Product Profile: Computer/CPUs

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Summary

Computers/CPUs are manufactured from an array of components many of which contain hazardous materials or heavy metals. Also, the vast number of computers in use and the speed with which they become outdated, have made computers a solid waste problem.

According to the data found, it is estimated that as many as 700,000 new computers (PCs and laptops) will be sold in Oregon this year. That is on top of an existing stockpile of 1.1 million PCs and 200,000 laptops. Waste composition studies in Oregon confirm the large number of computers being disposed, half a million in 2001. By tonnage, it is estimated that more than 10,000 tons of computers will be disposed in Oregon in 2001.

Almost 90% of all end-of-life computers are disposed. The consultant researched and interviewed businesses and non-profits involved in the end-of-life management of computers in Oregon. The number of businesses and organizations is expected to grow as the volume of discarded computers increases. A few of the major computer manufacturers, notably IBM, offer some recycling opportunities for old equipment.

Computer manufacturing and distribution is a worldwide marketplace dominated by several multinational corporations. Sales in Oregon are supported by hundreds of local computer dealers, including many used equipment dealers.

Introduction

Computers/CPUs are manufactured from an array of components many of which contain hazardous materials or heavy metals. In terms of volume, the vast number of computers and other electronics in current use and the speed with which they become outdated and replaced, have made computers an increasingly significant solid waste problem.

The goal of this series of research reports—including mercury products, carpet, CRTs (monitors and TVs), and computers/CPUs—is to collect data that would inform state decision-makers about the impacts of specific products of interest and about the product stewardship opportunities related to these products.

The specific project objectives include:

- Collect specific information about the manufacture, distribution, use, and end-of-life management in Oregon of the specified products.
- Document information about the major companies involved in each stage of the product life cycle.
- Quantify the flow of each product at different stages in their life cycle in Oregon.
- If possible, document the impact of current product life cycles on the environment in Oregon.

The consultant team's research about CPUs involved several strategies. The team investigated product and market information from recent industry and government resources. Consultants reviewed numerous reports about computer waste and recycling. Direct contact and interviews were conducted to get a better understanding of the industry and the flow of product into the state. Consultants sought information about the volumes of product flow from many industry sources. The interview processes worked most effectively to obtain information about end-of-life management practices. Specific Oregon sales data was not found from any sufficient number of businesses to be relevant.

As shown in the sections that follow, national market data is used to establish estimates of the volumes entering Oregon. Estimates of the amounts of computer waste (computers, monitors, and peripherals) generated and disposed have been established from waste composition studies completed by Oregon Department of Environmental Quality. The most recent published data is from 1998. A wide array of management options for waste computers was investigated.

An industry profile that details the national and Oregon state companies involved and the amounts involved in the manufacture, distribution, and sale of computers/CPUs is included in this report. Details about the industry are provided in a series of tables and in accompanying appendices.

Some obstacles were encountered in doing the research, including:

- Definitions: research began by looking at "computers" and "CPUs." These terms alone do not sufficiently describe the variety of computers, CPUs, and other related electronics products. Computers are thought of most often in terms of desktop or personal computers (PCs). There are also laptop or notebook computers, computer workstations, and mainframe computers. In addition, the term "computer" may or may not include the actual central processing unit (CPU), which is but one component of the entire computer. Also CPUs are used in a variety of "computerized" electronic products that are not necessarily thought of as "computers." The consultant team worked to isolate the specific information related to PCs and laptop computers and CPUs.
- Complexity: the computer/electronics industry is very complex. It is dominated by large, multinational companies whose sales and activities are spread over the entire globe. At the same time, the industry includes numerous small businesses that may build individual computers or entire networks from component parts purchased over the Internet. While following the conventional manufacturer–wholesale–retail–customer distribution chain, the consultant team found inconsistencies and gaps of information which suggest that the distinctions between these common sectors are often blurred in the computer world. For example, single companies may perform many or all those functions together.
- Cost: The consultant found numerous sources for information about computers that were unavailable due to the high cost of access. Some of these sources might have provided information of specific relevance to Oregon. It was common to find access charges in the thousands of dollars for privately held information.
- Inconsistent Data: Reported shipments of computers in the United States and around the world varied significantly (on the order of millions of units) from one source to another. The variations were sometimes attributable to the methodology or reliability of the source or to differences in the descriptions of the products being measured. For example, a Carnegie Mellon study reports that 70 million PCs were shipped worldwide in 1996, 26 million of those in the U.S. The Wall Street Journal, as reported by Massachusetts Dept. of Environmental Protection (MDEP), says 79 million PCs are sold annually without providing a year. Meanwhile, ADI Corporation estimated PC demand worldwide to be 66 million units in 1996, 86.6 million in 1998, and over 100 million in 2000. In most cases, the differences remain irreconcilable and are provided in the context of ranges.

Product flow

To understand the life cycle of products in the state, the consultant team looked at the flow of products in three parts. First is the flow of new products into active use, which is a function of manufacturers, wholesalers and retailers. The second phase of the life cycle is the time products are in active use by consumers. The quantity of products in the state at this phase can be thought of as part of a "stockpile." The stockpile changes constantly as new products enter and old products exit. The third phase is that time when products reach their end of life and must be managed for reuse, recycling, or disposal.

