Chapter 12
Silicon Forest

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The Silicon Valley in Santa Clara County, south of San Francisco, is well known and appropriately named given its focus on activities based on silicon-chip technology. On the other hand, perhaps "Silicon Forest" sounds a rather grandiose title for the new industrial and business service development in the Portland metropolitan area. It suggests that the scale, diversity, and dynamics of the region's high tech are becoming sufficiently prominent to be widely recognized at the national level. Of course, the adjective "silicon" has been hackneyed, devalued, even misconstrued by being permutated to describe so many other areas of the country, like Colorado's "Silicon Mountain" and Texas' "Silicon Prairie," and places abroad such as Canada's "Silicon Valley North" (Steed, 1986), central Scotland's "Silicon Glen" or Japan's "Silicon Island" of Kyushu. Yet, in a time of slogans, cliches and shorthand, the adage "Silicon Forest" seems to be apt for the contemporary Portland scene as it captures the imagination of the public, politicians, professionals and entrepreneurs alike and encapsulates a set of conditions and forces with strong implications for the future.

It is difficult to classify high tech activities in the Portland area. For this reason the focus here is on firms. Two sources of information are used. The first comprises data from the U.S. Bureau of Census' *County Business Patterns* covering the four counties -- Multnomah, Clackamas, Washington (in Oregon) and Clark (in Washington) -- that make up the Portland-Vancouver metropolitan area. Unfortunately the latest data on hand are three years old - for March 12, 1984. Furthermore, for reasons of confidentiality about specific firms, most Standard Industrial Classification (SIC) entries in this source do not give exact employment, only bands, such as a range of 2,500-4,999 employees in SIC 367 in Washington county. This provides a crude estimate of high tech employment in the Portland area as between a minimum of 26,548 and a maximum of 47,041 in the week including March 12, 1984 - figures albeit up on those of 22,928 to 44,019 in the same week in 1982.

The second source is a survey of firms conducted in 1985 by the Portland Chamber of Commerce and the Tualatin Valley Economic Development Corporation. This is certainly far more accurate, but may not be complete as it covers only 173 firms, while it is believed that there are now more than 200 high tech firms in Portland (Figure 12.1). The most striking specialization is in SIC 382, measuring and control instruments, a field dominated by Tektronix, followed by SIC 367, electronic components, a very diversified production group, and SIC 357, office, computing and accounting machinery. Of far lesser scale, but perhaps not importance, are SICs 366, 384, 361, and 737.

From this information it is not un-

Table 12.1. *A sample of 173 high tech firms in the Portland-Vancouver region by SIC groups, 1985 (Tualatin Valley, 1985).*

SIC		No. of Firms	Size ‹49	50-499	›500	Employment
356	General industrial machinery	2	2	-	-	12
357	Office, computing machinery	21	16	4	1	2,166
361	Electric transmission equipment	3	2	1	-	651
362	Electric industrial apparatus	12	10	2	-	498
365	Radio and Television equipment	4	3	1	-	145
366	Communications equipment	20	15	5	-	970
367	Electronic components	31	24	5	2	5,930
369	Misc. electrical machinery	5	3	2	-	301
372	Aircraft and parts	4	4	-	-	40
381	Engineering, laboratory, scientific instruments	9	7	2	-	260
382	Measuring and control instruments	28	23	3	2	22,515
383	Optical instruments and lenses	3	3	-	-	40
384	Surgical, medical and dental instruments	14	11	3	-	755
737	Computer, data processing service	17	14	3	-	652
Total		173	137	31	5	34,934

reasonable to estimate that up to 40,000 workers are employed in Portland's high tech today. This is equivalent to only one-tenth of the high tech work force in Silicon Valley (Saxenian, 1985). Although this seems to be a very small proportion, the following points should be borne in mind.

First, the U.S. Office of Technology Assessment (OTA) in 1984 calculated that Portland's high tech employment in 1976 was only half that figure (19,214), placing it 26th amongst U.S. SMSAs - albeit ahead of such centers as Austin, Texas, Miami, Florida, and the Raleigh-Durham, North Carolina, but well behind Seattle, Washington (c. 48,000). Since the report claims that Portland's 1976-80 high tech employment growth rate was only 18.3 percent - one of the lowest amongst all American SMSAs - most expansion must have occurred after 1980, considerably raising its U.S. rank.

Second, changes in the population of high tech firms since 1976 lend support to the reality of this growth. The Oregon Department of Economic Development claims that the number of computer and electronics firms alone in the State increased by 60 percent from 568 to 910 between 1972 and 1984, making it one of the regions of fastest high tech growth in the entire country. Based on this, only California and Massachusetts, the historic high tech core areas, have more of these firms on a population ratio basis than Oregon amongst the 50 states. New births, spin-offs from existing firms, and in-

movement of firms from outside Oregon explain these increments. But much growth was localized in Portland which, according to the American Electronics Association, now ranks 10th in the nation in the numbers of electronic and information-processing companies.

Third, until recently firms have significantly expanded numbers of jobs. For instance, by 1985, employment in Tektronix alone, the leading firm in Portland, exceeded 75 percent of the OTA's 1976 *total* of high tech jobs for the *entire* metropolitan area; and many other firms had grown, too.

Fourth, Portland-located firms have achieved very significant U. S. and world market penetration in selected high tech niches. This is particularly true of the "raw materials" end of the production chain. Two-thirds of the non-communist world's entire silicon wafer output for microchips is localized within 40 miles of downtown Portland. At the other end of the chain, Portland firms are pre-eminent in final goods such as measuring, controlling, and navigational instruments, array processors, and computer-assisted design (CAD) and computer-assisted engineering (CAE) equipment.

