatives from the City of Portland were involved. One Panel member stated it is important for the City to acknowledge the importance of the SIP even if the proposed investment is not physically located in the City. The City of Portland needs to collaborate with Hillsboro, Gresham, and other jurisdictions in strategies designed to boost regional employment.

In short, there is a need for regional cooperation. Panelists believe City Commissioners should take the leadership position. Even if the City does not take the lead in fostering cooperation, it needs to be willing to follow.

BUSINESS FORMATION AND ACCELERATION

CRITICAL MASS

The PMSA has a sizeable pool of high technology workers—both at the technical and managerial levels. In addition, local workers in other fields, such as law, accounting, and finance, have developed expertise in working with high technology enterprises.[31] It is this build-up to a critical mass that has facilitated the growth of high technology manufacturing in Washington County, while in the rest of the U.S. employment has fallen.

In the creative content side of the sector, Portland has not quite reached a similar critical mass. Companies find it difficult to find well-trained workers that have realistic expectations. The poor quality of arts education, especially in the public schools, is hurting this sector. The depth of the labor pool in film and post-production is, by one person interviewed, somewhat shallow.

Part of the problem is on the demand side. The communications and media businesses in the City are both sources of workers for creative content high tech and buyers of services, but the creative sector depends heavily on external customers. One person noted that local customers have an “if they’re local they can’t be good attitude.” There is a perception by some in Oregon corporations, and even in the public sector, that out-of-state creative content providers are better qualified. Fortunately for the industry it is not a perception shared by everyone outside of Oregon.

Sector Panelists noted that without Intel and LSI in the region, the high technology industry in the City and the surrounding areas would collapse. These companies have export-based fabrication plants. Consequently, they have a sizable net impact on the local economy. One Panel member argued

[31] Cortright, Joseph and Mayer, Heike. *The Ecology of the Silicon Forest,* March 2000. Page 5.

that other companies would not come if the chips were not here. However, another Panelist countered that chips are manufactured in China, yet companies in other parts of the world do business using those Chinese manufactured chips.

One Panelist noted that local employment at Intel has tripled in research and development during the past decade and argued the growth would not have happened if the chip-fabrication plant had not already been here. Another noted that the LSI campus in Gresham started as strictly a fabrication plant; however, because the campus had the most updated equipment, company officials located design teams in Gresham.

Given lower labor costs abroad, Panelists agreed that, in the long run, there would not be fabrication plants on US soil. Despite this trend, most Panelists believed the City needs to delay the departure of fabrication plants in the Portland area as long as possible and claim a share of the growing research and development work.

ACCESS TO CAPITAL

As noted before, eight of the ten largest high technology employers in our PMSA are headquartered in other states or countries. In the Portland region there have been many start-ups, but the level of activity is significantly less vibrant than what is seen elsewhere, in particular in Silicon Valley. The perception of the venture capital community is that Portlanders are more laid back and less apt to dedicate themselves entirely into risk ventures with high reward potential.[32]

With comparatively fewer investment opportunities here, venture capital is attracted to more fertile areas. It is, after all, a hands-on form of investing, so close proximity is a key variable in deciding what start-ups to invest in. As such, Oregon has always had difficulty attracting venture capital, even for high technology, even though it has a critical mass of talent. The State ranks 18th nationally in venture capital while Washington is 5th and California is first.[33]

TECHNICAL ASSISTANCE

Panelists had mixed opinions about the need for additional technical support for emerging businesses. Some Panelists believe some smaller firms could benefit from additional technical support; however, one Panelist countered that technical assistance is sufficient and pointed to the success of the Oregon Entrepreneurs Forum.

[32] Cortright, Joseph and Mayer, Heike. *The Ecology of the Silicon Forest,* March 2000. Page 9.

[33] Atkinson, R., Court, R., Ward, J. *The State New Economy Index*. Progressive Policy Institute. Page 9.

QUALITY OF LIFE

Panelists described the region's quality of life as declining as evidenced by weaker schools, more traffic congestion, and higher housing costs. These declines make it more difficult to attract people to the area and to keep them.

STRATEGIES

To address the issues identified above, the High Technology Panel identified, evaluated, and ranked strategies that the public sector (primarily, but not exclusively, the City of Portland) and the private sector could adopt and implement. It first made a *long list* of desirable strategies, and then reduce that list to a *short list of priorities*: the strategies that needed to be accomplished first because of their importance, the importance of other strategies that require their completion first, or both.

THE LONG LIST

Panelists considered the following four issues as most critical to the growth of the high technology sector and developed strategies to address each issue.

- Improve the university system
- Increase the capital and technical resources for emerging businesses
- Strengthen the airport
- Increase City involvement and regional cooperation

In the following sections, we detail the full list of strategies recommended by Panelists.

IMPROVE THE UNIVERSITY SYSTEM

The Panelists consider improving the university system, and particularly the Schools of Engineering and Science at PSU, as key to the sector's continued health.

- **Expedite completion of PSU Engineering Building and create scholarships.** (Priority strategy; see full description under "The Short List")
- **Fund engineering chairs**. The City of Portland should provide funds sufficient to support three chairs in the PSU School of Engineering. The action would underscore the City's commitment to develop a knowledge-based workforce to support the increasing demands of the high-technology sector.
- **Develop an engineering center**. The City and its partners should facilitate and fund the construction of a university center that would house classes from a number of elite engineering schools. The center

would offer a building with state-of-art telecommunications infrastructure. Participating schools would provide equipment and faculty.