New Computers

After considering a wide variety of industry and government source materials, the consultant team used a major report completed by Stanford Resources, Inc., on behalf of the National Safety Council as a primary source of information. Known as the "Baseline Report" (for "Electronic Product Recovery and Recycling Baseline Report"), it documents the state of computer recovery and recycling in 1999. The report also provides detailed information on the projected flow and lifespan of new computer products. The Baseline Report is a common source of information for representatives from governmental agencies and non-governmental organizations involved in computer product stewardship.

According to the Baseline Report, there are four main types of computers:

- Desktop Personal Computers (PCs)
- Notebook or Laptop Computers
- Workstation Computers
- Mainframe Computers

The first two tables that follow show the shipments of different kinds of computers in the United States, as reported in the Baseline Report. CPU Table 3 applies Oregon population data to estimate the number of personal computers and laptops shipped to Oregon. The consultant team believed that per capita computer use for PCs and laptops in Oregon would likely mirror national averages. Because the use of workstations and mainframe computers relate more to specialized commercial, scientific or research functions, it could not be assumed that such uses were evenly split around the country. The consultant could not find a basis for making an estimate of the flow of workstation and mainframe computers into the state. Nevertheless, the data on workstation and mainframe computers is provided for overall context.

CPU TABLE 1: U.S. Computer Shipments (millions of units)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
PCs	15.8	17.1	21.4	31.4	36.7	42.6	48.9	49.9	52.0	53.3
Notebook	3.0	3.4	4.5	5.4	6.0	6.7	7.5	8.4	9.3	10.5

Source: Stanford Resources, Inc., 1999, data from numerous sources. (Figures for 1999-2003 are forecasts.)

CPU TABLE 2: U.S. Workstation and Mainframe Shipments (thousands of units)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Workstation	540	550	610	700	810	890	910	930	930	1050
Mainframe	11.7	11.4	11.7	11.7	11.5	11.0	11.0	10.0	9.0	8.0

Source: Stanford Resources, Inc., 1999, data from numerous sources. (Figures for 1999-2003 are forecasts.)

CPU TABLE 3: Estimated Oregon Computer Shipments (thousands of units)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
PCs	189.6	205.2	256.8	376.8	440.4	511.2	586.8	598.8	624.0	639.6
Notebook	36.0	40.8	54.0	64.8	72.0	80.4	90.0	100.8	111.6	126.0

(Figures for 1999-2003 are based on forecasts.)

Computer Stockpile

For the purpose of this report, the amount of computers in the Oregon "stockpile" was determined using the method described in the Baseline Report. This methodology compares the volume of computers purchased since 1992 with the estimated lifespan of these computers. (Pre-1992 computers still in use or in "storage" were not included.) The term "obsolete" as used in this report and in the Baseline Report refers to computers that have gone beyond their estimated average life span. The Baseline Report assumes that obsolete computers are headed for one of three fates: about 3% are refurbished and resold (thus re-entering the product stockpile for a short time). Around 11% are recycled. The rest are disposed.

The issue of computers kept in "storage" blurs the distinction between stockpile and obsolete. The consultant team investigated government and industry sources for information about the number of computers being stored in basements, offices and warehouses. Reliable data about computer storage could not be found.

The available data treat the "stockpile" as the quantity of computers still within their active lifespan. Computers in storage are likely "obsolete" as defined by the passage of their average lifespan, yet they have not entered the end-of-life management stream. The volume and characteristics of these stored computers is an important gap in our understanding of computer life cycles.

The computer stockpile is very dynamic. The number of new computers entering the stockpile is increasing rapidly. At the same time, the average lifespan of computers is decreasing significantly, meaning computers enter and exit the stockpile rapidly.

The Census Bureau provided information about the significant growth in use of computers in the home. For example, "computer presence in the home" rose from 8.2% in 1984 to 36.6% in 1997. However, this does not establish the number of computers per household.

According to the New York Times Almanac, approximately 53.8% of U.S. households have a personal computer. The Census Bureau, counted 1,105,362 households in Oregon in 1990. Applying this data, Oregonians would have a "stockpile" of about 595,000 computers in their homes. A recent survey of household appliance ownership by homeowners in the United Kingdom found that there were 620 computers for every 1,000 households. Applying this figure yields a somewhat larger estimate of 685,324 computers in Oregon homes.

These household estimates do not include the number of computers in use by Oregon businesses, government agencies and schools. When the number of business, government, and school computers are considered the state's "stockpile" nearly doubles.

To estimate the size of the entire stockpile, the consultant team used the lifespan model developed for the National Safety Council's Baseline Report. This lifespan model estimates the flow of products from the year they were shipped to the time they become obsolete (past their average lifespan). The model assumed a gradual reduction in the average lifespan for each year's shipments. The model did not attempt to account for the stockpile of computers in "storage" in attics and basements.

Using the model developed in the Baseline Report for PCs and a similar model for notebook computers, the consultant prepared estimates of the number of computers in the stockpile. This model is not applicable to workstation or mainframe computers, or other computerized equipment. Table CPU 4 shows the size of the state stockpile for the next three years.