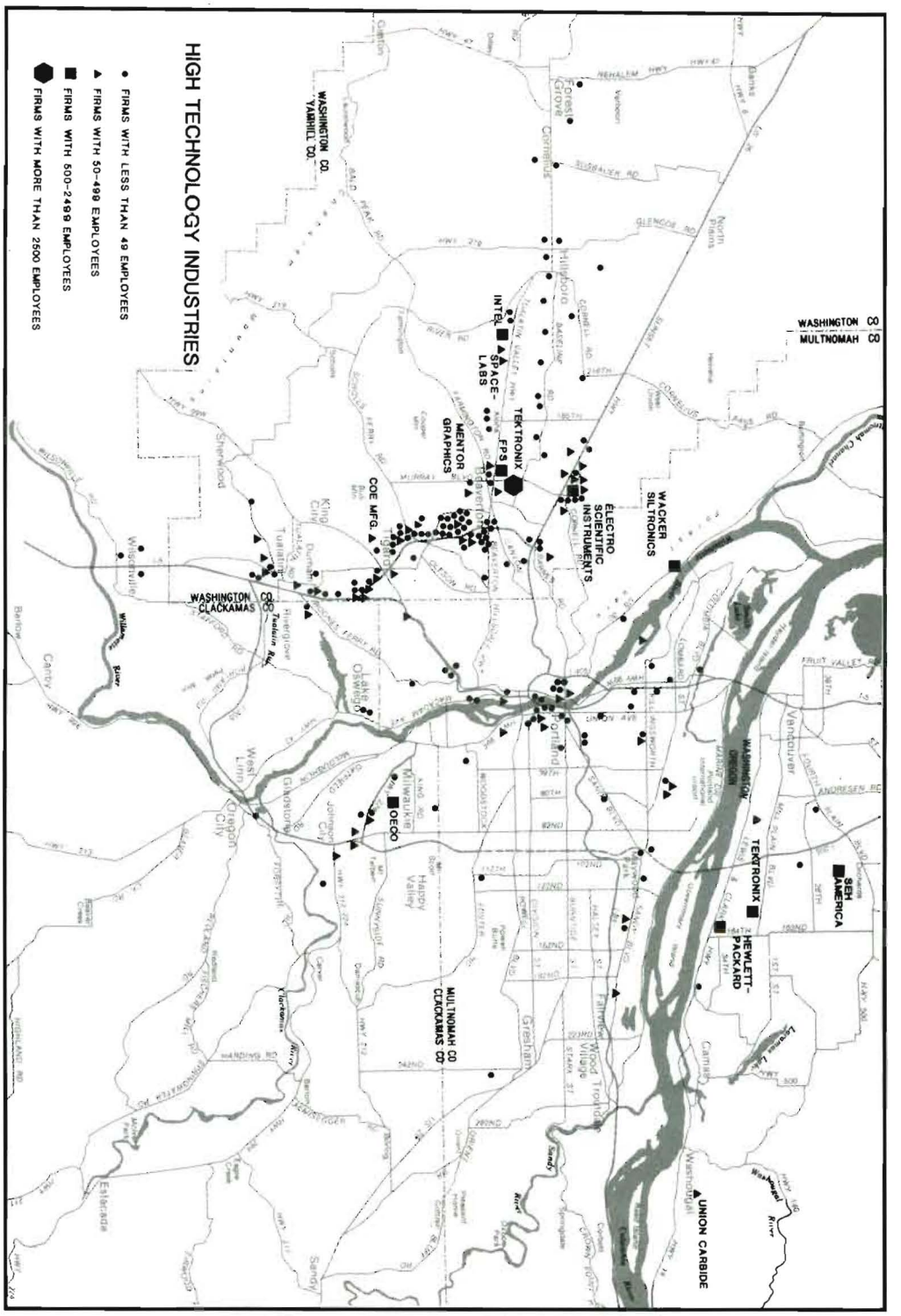
The location of high tech firms in the Portland area is characterized by clusters (Figure 12.1). The dominant aggregation is on the west side along the Interstate Highways I-5 and I-217, especially in Tigard and Beaverton, and in the Sunset Corridor in Beaverton, Hillsboro and Forest Grove along U. S. Route 26. Growth here has been the major phenomenon of the last decade. By far the largest firms (by employment) have located here on spacious sites: Tektronix (13,024 workers), Floating Point Systems (1,320), Electro Scientific Instruments (800) and Mentor Graphics (780) all near Beaverton; Intel Corporation (3,250) in Hillsboro; and Coe Manufacturing (150) in Tigard. All in all, about 23,000 jobs are localized in this zone.

Other clusters are far less marked. Those worthy of note occur: in central and inner Portland, which with over 1,000 employees, still serves as an "incubator" for small firms but also concentrates several important computer software producers; and in the southeastern Milwaukie/Clackamas area along highway U.S. 224 near the I-205 interchange (Figure 12.1). There, some medium-sized firms were joined in 1986 by OECO (650 workers) which relocated from inner southeast Portland to what is believed to be the area's largest new electronics facility since 1979. About 3,000 people work in high tech in this zone. Many small firms are scattered elsewhere, though medium-sized ones are sited near Portland International Airport in the northeast. Wacker Siltronic (800) forms a major "outlier" along the Willamette River in the northwest. Across the Columbia, Vancouver, Washington, hosts a notable group of firms with about 3,000 employees, the most prominent being Shin- Etsu Handotai (SEH) America (675), Hewlett-Packard (500), and a branch of Tektronix.

FACTORS IN THE RISE OF PORTLAND'S HIGH TECH INDUSTRY

Silicon Valley is located near the site of the first electronics breakthrough -- the invention in 1912 of the cyclotron, from which television, telecommunica-

Figure 12.1: Distribution of high tech establishments in Portland metropolitan area (various sources).