- **Develop programs for engineering professionals**. Public universities should collaborate to develop a competitive post-graduate engineering program. The program would be modeled on the Oregon Executive MBA program, which is currently offered by PSU, UO, and OSU. The program would select a limited number of regional professionals interested in obtaining a Masters degree.

- **Engineering and science magnet school.** City leaders should collaborate with the Portland Public Schools to create a magnet school focusing on engineering and sciences. The school would be based on existing models in Washington County and Gresham.

INCREASE THE CAPITAL AND TECHNICAL RESOURCES FOR EMERGING BUSINESSES

Panelists believed technical and capital resources for new and emerging businesses in Portland were inadequate. Panelists proposed four strategies in this area.

- **Create a permanent high-technology advisory panel**. (Priority strategy; see full description under "The Short List").

- **Accelerate tech transfer for commercialization.** Local universities, industry, and the PDC should advocate for a system that promotes the efficient identification, management, development and commercialization of marketable research and technologies. PDC may also have opportunities to participate in tech transfer activities or funding, depending on resource availability. Through tech transfer programs, additional capital will be made available to local professors, so they can teach part time as they continue to develop their products. PDC would play a key role in developing and supporting a network that attracts capital to the region to fund feasible projects.

- **Leverage public pension fund investments to draw venture capitalists to the region.** As a condition of state and local investments in alternative funds, state and local governments should require that venture capitalists associated with the funds, visit the region to assess local investment opportunities. The agreement would not require investments in Oregon companies but would ensure that fund representatives periodically visit the region to review selected business plans. Such agreements would immediately improve local access to capital and would cost state and local governments almost nothing.

- **Create a high-technology business incubator.** The business incubator would be located adjacent to PSU and offer technical assistance to small and emerging businesses.

STRENGTHEN THE AIRPORT

- **Attract an Asian Airline carrier to PDX.** Several high-technology companies list the lack of a direct flight to Asia as the issue most likely to limit the sector's future growth. With the right incentives, an Asian airline carrier may consider PDX. Flights could come from California and make a shorter flight to Asia.

INCREASE CITY INVOLVEMENT AND REGIONAL COOPERATION

- **Endorse UGB expansion to increase supply of industrial lands**. (Priority strategy; see full description under "The Short List")

THE SHORT LIST (PRIORITIES)

After the High Technology Industry Panel identified the full list of strategies, they ranked the strategies to identify the most important. The following strategies were identified as their priorities:

PRIORITY ONE: EXPEDITE COMPLETION OF PSU ENGINEERING BUILDING AND CREATE SCHOLARSHIPS

The City of Portland should double its contribution to the PSU Engineering Building, from $5 million to $10 million. City Councilors should actively raise funds for the remaining balance of the building's capital campaign. A state-of-the art building would strengthen the university's ability to attract additional quality faculty and students to the region and would represent the first step in the creation of a world-class engineering program. In addition, the City, university, and business leaders should create a scholarship program using the American Electronics Association model. Recipients would receive $2,500 annually and would be offered paid internships at participating businesses and government agencies. As a full participant in the program, the City would offer five scholarships to students in each entering PSU engineering class—or a total of 20 scholarships when the program reaches full implementation. Student interns would work in the engineering divisions of a number of City bureaus. The program would serve to retain the state's best students and increase the likelihood that they would remain in Oregon after they graduate. The program should begin in Fall 2003.

Who: City, business leaders, PSU
When: Beginning Fall 2003.
Resources: General Fund for City scholarships and internships

PRIORITY TWO: ENDORSE UGB EXPANSION TO INCREASE SUPPLY OF INDUSTRIAL LANDS

To address a documented shortage of industrial lands in the metropolitan area, the City and its regional partners should pass a resolution supporting the careful expansion of the urban growth boundary with the specific goal of creating additional parcels large enough for industrial expansion. The resolution would signal that City policymakers recognize the critical role that regional economic growth plays in fostering the City's long-term vitality. The City should pass the resolution prior to the completion of Metro's periodic review of the UGB, which is scheduled to conclude in late 2002.

Who: City Council
When: Fall 2002
Resources: None

PRIORITY THREE: CREATE A PERMANENT HIGH-TECHNOLOGY ADVISORY PANEL

The City should convene a permanent advisory panel for the high-technology sector. City should look to existing associations and major companies for membership. The Panel would provide the City on-going input about its workforce, capital access, and building space needs. The Panel would collaborate with the Software Association of Oregon, Oregon Entrepreneurs; Forum, and the American Electronics Association to disseminate business development and capital formation strategies to small and emerging companies. Additionally, the City would directly sponsor a number of technology forums to facilitate an idea exchange between area companies. PDC staff would organize meetings, which would be held at PSU's engineering facilities. The City would convene the Panel and within three months of adopting the strategy. During its first meeting, the Panel would establish a goal statement, work plan, and long-term meeting schedule.

Who: Portland Development Commission, City Council, PSU, business leaders, industry associations
When: Within 3 months of strategy adoption
Resources: General fund for meetings and conferences