CPU TABLE 4: Estimated Oregon Computer Stockpile (thousands of units)

	2001	2002	2003
PCs	1186.1	1119.4	1100.6
Notebook	170.4	190.8	212.4

According to this model, there are about 1.1 million PCs and a growing number of notebook or laptop computers (from 170,000 in 2001 to 212,000 in 2003) in the Oregon stockpile.

Computer Discards

Currently, computers and computer-related equipment live two or more lives. The product's "first" life is measured from when it is purchased as a new machine until it is abandoned by its original owner. The "second" and subsequent lives of the machine may include "cascading" (i.e., being passed down within an organization), resale, donation or other reuse of the intact machine. Upgrading, repair, or other refurbishment may take place at any of these points. Table CPU 5 illustrates the extended lifespans for different types of computer equipment.

TABLE CPU 5: Average Product Lifespans (in years)

	First Life	Total Lifespan
Desktop PC - 386	4	4-6
Desktop PC - 486	3-4	4-6
Desktop PC – Pentium I	3	4-5
Desktop PC – Pentium II	2-3	3-4
Mainframe computer	7	7
Workstation computer	4-5	4-5
CRT computer monitor	4	6-7
CRT TV	5	6-7
Notebook PC	2-3	4
Computer peripherals	3	5
Telecommunications equip.	Not available	Not available

Source: Stanford Research, Inc., 1999

As described by the National Safety Council's Baseline Report:

> "From the perspective of new computer sales, once a computer passes from the first life to the second, it has been replaced. From the end-of-life perspective, however, the computer is still in use. The end of a computer's second life is the point at which it can no longer be resold intact and its only monetary value is the worth of its parts or raw materials. At the end of the second life, the product can

either be sent to a recycler, where most (estimated to be 95 percent) of the components and materials are reused, or to a landfill, in which case none of the components are reused. Desktop PCs occasionally go from "second life" to storage; once removed from storage, the PC essentially has only raw material value or a negative value if the cost of processing the PC or any of its components (for example, CRTs) is higher than the value derived from the parts."

The following Table CPU 6 shows the Baseline Report's estimate of total number of obsolete computers for the U.S. Table CPU 7 shows the resulting estimate of the number of obsolete computers generated in Oregon each year.

TABLE CPU 6: U.S. Total Obsolete PCs by year (millions of units)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
PCs	20.6	23.8	31.6	41.9	55.4	63.3	61.1	63.4	59.8	61.3

Source: Stanford Resources, 1999
Note: Estimates based on a range of life spans for each year's shipments, starting with 1992 shipments. Does not account for any of the stockpile of computers in attics, basements or warehouses.

TABLE CPU 7: Estimated Obsolete Oregon PCs by year (thousands of units)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
PCs	247	286	380	503	665	760	730	761	718	736

Based on the unit figures above and the "average" weight of a computer, the following Table CPU 8 estimates the tonnage of obsolete computers in Oregon. The average weight is taken from a Carnegie Mellon University study, July 1997. These researchers found that a typical 1990 desktop computer weighed about 30 lbs. (2 cubic feet). Newer, desktop machines weigh roughly 50 lbs (3 cubic feet by volume), while laptop machines weigh roughly 7.5 lbs (0.14 cubic feet). The fraction of laptop sales is approx. 20%, so the "weighted average" of a landfilled machine today is 42 lbs each. Computer monitors contribute nearly 50% of the mass and volume of computer systems.