HIGH TECHNOLOGY INDUSTRIES
• FIRMS WITH LESS THAN 49 EMPLOYEES
▲ FIRMS WITH 50–499 EMPLOYEES
■ FIRMS WITH 500–2499 EMPLOYEES
⬢ FIRMS WITH MORE THAN 2500 EMPLOYEES
WASHINGTON CO
MULTNOMAH CO
WASHINGTON CO
CLACKAMAS CO
MULTNOMAH CO
CLACKAMAS CO
INTEL
SPACE-LABS
TEKTRONIX
FPS
MENTOR GRAPHICS
COE MFG.
ELECTRO SCIENTIFIC INSTRUMENTS
WACKER SILTRONICS
OECO
SEH AMERICA
TEKTRONIX
HEWLETT-PACKARD
UNION CARBIDE
WASHINGTON CO
YAMHILL CO
Portland
Beaverton
Hillsboro
Tigard
Lake Oswego
Tualatin
Wilsonville
Sherwood
Tualatin River
Willamette River
Columbia River
Sandy River

tions and computers were all developed. By contrast, Portland's high tech originated only 40 years ago. Yet the seeds were sown in the 1930's. Then, Portland had a lively radio club, a reflection, perhaps, of the desire of Oregonians to reduce or overcome their relative isolation from the mainstreams of American life and economic change. If that club introduced people to radio and electrical technologies, then two other events -- the building of the Bonneville hydroelectric power station on the Columbia in the 1930's and World War II -- had a profound effect bringing engineering into major prominence in the region's economic life.

Franklin D. Roosevelt had envisaged that Bonneville Dam, built with U. S. federal funds, would "transform Portland into a city of whirring machinery." In fact, the dam created the pre-conditions, in the shorter term, for the growth of industries to serve America's Pacific war effort and in the longer term for development of electro-metallurgical and electro-chemical industries. Being one of the west coast's few deep water ports, Portland shared significantly in the massive expansion of military industries located from Seattle to San Diego, especially shipbuilding along the Willamette and Columbia Rivers. Although this could hardly be considered "high tech," it stimulated the birth and development postwar of local firms to manufacture navigational devices and instruments. No less important for long-term economic growth and modernization in Portland, was the large influx of workers from other states, often bringing new skills, the engagement of women in factory work, and the exposure of average citizens to modern technologies on sea and in the air. The emergence of high tech industrial development in Portland since 1945 can be linked to three major factors.

New Market Opportunities

Local and Pacific Northwest regional market opportunities induced the development and adaptation of existing firms and the birth of new ones. Often, these forged linkages with the "staples": logging, paper making, wood manufacturing, shipbuilding, aluminum, as well as with salmon fishing, river and marine navigation. Opportunities changed, however, as postwar growth gave way in the 1970's to marked decline in production and restructuring in these industries, requiring Portland suppliers to search for new markets elsewhere and to introduce new products.

A classic case is Precision Castparts Corporation (PCC) (Portland) which, in the 1950's, began casting tougher metal cutters to meet the needs of local chain saw manufacturers (like Omark) serving an expanding lumber industry. Gradually, by investing heavily in research and development, applying a new ceramic shell process to forge larger castings, and by searching for customers outside the Pacific Northwest, PCC has diversified into custom-made castings not made elsewhere in the U.S. Today, it is the nations' largest, and the world's second largest, producer of high tech jet engine castings, using titanium supplied by the Oregon Metallurgical Corporation of Albany, and catering to the makers of civilian and military aircraft and the Space Shuttle. Although this is a link with a major West Coast high tech industry - Boeing in Seattle and Lockheed in Los Angeles - the link is indirect. The castings are supplied to engine manufacturers, General Electric and Pratt & Whitney, located elsewhere in the U.S. and from PCC's subsidiary manufacturing facilities in England and France to Rolls Royce in Europe. PCC

is one of Portland's leading high tech firms, a multinational corporation, ranking by revenue, as the 12th largest public company in Oregon.

Hyster, another longstanding Portland firm, has stimulated local entrepreneurs to design and manufacture new process equipment for its business activities. Although no longer producing hoisting equipment (the origin of "hyster") it recently opened a new research and development unit in Troutdale (east of Portland) which makes extensive use, for instance, of computer-aided design (CAD) and computer-aided engineering (CAE) products developed and manufactured by Mentor Graphics and Metheus Corporation.

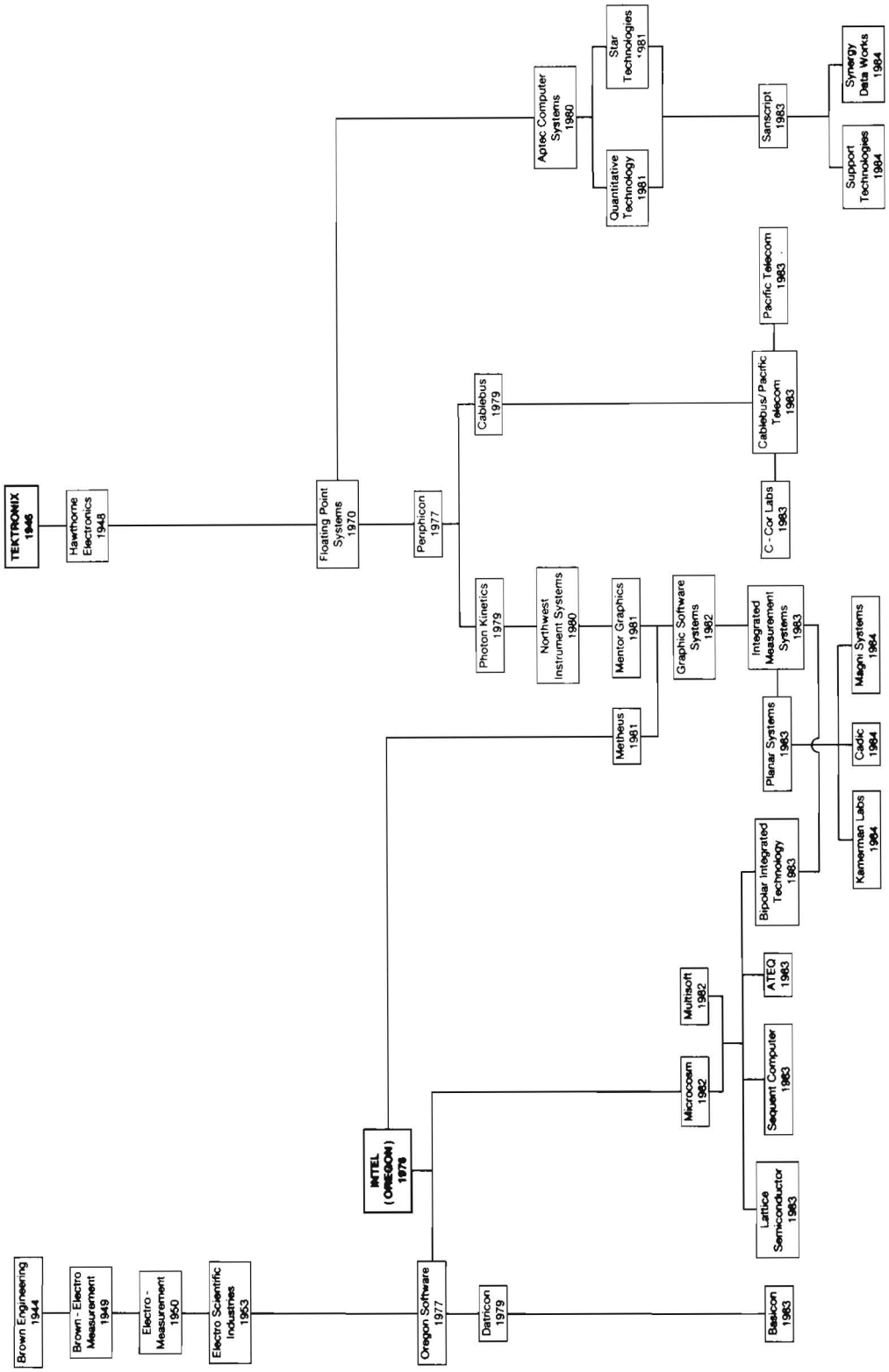
A survey of other Portland area high tech firms shows similar market linkages to Pacific Northwest "staples." For example, North American Controls Inc. (Portland) makes electronically-controlled saw milling machinery while Coe Manufacturing Co. (Tigard) specializes in laser measurement devices for plywood and sawmill equipment. Others include Accuray Corporation producing software for the paper industry, Concept Technologies which manufactures graphics laser printers for the printing industry (a significant local activity), and Aquidata Corporation making electronic measuring instruments for grain farming and silos (important for agriculture in the region). Pace Industries (Beaverton) specializes in marine electronics and fish lures and Matthews Marine Systems Inc. makes ship-steering equipment. Arnav has recently diversified from marine navigation instruments into aviation navigation systems, bought mainly by west coast based aircraft manufacturers.

Local Entrepreneurship

The region's human resources, especially entrepreneurship, have been decisive in establishing and developing innovative activities. Fortunately, the drive of locally-born and immigrant entrepreneurs, who preferred to remain in Oregon, has combined with improvements in the riverport, airport, highways and land management around Portland to launch substantial industrial diversification. Experience individuals gained in wartime industries often spawned engineering or electrical expertise, innovation and entrepreneurship which in peacetime has proved itself capable of penetrating national and overseas markets with new products. These changes created the preconditions for the "take-off" in the 1970's and 1980's of the latest high technology industries.

In 1947 two of these former Portland radio club enthusiasts -- Howard Vollum and Jack Murdock -- founded a firm they called Tektronix. It started making the world's first synchronized oscilloscope which Vollum had invented. Producing a wide range of electronic measuring, testing and control devices and instruments, Tektronix today has a payroll of 13,024. Apart from the State it is Oregon's largest employer. Besides stimulating development of other local firms to supply it materials and components, Tektronix gave birth after 1970 to more than a dozen "spin-offs" to manufacture new product lines (Figure 12.2).

This type of development - the "spin-off" - may add diversity but it also frequently deepens local specialization. The process of a new firm developing from an existing one has become particularly frequent in the new high technology of the past decade. One "spin-off" from Tektronix, Floating Point Systems (Beaverton), already the biggest U.S. maker of computer array processors, is the area's third largest


Brown Engineering 1944
Brown - Electro Measurement 1949
Electro - Measurement 1950
Electro Scientific Industries 1953
Basicon 1963
Datricon 1979
Oregon Software 1977
INTEL (OREGON) 1978
Lattice Semiconductor 1983
Sequent Computer 1983
Microcosm 1982
Multisoft 1982
ATEQ 1983
Bipolar Integrated Technology 1983
Kamerman Labs 1984
Cadic 1984
Magn Systems 1984
Planar Systems 1983
Integrated Measurement Systems 1983
Metheus 1981
Graphic Software Systems 1982
Mentor Graphics 1981
Northwest Instrument Systems 1980
Photon Kinetics 1979
Cablebus 1979
Peripheon 1977
Floating Point Systems 1970
Hawthorne Electronics 1948
TEKTRONIX 1946
C - Cor Labs 1983
Cablebus/ Pacific Telecom 1983
Pacific Telecom 1983
Aptec Computer Systems 1980
Star Technologies 1981
Quantitative Technology 1981
Sanscript 1983
Support Technologies 1984
Synergy Data Works 1984

high tech firm, currently employing 1,320 workers. Two other Tektronix spin-offs, Mentor Graphics and Metheus Corporation, together employ 450 workers. Although both these firms were only founded in the early 1980's they are accredited with supplying one third of all CAD/CAE equipment used in the U.S. The latest Tektronix "birth", Magni Systems Inc., set up in 1984, produces test equipment for video and television transmission systems and is already finding markets all over the U.S. and Japan (Figure 12.2).

Intel Corporation, an arrival from California in 1976, has been another important source of spin-offs. One, Sequent Computer Systems (Beaverton), set up in 1982, has just won the largest electronics export contract ever recorded in Oregon - to supply scientific computers to Siemens A.G., the West German electrical engineering and electronics corporation. Another, Lattice Semiconductor (Beaverton), spun off in 1983 to make high speed semiconductors, and increased its employment by 25 percent to 150 employees while doubling sales in 1986. Now on the brink of being the first U.S. firm to manufacture a 256K fast static random access memory (RAM) chip, Lattice Semiconductor illustrates the speed with which innovation is occurring amongst new Portland region spin-offs. It is claimed that this new product could fundamentally alter the way super computers are built, vastly increase their speed and decrease their costs per unit calculation (*The Oregonian*, July 27, 1986, p. D1). Yet Lattice concentrates on research and development, testing and marketing in their new Sunset Corridor complex, sub-contracting chip manufacture to Japanese and Californian suppliers.