TABLE CPU 8: Tonnage of Obsolete Oregon PCs, including monitors

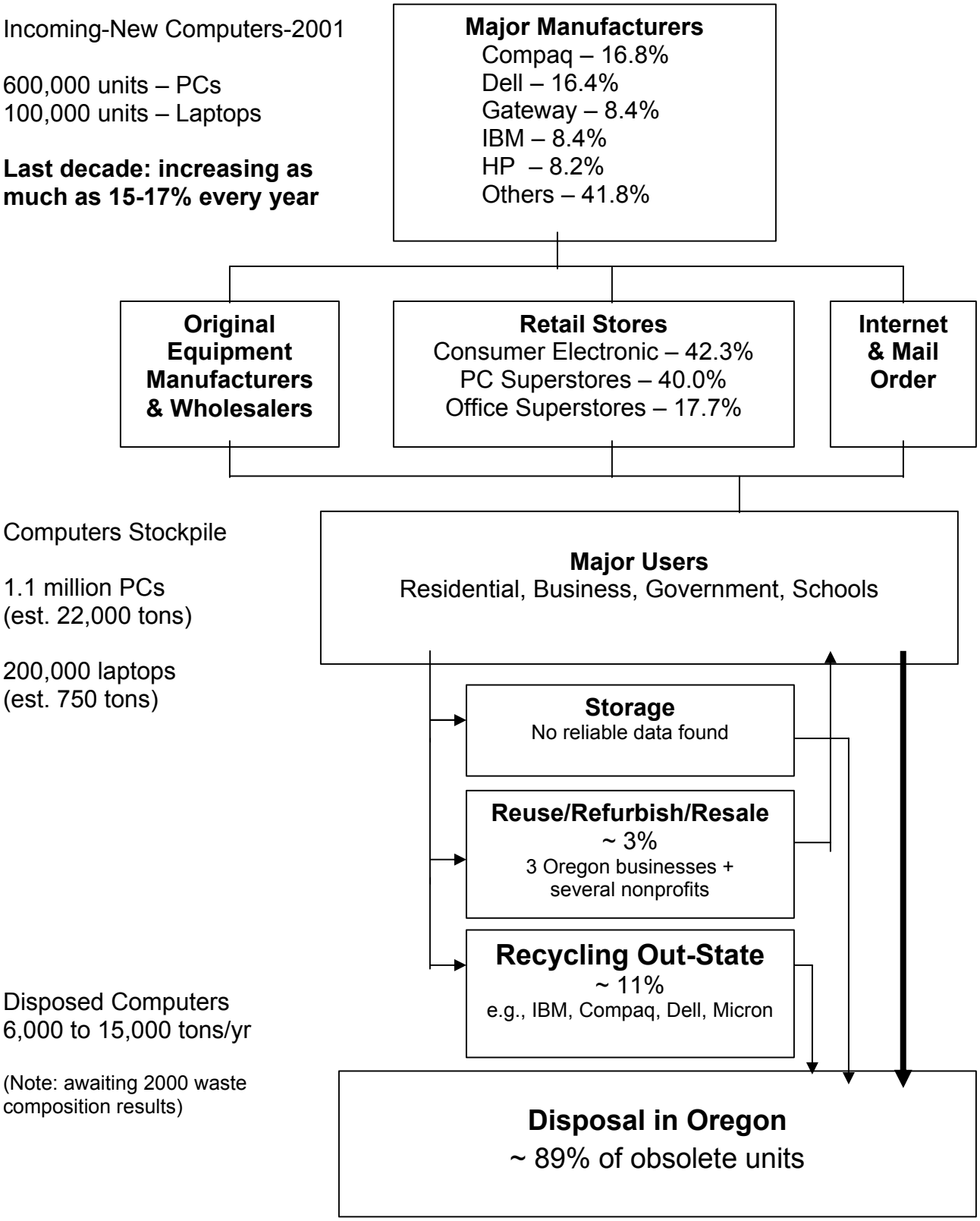
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
PCs	5,187	6,006	7,980	10,563	13,965	15,960	15,330	15,981	15,078	15,456

This estimate of the weight of obsolete PCs developed from available data was compared to the weight of "computers" sorted during Oregon's last reported waste composition study (1998). At that time, the computer category—including computers, CRT monitors, and peripherals— accounted for 0.25% of the state's 2.7 million tons of solid waste, or 6,750 tons. On a statistical basis, the potential tonnage range of the computer category in 1998, at the 90% confidence level, could be as low as 3,510 tons to as much as 9,990 tons. This finding would tend to validate the estimate available from the estimates published in the Baseline Report.

As shown in the previous table, the estimated tonnage of computers and monitors for 2001 was 10,563, and it was predicted to rise to nearly 16,000 tons annually in 2005. Data from more recent waste composition studies has not yet been published.

CPU Figure 1, on the following page, provides a summary diagram of the flow of computer/CPU products in the state, beginning with manufacturing, then through the wholesale and retail distribution chain to residents and businesses. The inflow of computers into the state is quite complex and involves hundreds of businesses in all parts of the world. The figure is thus necessarily simplified. The major end-of-life management methods are shown as well.

CPU FIGURE 1: Estimated Computer Flows in Oregon



End-of-life management

Computer equipment is becoming obsolete on average every 3 to 4 years. This lifespan is expected to decrease to as little as 2 years in the near future. The following recommendations to determine the proper method of end of life handling were published in *Smart Business* by Jim Conley:

- For individuals—sell the computer after two years; donate it after three years and pay for disposal costs after four years.
- For corporate users—disposal is the least expensive option due to the cost of removing confidential files.

In the computer lifespan model developed for the National Safety Council's Baseline Report, Stanford Resources estimated that 20.6 million personal computers became obsolete in 1998. This number was expected to grow to 42 million for 2001 and 63 million for the year 2003 and beyond.

According to reports by recyclers and third-party organizations, about 2.3 million PCs (11%) were recycled in 1998. In 1999, about 24 million computers became obsolete and 3.3 million (14%) were recycled. The report estimated that adding in the number of PCs refurbished, resold, or donated by third parties increases the amount diverted an additional 3%.

There has been very little reuse and recycling opportunities for this equipment. The ratio of PC CPUs recycled compared to PC CPUs shipped in 1998 was only 6%. In contrast, the same ratio of number recycled to number shipped for major appliances (e.g., washing machines, water heaters, air conditioners, refrigerators, dryers, dishwashers, ranges, and freezers) was about 70%.

The following Table CPU 9 provides a detailed view of the contents of a ton of computer waste. This study does not include monitors or peripherals. It breaks down a random ton of computer CPUs into its elemental components.

TABLE CPU 9: Waste Generated per Ton of CPUs, 1999

MATERIAL	LBS/TON	MATERIAL	LBS/TON
PLASTICS	600	CADMIUM	.79
COPPER	286	TANTALUM	.38
IRON	90	MOLYBDENUM	.31
BROMINE	56	PALLADIUM	.25
LEAD	54	BERYLLIUM	.18
TIN	44	COBALT	.17
NICKEL	40	CERIUM	.10
ANTIMONY	22	PLATINUM	.07
ZINC	9	LANTHANUM	.06
SILVER	1	MERCURY	.02
GOLD	1		

Note: This table does not include CRTs, which would approximately triple the percentage of lead, nor does it include computer peripherals such as printers, mice, modems, etc.
Source: Technical University of Denmark

The convergence of rapidly increasing rates of PC use combined with ever shorter lifespans pushes the estimates for obsolete PCs in Oregon to over 500,000 for 2001. That is 2.5 times the waste and environmental impact generated from computers from just three years earlier.