Entrepreneurial activity and innovation has thus generated an increasingly "information-rich" environment, resembling "Silicon Valley" in some respects and in miniature. Portland entrepreneurs have certainly created a young and vigorous "Silicon Forest".

Figure 12.2: Geneology of high tech industries in Portland. The process began after World War II with the development of Tektronix and Electro Scientific Industries. Employees from these businesses eventually began their own businesses resulting in more and more "spinoffs" producing the multiplicity of firms that now exist.

The In-Movement of High Technology Firms

The most significant new trend in the area's high technology development is in in- migration of out-of-state American-owned and foreign firms. Inward movement has swollen the range and the ranks of new industries in the area during the past decade. Early in the 1970's the corporate managements of two leading American high tech employers -- Data General and Digital Equipment -- decided, after lengthy investigations, not to locate in Oregon. They found the State apathetic. The turning point came in 1976-77 when Silicon Valley-based firms Hewlett Packard and Intel Corporation established plants in Portland to make personal computers, printers, silicon wafers, micro-processors and memory components. Today Intel is the area's second-largest high tech firm, with 3,250 workers. Other U.S. firms followed, such as Spacelabs Inc., a Squibb pharmaceutical subsidiary, making electronic medical monitors; Union Carbide, produc-

ing crystal materials for semi-conductors and polysilicon; and Litton Industries, making aerospace electronics.

The most dramatic change, though, has been the sudden "invasion" in the 1980's by foreign multinationals, locating throughout the metropolitan region. First came Wacker Chemie (Siltronic) from West Germany which now manufactures 35 percent of all American-made silicon wafers. Currently it is extending its operations relocated along the Willamette River by adding the world's largest factory for manufacturing polysilicon, a new substitute for silicon. The presence of such industries is testimony to the way the environmentalist lobby in Oregon has paid off. Output of these products needs clean water in large quantities.

Then came Japanese firms, almost in follow-the-leader fashion, mainly in 1985. SEH America, a subsidiary of Shin-Etsu Handotai Co. Ltd. (Tokyo) making silicon wafers relocated from San Jose to Vancouver (Washington). National Electric Corporation (NEC), the first Japanese company to build a factory in Portland, is spending $25 million on a fibre optics plant for radio and telecommunications. Fujitsu is investing $170 million in two plants, one for making semi-conductors, the other for disk drives. Epson, a Seiko- owned corporation, will assemble computer printers in a $30 million facility. Three of these plants are clustered between U. S. 26, the Sunset Corridor, and the Hillsboro Airport; the Fujitsu microelectronics plant is being built in the east, near Troutdale (Figure 12.1). Just across the Columbia, in Vancouver, Kyocera Northwest Inc., a subsidiary of Kyocera Corporation (Kyoto, Japan) will soon open a semiconductor factory which is expected to supply surface-mounted ceramic capacitor chips to revitalizing markets in aerospace, biomedical, communications and automotive industries, some of which are located in the Pacific Northwest.

WILL THE SILICON FOREST GROW TALL OR SHED ITS LEAVES?

Local entrepreneurship alone explained the growth of high tech industries in the Portland metropolitan region until the late 1970's. Innovators, mostly dedicated Oregonians or immigrants "addicted" to Oregon, neither wanted nor needed to locate elsewhere in the U. S. Initially they found adequate markets in the Pacific Northwest but their products were light, high value, and easily transportable by truck or air to other regions of the country and abroad. A threshold or "critical mass" of manufacturers developed around the base provided by Tektronix, generating sufficient volume and diversity of market needs, components, products, software, information and ideas in a rapidly changing technological field, to act as a magnet for more new entrepreneurial endeavor. The cluster of locally-owned firms created a vigorous business environment for self- sustaining growth and development. But high wages, strict environmental controls, and substantial distance from larger U. S. market regions had in the past discouraged managements of many industries from even considering a location in Oregon.

By the 1980's, however, the shape and form of high tech in Portland was becoming more dependent on increasing numbers of engineers, venture capitalists, and firms being drawn in from more distant regions, particularly from California; and on in-migration of foreign firms. In part, this has been induced by other important changes, especially by increased state and local

initiatives.

State and Local Initiatives: Stimulants to Development

Most fundamental has been a major shift in the attitudes and policies of Oregonians -- largely in response to a deepening crisis caused by declining, even disappearing, staple industries (see Chapter 10). After years of discouraging immigration and investment -- to prevent Oregon from becoming another California -- the State has been forced to court new business. State policies for protecting environment and raising the quality of life, however, have had their positive long term effects in inducing local enterprise.

A strong commitment to excellent State medical and health care, which is virtually free to State employees, has been an important stimulus to localization in Portland of a multitude of medically-orientated high tech firms. Examples are Drake Willcock (artificial kidney machines), Cardiac Resuscitator Corporation (pacemakers), Horizon Laser Systems (ophthalmic laser surgery systems), Life Science Instrumentation (cardiac monitors), Parks Medical Engineering (Diagnostic equipment), National Appliance Co. (biomedical research equipment) or Kirkman Laboratories making dental appliances. Hewlett Packard has a branch in McMinnville, southwest of Portland, making cardio-pulmonary resuscitation and X-ray equipment.

Similarly, State concern for the environment has opened new markets for firms like Harco Manufacturing making water, noise and wood-stove pollution control devices and Grinnell (Lake Oswego) fire protection systems. A large recycling business has developed to serve markets both in Oregon and environmentally-conscious northeastern states. The city is a major center for recycling newsprint, cardboard and glass, which may not be "high-tech" operations, but Oregonian attitudes have acted as "push" and "pull" factors in the innovation of high tech processes and products by existing and new firms. For instance, a division of Tektronix recycles mainly to recover valuable precious metals. In 1984 Environmental Pacific Corporation (EPC) of Lake Oswego was founded to recycle materials from all kinds of batteries. Now EPC makes a wide range of leak-proof steel and plastic containers for transporting hazardous cargo, recycles batteries from as far away as New Jersey, and works at the cutting-edge of technology to re-use plastics. Thus Oregon policy creates comparative advantages for local firms to exploit and deepen the richness of the local information and technology environment.

By contrast, U.S. federal policy has played little role in high tech development in the metropolitan region. While many American high tech centers, including Silicon Valley and Boston, have greatly benefitted from the external stimulus of federal defence spending (Glasmeier, Hall and Markusen, 1985), no major defense-related contracts have ever been placed with Oregon firms. It was recently reported (*The Oregonian*, April 4th, 1986), however, that Floating Point Systems has a new FPS T computer which may be the kind needed in "Star Wars" anti-missile defense systems. If so, history could be changed, depending on Oregon lobbying in Washington and the outcome of superpower agreements on arms control. But on May 8, 1986 the U.S. Department of the Interior closed its Bureau of Mines' Albany Research Center specializing in thermodynamics. Located in the "Oregon high tech corridor" south of Portland -- embracing Salem, Albany, Corvallis and

Eugene -- the laboratory was a major promoter of high tech metallurgy processes locally, not least for PCC. Not surprisingly, many Oregonians believe that there is longstanding and deepening federal discrimination against their state.

Since the late 1970's state and local authorities in Oregon have replaced apathy towards to downright discouragement of businesses, by vigorous campaigning for clean industry combined with plans for careful environmental management and improvement. Policies are now orientated to stimulating new industrial development and have taken several forms:

(i) Delegations of Oregonians have visited East Asia, especially Japan, to recruit firms by selling the advantages of industrial location in Oregon. With the further objective of securing major export contracts for both staple and high tech manufacturers, Oregon officials have "twinned" their State with the Province of Fujian, China, in the coastal zone lying between Shanghai and Guangzhou (formerly Canton), an area favored as a "forward zone" for Den Xiaoping's economic modernization program. Portlanders who, for a century, have romanticized about their city as the "Gateway to the Orient" are now endeavouring to turn it into economic reality. One trade delegation to Tokyo in 1984 produced the promises of investment by NEC, Fujitsu and Epson -- provided that Oregon reform its tax system on multinational corporations. The State obliged. And in March 1986 a Keidanren delegation of leading Japanese businessmen toured sites in the Portland area.

(ii) Repeal, in August 1984, of the state's unitary tax laws replaced a levy on the worldwide business of any multinational located in the state by a tax only on its Oregon operations. This measure "opened the gates" to foreign investors, particularly those Japanese firms which, up until now, had refused to locate plants in the U.S. states, of which there are 11 including California, that still retain the unitary tax system. Following the repeal all the promised investments from Japan became building operations and Wacker Siltronic decided to go ahead with the addition of its polysilicon plant.

Less easy to assess is the effect of Oregon's lack of a sales tax (one of the few states so remaining). Introduction of such a tax was rejected by the Oregon legislature in 1985. Big retail shopping centers and what is reputed to be America's largest Safeway supermarket are located on the Portland side of the Columbia to tap the Washington consumer market (which has a sales tax). But that may have far less tangible effects on the growth of high tech (or other) industries because, in contrast to most states, Oregon still does not offer financial incentives to induce business to the State: Oregonians prefer to advertise its superior environmental advantages, natural beauty, and quality of life. Opinions have been expressed, though, that Washington state uses monetary inducements to firms like Kyocera, SEH America, Hewlett-Packard, Union Carbide, RCA and Sharp to locate in Vancouver while employees enjoy the same access to Oregon's environment!

(iii) Adoption and implementation of land use plans to zone commercial, industrial, residential and transport functions in the area enable local authorities, in former Governor Victor Atiyeh's words, "to combine development with environmental quality." This is particularly critical in suburbs west of Portland where, almost repeating history of the Oregon Trail, the Tualatin Valley has become the most desirable

settlement zone - this time for high tech industries, and their employees. Original firms like Tektronix quickly outgrew their central or inner city sites, especially the "incubator zone" of the central east side, relocating to the western semi-rural fringes in and around Beaverton, today a thriving suburb and the very hub of the "high tech corridor" (Figure 12.1).

In 1981 Washington County adopted the "Sunset West" Plan for the zone along U.S. 26, a route long called the Sunset Corridor leading out of Portland to the coast. The name today is paradoxical since it hosts increasing numbers of "sunrise" industries. The Sunset West plan, collaborated through the Tualatin Valley Economic Development Corporation with plans for adjacent parts of Clackamas and Multnomah counties, embraces two-thirds of the buildable land within the metropolitan region and so holds the key to its economic future. Plans seek to sustain the very high environmental standards already set by Oregon entrepreneurs and residential developers in creating distinctive landscaping styles of attractive buildings sited to preserve groves of oaks and firs, with office or house windows facing snow-capped Mount Hood on the eastern skyline.

An important role in marketing and managing land is played by the Port of Portland (see Chapter 11). Owning half the available industrial land in the Rose City, a quarter of that in the entire metropolitan region, the Port coordinates the architectural and landscaping laying out of manufacturing, science, research and development and warehousing parks with improvements in the handling capabilities of the riverport and city's three airports (Portland International, Hillsboro and Troutdale) which the Port of Portland also owns and manages. And recently, the I-5 Corridor Association has launched a major campaign to advertise the advantages of the zone embracing Tigard, Lake Oswego, Wilsonville and Aurora around the I-5, I-205 and I-217 interchanges.

In contrast to the congestion of the San Francisco Bay area or Los Angeles, the ability to provide attractive living and working environments in Portland within one or two hours' easy drive of dense forest, majestic mountains, fish-filled rivers, an imposing coast of cliffs and sandy beaches, Indian reservation resorts, and desert, is clearly an extremely powerful locational incentive to businessmen who put a high premium on the quality of life.