The system used by many major private companies for managing discarded electronics has been compared to a "triage" system that assigns each electronic item to one of four grades: Resale, Upgrade, Scrap, or Export (RUSE). Most electronics dealers trade in and out of all these grades. Many tend toward focusing on one of these niches. Key players in the RUSE system include repair shops, non-profit organizations, and scrap recyclers.

Computer Recycling Opportunities

The website for "thegreenpc.com" contains valuable information about computer recycling. According to the site: There are only a few plastic recyclers in the country capable of recycling the special plastics used in computers. There are only three CRT recyclers in the U.S. There are less than a dozen metal refiners that can process the electronic boards in a computer. The feedstock for these plants must come from thousands of different locations to provide the necessary volume.

Precious metals from computer boards are handled at a few metal recyclers. However, the amount of precious metals found in computers is decreasing, which minimizes the value of the product to recyclers and decreases the life span of the product.

Batteries in computers are a source of toxic heavy metals. Nickel cadmium, nickel metal hydride, and lithium batteries are all found in computers. The Rechargeable Battery Recycling Corporation (RBRC) receives batteries for recycling in Pennsylvania.

Approx 80% of the scrap volume of computers is miscellaneous metals and plastics. Due to the high labor requirement for further processing, this material is sent to the Far East for handling. The U.S. Department of Defense is funding a detailed study on the best economic approach to recycling electronics. Aimed initially at military electronics, this project will likely impact consumer electronics recycling. This study is scheduled for completion in 2002.

One of the few recyclers in the nation handling electronic equipment is the Goldsmith Group in Indiana. This company accepts various materials from Oregon collectors for a recycling market.

In the European Union, all computer manufacturers will be required to have a recycling program in place for old machines by 2003. Currently, **IBM** is the only company that has implemented a system available to everyone in North America. This program accepts any manufacturer's system, including peripherals, for donation, refurbishing and/or recycling. The user prepays for the shipping through IBM via UPS, currently at $29.99 per unit. The company expects to landfill only about 3% of the incoming material.

Compaq offers their Computer Asset Recovery Services to corporate customers. Compaq receives the returned equipment and documents the asset recovery for the client. They handle product routing, parts warehousing, distribution, recycling and EPA-approved disposal. The customer receives accurate asset recovery documentation for accounting purposes.

Dell offers two asset disposition services to their corporate customers, Value Recovery Services and PC Recycling Services. VRS receives working systems to give as donations to educational facilities. The service cleans the system of proprietary data and returns to the company all asset accounting information to track and document the asset recovery process. PC Recycling Services are for broken or outdated equipment. Dell offers EPA-compliant handling of all equipment and facilitates the packing and transportation to their facility. They also document all asset disposals for their customers' accounting requirements. Both Dell and Compaq price these services based on a variety of customer variables.

Micron PC offers similar recycling opportunities for their customers. A customer is allowed to recycle computer systems up to the number of new Micron systems that are purchased. Pricing for this service is variable and quoted in advance.

Local or Regional Collectors

As of this date, there are three companies in Oregon that handle electronic equipment for recycling, dismantling and donation. They are Quantum Resource Recovery in Beaverton, Computer Drive Connection in Cornelius, and Earth Protection Services in Lake Oswego. Waste Management will begin operations at a collection facility in Portland sometime this year. They have operating facilities elsewhere and are expanding their regional services. Financial arrangements for the collection and recycling of materials are considered proprietary. Similarly, the consultant team asked for end market information, but in most cases that was considered proprietary by the collectors.

Quantum Resource Recovery receives electronic scrap from commercial and industrial sources as well as public drop-off opportunities. They collect all electronic equipment and computers and peripherals with the exception of televisions, stereo speakers, and microwaves. They handle ferrous and non-ferrous metals and all kinds of postindustrial plastics. Currently they collect about 15 to 20 tons of electronic scrap, including but not limited to CPUs, with about 95% of that coming from their industrial clients. Occasionally, a company will have an internal roundup that causes the volume to peak for that month. The monitors are currently shipped to a facility in California that tests them for functionality and refurbishes them for reuse. Within 75 miles of Portland this company will haul materials into their facility using their own equipment. They will take delivery of pre-approved loads from other locations. This company has also worked with the local governments of Lane County, Tigard and Portland to offer collection services at neighborhood roundups. These collection events include various non-profit organizations that will test equipment and accept working materials as donations. These organizations will be discussed later in the report.