(iv) At the region's very heart, the City of Portland is strenuously improving the national and international magnetism of the Silicon Forest. To uphold the image of the "Rose City", "America's most livable city," and to avoid the fate suffered by so many U.S. cities with dying or decaying downtown areas, the City has raised and spent $1.25 billion in the central district since 1970 (see Chapter 4). Attractive new residential developments rise near a waterside park and marina which replaced the scruffy riverside highway along the Willamette River in the early 1970's. Squares combine architecturally exciting public and private office buildings and open spaces with pavement cafes, trees and cascading waterfalls. Major hotels have been joined by a Performing Arts Center, a Civic Auditorium, an expanded or restored historic Old Town resembling London's Covent Garden, and a restored "Chinatown," attract tourists and Portlanders alike. Finally, a central transit mall on SW 5th and 6th Avenues, reserved only for buses and pedestrians, has been adorned with

domed bus shelters, trees, flower beds, rose baskets, cafes and statues, to re-create the appearance and atmosphere of the Parisian boulevards.

Major attention has been paid to improved public transport. An extensive "Tri-Met" bus network offers frequent and relatively inexpensive services, with completely free travel in the downtown "Fareless Square." Construction of a fast light rail system (MAX) from the outermost eastern suburb of Gresham to downtown Portland, a distance of 12 miles, is the latest attempt to make the central city highly accessible.

Such developments partly explain why employment in central Portland has doubled in the last 15 years to 85,000 jobs today. City officials and local businessmen hope this will further attract major corporations. Recent decisions by Eastman Kodak, Honeywell, Westinghouse Electric and major insurance firms like Prudential, Philadelphia Life, and Sun Life of Canada, to set up their Pacific Northwest offices at Johns Landing beside the Willamette near the downtown are signs that Portland is becoming a "regional headquarters city," a trend which could strengthen its pull on high tech industry and services.

Very relevant to these aspirations is that Portland now offers extensive land sites (greater than 3,000 acres) ready for industrial development beside deepwater port installations along the Columbia and Willamette Rivers as well as 130 industrial and business park sites (ranging from 5 to 500 acres). As the only significant metropolis between San Francisco and Seattle and one of only five major "Pacific Rim" gateways along the U.S. west coast, Portland may be able to exploit outstanding "intervening opportunities" to become a major crossroads, tapping business along the north-south Alaska-California and east-west U.S. Eastern Seaboard-Pacific routes.

CONSTRAINTS ON HIGH TECH DEVELOPMENT?

The foregoing factors operate simultaneously with worsening problems in California to tip the balance of advantages for high tech industries more positively toward the Silicon Forest. But there are several reasons why Portlanders cannot be complacent about the inevitability of high tech growth in their region. This has been recognized, for instance, by the Bonneville Power Authority which in 1983 predicted that Oregon's high tech would employ 180,000 people by 2005, but has since revised that estimate substantially downward to between 100,000 and 140,000. Any of these figures could be over-optimistic because of: rising land values, alternative locational opportunities elsewhere for high tech development, competition and business cycles, and constraints in local labor markets, venture capital supplies, and educational facilities.

Land Values

Escalating land and housing costs around Silicon Valley and increasingly lengthy and time-consuming commuting for workers are prime factors pushing Santa Clara Valley businessmen to "seek greener pastures." Some are finding them in Oregon. Thus Portland may be able to siphon off some high tech from other areas. Good homes in less crowded surroundings sell at one-third to one-half the prices of those in comparable areas of California. Several engineers have sold their San Francisco Bay area homes, bought new ones in Oregon, using the capital saved to start their own high tech businesses. These are just the kind of people that Oregon officials wish to attract because they "import" the newest technologies to

the Silicon Forest, adding to its vigor and diversity. Of course, not all this growth is occurring in the Portland area. There are other clusters of high tech around Eugene and Salem, and in the Medford-Ashland area near the California border where research support can come from the Oregon Institute of Technology at Klamath Falls.

The influx of engineers and firms into the Silicon Forest is, of course, already having important local repercussions on the demand for land. Prices are rising fast, bringing other changes in their wake. Tualatin Valley grain farmers are under increasing pressure to sell their land. So, too, are the filbert producers who have no serious world market rivals except for Turkey. Some rural landscapes will become estates or industrial and science parks within the framework of the Sunset West plan. Yet some small, rundown settlements, like Orenco, which are more accessible to the western high tech corridor are also being revitalized.

The Potential for Relocation and Locational Displacement

Much doubt hangs over the value of drawing away from California industries such as Hewlett-Packard's calculator-assembly plant located in Corvallis. That kind of operation essentially creates semi-skilled jobs in standardized goods output which is highly susceptible to short-term cyclical fluctuations, rapid obsolescence, or medium-term relocation to very much lower labor cost regions. The "Gateway to the Orient" in this sense means a drain of manufacturing jobs across the Pacific to Asia. An example is Code- A-Phone Corporation (Clackamas), founded in 1958 to make answer phone devices. Since the divestiture of American Telephone and Telegraph Co. (AT&T) in 1983, Code-A-Phone's sales have doubled and now account for 15 percent of the U.S. market, but the manufacturing of the latest machines has been transferred to Japan and South Korea.

On the other hand, investments by Japanese firms in Portland, e.g., NEC, Fujitsu and Epson may merely be diversions from California only so long as it retains unitary taxes. Time will tell whether the in-migration of Japanese firms is going to be sustained. There could be stagnation in Oregon high tech investment by foreign firms, though probably not in "raw materials" production of silicon, polysilicon and other substitutes (such as gallium arsenide) in which Oregon seems to have a comparative advantage. The currently high exchange value of the yen against the dollar may accelerate relocation of production from Japan to the U.S.A., a process in which Portland may share. But, in any case, such growth or inward movement depends very much on the absorption capacities of the U.S. and world markets for high tech final products, an issue discussed below.

Labor Markets

It is unclear as to how far either the number of jobs created in high tech industries, or the levels of remuneration and skill engendered, can truly compensate for jobs already lost or about to be lost in the region's traditional industries. For instance, in July 1985 Recording Corporation of American (RCA) and Sharp (Japan) announced a joint venture to bring 700 jobs by 1989 and 2,000 by 1995 to the Vancouver-Camas area along the Columbia River. But this would not have compensated for the 2,500 jobs last by the threatened closure of the Crown Zellerbach paper mill. Yet in announcing their plan RCA and Sharp made it clear that they

would bring in highly skilled electronics workers from other regions because many Camas paper mill workers would be unsuited even to retraining for the new jobs. By contrast, Fujitsu managers claim that they can turn loggers successfully into high-tech workers! Only time will tell if they are simply trying to "blind" Oregonians to reality.

Perusal of job advertisements provides evidence that, with the exceptions of highly- paid executive and research and development positions, most high-tech workers can only expect poor pay ($12,000 to $30,000 per annum) compared with recent wages of up to $55,000 per annum in mining, logging, paper making and other regional "staples". Under these conditions it may not be surprising if some formerly highly-paid workers from traditional industries choose not to work in high tech. Labor supplies in the metropolitan area, however, are unlikely to constrain new development, even in highly-skilled functions, for reasons outlined below.

Competition and Cycles in High Tech Business

What makes the benefits of high tech employment even more doubtful is the strongly cyclical and highly competitive nature of the industry. There is already much overcapacity in some final products markets, with feedback effects on the demand for the "raw materials and energy" inputs, especially of microchips. The world has been experiencing a major "microchip war" between Japanese and American firms. Their factories are operating at only about 70 percent capacity. Although some agreement has been reached by the two countries on this issue, no guarantees can be given that the new generation of semiconductors to be produced by Lattice Semiconductor, for instance, will not be susceptible to similar problems in the shorter term, given the accelerated pace of innovation. Moreover, there are high levels of automation and use of numerically-controlled machines in the production of semiconductors, not only with limited job-creation capacity, but also with a significant propensity for new development in newly industrializing countries of East and Southeast Asia.

Several examples from the experiences of the metropolitan region in the past two years well illustrate these problems. Since January 1985 Tektronix had laid-off 1,500 workers, affecting several facilities in Portland, while Intel Corporation has shed more than 1,000 jobs, involving closure of a plant in Aloha. Both are a response to depression in, and saturation of, the world computer market. The same difficulties have slowed construction of Kyocera Northwest Inc.'s chip factory in Vancouver and postponed indefinitely its plan for a research and development unit there. National Semiconductor, a Silicon Valley headquartered firm, potentially one of Portland's largest newcomers, recently abandoned plans to build a $150 million research and development laboratory and 32-bit chip factory in Hillsboro. Most dramatic was the 10 July 1986 cancellation of the proposed U.S.-Japanese joint venture, the Camas semiconductor manufacturing plant and research and development unit. In this case, General Electric's December 1985 acquisition of RCA doomed the project; GE had already commissioned an expensive state-of-the-art plant for similar microchip production in North Carolina's Research Triangle and wanted to eliminate potential competition from a rival U.S. firm which had Japanese backing. Severe competition is thus occurring between regions concentrating high tech within the U.S.A. Finally, one

of the metropolitan region's leading high tech manufacturers, Floating Point Systems, has suffered serious devaluation of its stock market rating following the announcement of reduced revenue earnings. These ensued from budgetary cutbacks by commercial, academic and government organizations which restricted the market for high- speed scientific and engineering computers.

Venture Capital

Another worry concerns the role of venture capital as a possible constraint on the development of Portland's high tech industry. Unlike San Francisco or Seattle, Portland is not a major banking and financial center or a source of venture capital which has been so instrumental in taking the risks and supporting the high tech successes, for instance, of Boston or Santa Clara Valley. Portland firms must obtain their venture capital primarily from outside the state. Indeed, Magni Systems Inc., raised capital in 1986 from a combination of sources in Portland, Silicon Valley, and Tokyo. Some Oregonians, with typical business caution, are questioning the extent to which even the limited venture capitalists seek to maximize the speed and scale of their profits and, in so doing, propel high tech firms through short "boom-and-bust" life cycles. Then, too, some entrepreneurs may welcome such pressures because they might be in business to "get rich quick," without either care for local economic health or any commitment to the long-term utility of the product they are making.

In an effort to reduce some of these negative features, the State began in 1985 to use 20 percent of the $88 million revenue raised by its new lottery for venture capital and to make careful selection of the recipient companies. Picking likely "winners," however, is risky, but Oregonians generally seem to accept the use of some of their lottery money for the good causes of job and business generation. To assist in this process, The Northwest Financial Symposium for Emerging Companies is offering an annual forum for firms to present their cases to groups of venture capitalists from all over the U.S.A. Having helped firms like Lattice Semiconductor and Metheus Corporation to obtain capital in the past, there is optimism for Portland's future.

Educational and Training Facilities

Finally, there is a view that neither Portland nor Oregon and southwest Washington can match the quality and quantity of educational facilities that have contributed to the high tech leadership of the Boston and San Francisco Bay areas. Nor, some admit, do they match the educational facilities that are key ingredients in growth in North Carolina's "Research Triangle," Colorado's "Silicon Mountain" or Texas' "Silicon Prairie." Thus capital from Tektronix and other leading Portland firms has established the Oregon Graduate Center (OGC) as a private non-profit educational institution on the cutting edge of research in physical and biological sciences, engineering and electronics. Recently it spearheaded the development of the OGC Science Park in the Sunset Corridor to combine research and to expand high tech manufacturing. Planar Systems and Bipolar Integrated Technologies Inc., both local spin-offs, are its first occupants.

Moreover, electrical engineering and other science departments at Oregon State University (Corvallis), the University of Oregon (Eugene) and Portland State University, once rivals, are now collaborating to pool knowledge, to under-

take key research and to develop or intensify links with business. Great store is being placed on their capabilities, for instance, to innovate economic production of gallium arsenide by a local firm on a sufficient scale to gain a world comparative advantage in what is now known as the major substitute for silicon. They may have already "missed the ship"; Hughes Aircraft Company recently announced the development of a gallium arsenide chip in California (*Far Eastern Economic Review*, October 17, 1986).

Moves are also afoot to upgrade Portland State University - with an Advanced Technologies Institute, International Center for Trade and Commerce, and Urban Studies and Geography Departments -- into a more effective force in fostering, understanding and predicting the role of high tech activities in the daily lives and work of the people of Oregon and the Pacific Northwest. With so much innovation and drive amongst the area's high tech entrepreneurs the future appears to bode very well indeed.

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