Computer Drive Connection handles computer/electronic materials and metals. They accept monitors, computer systems, disk drives, CD ROMs, VCRs, Fax machines, telephones, keyboards, printers, power supplies, etc. This company adheres to the garbage hierarchy, stressing reuse over recycling. The collected computer equipment is refurbished and resold if possible, or recycled. This company teamed up with Bring Recycling and a local non-profit for a Lane County roundup. Computer Drive Connection teamed with Marion County SW to allow free drop-offs at Salem-Keizer Recycling and Transfer site. A 30-yard container was filled in three weeks. They are planning similar roundups for Clark County (Washington), Astoria and Newberg. Collection containers and transportation are provided for the first few public collections. Individuals that drop off materials are asked to pay $2 for each monitor. They collect about 160 tons of material per month.

Earth Protection Services, Inc., accepts computer equipment for reuse and recycling. The company has an agreement with a non-profit organization that refurbishes systems and donates them to schools. They offer 2 to 3 pallets of computers and monitors and a

Gaylord box of printers, copiers, keyboards and other peripherals to a non-profit approximately every 2 months. A conversion factor was not provided by the vendor. The non-profit organization gleans the usable parts and Earth Protection services sends the balance of the goods to their Arizona facility for sorting, and then to Waste Management's Asset Recovery Group in Phoenix. This company worked with Washington County Cooperative and a non-profit to collect electronic equipment from residents during a one-day collection event. Equipment weight from this collection was not recorded for this event.

On-line Equipment Brokers

Share Technology offers a web page designed to connect computer donors and non-profit donation seekers throughout the country. This website facilitates the connection between computer donor and non-profit organization or persons with disabilities. Share Technology states that they have facilitated 371 donations so far in 2001 and 965 during 2000.

"Free-e-com.net" offers an on-line connection between purchasers and sellers of computer equipment. For a small monthly fee, want-to-buy and want-to-sell ads are posted on the web page and sent out via email to members.

Non-profit Organizations

There are several non-profit organizations that are set up to accept computer systems to repair, donate and/or resell. Some of these organizations use this as an educational opportunity for job training. Recycling of unusable electronic equipment is available at each of these sites.

StRUT, Students Recycling Used Technologies, is an organization that has now spread statewide with 131 schools participating. This organization accepts electronic equipment donations for educational uses in schools. Working systems are donated for immediate use in classrooms. Non-working systems are used as instructional aids in hardware, software and system maintenance training. All equipment that is collected statewide is funneled into the warehouse and repair shop in Portland and is used within the K-12 classrooms. None is sold. Items that they cannot use are recycled.

This organization worked with Washington County Cooperative for a weekend roundup of electronic equipment. During the October weekend, they collected 270 items from individuals and an additional four Gaylord-sized boxes of donations from local businesses. StRUT also worked with the National Guard in Winston, Oregon, just south of Roseburg, to collect electronic donations from residents and businesses in that region. They collected 80 pallets of material that were transported to Portland by a local trucking company. They worked with Bring Recycling for one of Lane County's two regional

roundups of electronic equipment. They tested all incoming components and got first rights of refusal on anything that worked. This roundup invited local businesses and residents to donate their old computer equipment and peripherals. StRUT has a continuing agreement with Computer Drive Connections to get any equipment that they need for the schools.

StRUT estimates that they receive 25 to 40 pallets a day of computer equipment plus 10 to 15 individual donations. They have an agreement with a metal reclaimer to handle the precious metals and with another recycler for ferrous metals and plastics. All donated cell phones are given to Motorola's 911 Alert program. Unneeded monitors are shipped to an Asian market. StRUT recently began keeping records of number of units and amount of material handled. Historical information is not available. Costs for recycling services are not known.

Free Geek is a non-profit organization in Portland that accepts all computer technology regardless of condition for repair and reuse. Through this program, members can earn a free Linux operating system computer in exchange for donated time. Volunteers are used extensively for running the business and the training. Members get free Internet access and computer job training. Donations of $5 are required for donations of older systems to offset the cost of refurbishing, recycling and repairing. Volunteer opportunities include:

- Donation coordination
- Computer prep
- Computer maintenance
- Computer recycling
- Administration (reception, filing)
- Remodeling (construction)
- Member/volunteer coordination

This organization has been actively accepting and repairing computer equipment and training volunteers since the Fall of 2000. Free Geek has not kept records on the number of systems refurbished and returned to use, but they estimate that it is in the hundreds. When the organization began, it was not ready to record weights and amounts of material handled, refurbished, and recycled, so no information exists.

All of their unusable material is recycled through Quantum Resource Recovery; the total to date is about 10.5 tons. They receive an occasional donation from outside the Metro region, but most equipment comes from businesses and individuals in the area. Most of their volunteers and members are local, also.

Oregon Public Networking of Eugene makes Internet-ready computers available to low income individuals and non-profits. They accept working, late model units, both Macintosh and PCs. The equipment is repaired by volunteers and distributed to the recipient on a first come, first served basis. There is currently a waiting list. During the year 2000, they refurbished approximately 150 systems (i.e., CPU, monitor, keyboard, with an average weight of 28.5 pounds each. They recycled or disposed of an equal

amount of material. This organization, working through the Eugene Free Community Network, employees local volunteers to refurbish systems that are kept in their community. Funding sources for the organization were not researched.

Goodwill Industries of the Columbia and the Willamette Valley, and Goodwill of Lane County accept working computers only. The Goodwill of Medford has set up a technology repair and refurbishing business that accepts a wide variety of electronic components. They train the staff to rebuild them into working systems for resale. Goodwill is funded by individual and corporate donations.

Societies of St. Vincent DePaul in Portland and in Bend do not accept any computer equipment at this time. The Lane County Society has plans for exploring equipment refurbishing options in the near future.

Repair Shops

Twenty-six repair shops were interviewed in seven cities/towns around the state to determine their end-of-life handling of electronic material. The results of these interviews are summarized in Table CPU 10. Anecdotal evidence from some of these repair shops indicates that some self-employed entrepreneurs collect computer material for recycling at random times, as well.

TABLE CPU 10: REPAIR SHOP ELECTRONIC MATERIAL END-OF-LIFE HANDLING

Total number of interviewed repair shops	**26**
Repair shops that recycle almost everything	8
Repair shops that sold as much used equipment as possible, then donated some of the remaining to schools, scouts and various agencies and then recycled remaining material	3
Repair shops that require customers to be responsible for all waste	1
Repair shops that sold some used equipment and landfilled remaining material	3
Repair shops that donated usable materials and landfilled all other materials	3
Repair shops that recycle metal casings and landfill all other materials	1
Repair shops that landfill everything	7

Industry profile

Early in the project the consultant team developed a process for gathering information about CPU manufacturing, wholesaling and retailing in Oregon based on established industrial classification and data gathering systems. The industry data systems are based on the North American Industrial Classification System (NAICS) and Standard Industrial Classification (SIC) codes.

The SIC system was developed and is used by U.S. agencies, while NAICS is intended for all North American countries. The SIC system uses a four-digit descriptor, while NAICS uses up to six digits to further refine its listings. Since 1997, all agencies have been moving toward using the NAICS code system.

The most recent year for which economic data is available is 1997 and uses both SIC and NAICS codes. The consultant created data tables using both code sets. Because of its more detailed categorization of industries (up to the six digit code), the NAICS information provides more precise information on industry involvement.

CPU Manufacturing

As described above, the consultant used NAICS and SIC based resources to identify manufacturers. One difficulty in identifying CPU manufacturers is that some companies make parts of CPUs, which are ultimately assembled by another company. Some businesses that assemble CPUs also wholesale them. These could cause "double counting" of manufacturers or overlap in the manufacturer and wholesaler categories.

In 1999, shipments of computers manufactured in the U.S. were valued at $62.7 billion, with a total of 28.3 million units shipped. No separate breakdown of shipments for Oregon was found. The breakdown of different types of computers sold is shown in Table CPU 11. The largest type of computer manufactured is personal computers with approximately 19 million being produced or assembled in the U.S.

TABLE CPU 11: Quantity and Value of Electronic Computers by Type
NAICS Code: 334111

Description	1999		1998	
	Units	Value ($000)	Units	Value ($000)
Large computers (mainframes and super computers)	1,289,358	6,088,980	751,779	5,201,352
Medium systems and Unix servers	965,780	8,048,996	657,565	6,952,037

PC servers	630,339	2,498,740	ND	ND
Other host computers	27,024	541,629	ND	ND
Single User Computers				
Personal Computers	19,397,775	26,307,648	15,585,321	24,524,278
Workstations	744,846	10,172,995	721,737	9,806,737
Laptops	ND	ND	190,494	537,812
Notebooks, subnotebooks	ND	ND	2,470,482	5,809,554
Personal digital assistants	ND	ND	69,374	47,546
Other portable units	ND	ND	223,378	162,776
Other single use units	207,407	109,579	205,916	113,167
TOTAL	28,294,408	62,711,900	23,063,796	56,891,491

ND – Withheld to avoid disclosing data for individual companies
Source: Census Bureau – *Computer and Office and Accounting Machines* Industrial Reports

Business statistics for the U.S. and Oregon are listed in Table CPU 12. This 1997 data shows 563 national businesses and 12 Oregon businesses in the "Electronic Computer Manufacturing" category.

TABLE CPU 12: Electronic Computer Manufacturing for 1997
NAICS code: 334111 / SIC codes: 3571

	U.S.	***Oregon***
Value of Shipments	$65,923,736,000	$1,055,341,000
Employees	105,383	1,406
Payroll	$4,251,722,000	$73,521,000
Establishments	563	12

Source: U.S. Census Bureau Publications: *Manufacturing Industry Series* for U.S. and for Oregon and *County Business Patterns* for Oregon

The consultant sought the names of specific computer manufacturers in Oregon from Qwest. The Qwest Dex website only offered a list of two dozen businesses grouped together as computer manufactures and wholesalers. This list of businesses is included as CPU Appendix 1.

A 1995 study by EPA showed approximately 156 businesses in Oregon that qualified as "Companies in the Electronics/Computer Industry." Companies that fell in this category manufactured printed circuit boards, semiconductors & related devices or cathode ray tubes. The consultant found few cathode ray tube manufacturers in Oregon, so a large number of the 156 businesses must be printed circuit board, semiconductors & related devices manufacturers. CPU Appendix 1 shows some of the businesses that also manufacture computer parts.

The top 50 Oregon businesses compiled by "oregonlive.com" included the five computer businesses shown in Table CPU 13. This data suggests there is a large circuit manufacturing presence in Oregon.

TABLE CPU 13: Major Computer-Related Manufacturing in Oregon

Company Name	*Products Manufactured*	*Revenues for 1999 (in millions)*
Tektronix Inc.	Makes test and measurement tools for the electronics industry, including chips.	$1,861.5
RadiSys Corp.	Manufactures industrial computers	$251
FEI Co.	Produces Ion-beam workstations for integrated circuit makers	$216.2
TriQuint Semiconductor Inc.	Manufactures integrated circuits	$163.7
Merix Corp.	Makes printed circuit boards	$114

Source: "Top Technology Firms By Revenue." Retrieved January 2001, from the World Wide Web: http://www.oregonlive.com, from *Oregon Live*

CPU Wholesalers

CPUs are distributed by manufacturers using many distribution routes. They may be sold under the manufacturer's name through retail stores, original equipment manufacturers (OEMs) or other system retailers, such as Compaq.

The classification category that includes wholesale computer CPUs is "Computers and Computer Peripherals Equipment." The description of businesses in this category according to NAICS is industry establishments that wholesale computers, computer peripherals, loaded computer boards, and/or computer software. Table CPU 14 shows the number of U.S. and Oregon businesses in this category according to the U.S. Census Bureau's 1997 study.

TABLE CPU 14: Computer and Computer Peripheral Equipment and Software Wholesalers for 1997
NAICS code: 421430 / SIC code: 5045

	U.S.	*Oregon*
Industry Sales – All Products	$221,477,412,000	$935,594,000
Employees	317,662	2,202

Payroll	$17,305,512,000	$102,325,000
Establishments	16,929	210

Source: U.S. Census Bureau Publications: *Manufacturing Industry Series* for U.S. and for Oregon and *County Business Patterns* for Oregon

Top U.S. Computer wholesalers are found in the NAICS category "Computer and Computer Peripheral Equipment and Software Wholesalers" are listed in table CPU 15. Qwest listed 88 wholesale computer businesses in this classification located in Oregon. A complete listing of these Oregon businesses is in CPU Appendix 2. There may be some overlap between CPU Appendix 1 and CPU Appendix 2.

TABLE CPU 15: Computer and Computer Peripheral Equipment and Software Wholesalers in 1997
NAICS code: 421430 / SIC code: 5045

Company	*City*	*State*	*Sales Volume (million $)*	*Number of Employees*
Top U.S. Computer and Computer Peripheral and Software Equipment Wholesalers				
Avent Inc.	Great Neck	NY	5,390	9,400
Tech Data Corp.	Clearwater	FL	4,599	3,400
Mitsubishi Electronics America	Cypress	CA	4,400	3,000
Merisel Inc.	El Segundo	CA	4,049	2,300
InaCom Corp.	Omaha	NE	3,900	2,900
Intelligent Electronics Inc.	Exton	PA	3,588	2,600
Hitachi Amerca Ltd.	Tarrytown	NY	3,500	6,000
Comdisco Inc.	Rosemont	IL	2,819	2,400
Hitachi Data Systems Corp.	Santa Clara	CA	2,000	2,300
CompuCom Systems Inc.	Dallas	TX	1,995	3,700
CHS Electronics Inc.	Miami	FL	1,855	2,300
Ingram Book Group, Inc.	La Vergne	TN	1,820	2,500
Pioneer-Standard Electronics	Cleveland	OH	1,509	2,100
AmeriData Technologies	Stamford	CT	1,500	3,500
Lanier Worldwide Inc.	Atlanta	GA	1,270	7,000
Wyle Electronics	Irvine	CA	1,245	1,500
Decision Data Inc.	Horsham	PA	1,240	2,500
Marshall Industries	El Monte	CA	1,185	1,400
Handleman Co.	Troy	MI	1,181	3,500
Access Graphics Inc.	Boulder	CO	1,032	6,000
Ingram Micro Inc.	Santa Ana	CA	990	2,000

Satellite Information Systems	Boulder	CO	838	<100
Avnet Computer Inc.	Tempe	AZ	800	600
Computer and Computer Peripheral and Software Wholesalers in Oregon				
IBM Corp	Beaverton	OR	100-500	1,000-4,999
Sun Microsystems Inc.	Beaverton	OR	100-500	100-249
Timberline Software Corp.	Beaverton	OR	50-100	250-499
Christenson Electric Inc.	Portland	OR	50-100	100-249
Allen/Falk Inc.	Beaverton	OR	50-100	50-99
Epicor Software Corp.	Tualatin	OR	50-100	50-99
Microstandard Distributors	Beaverton	OR	20-50	50-99
Graybar Electric Co	Portland	OR	20-50	50-99
Avnet	Beaverton	OR	20-50	20-49
FEI America Inc.	Tualatin	OR	20-50	20-49
North Pacific Technology	Portland	OR	20-50	20-49
Sun Microsystems Inc.	Beaverton	OR	20-50	20-49
Supercom	Beaverton	OR	20-50	20-49
Convergence Communication	Portland	OR	20-50	20-49

Source for National Data: Wholesale and Retail Trade USA, Second Edition
Source for Oregon Data: Database from Qwest

CPU Retailers

ADI Corporation estimated 1996 worldwide demand for PCs at 66 million, growing to 86.63 million in 1998, and over 100 million in 2000. Most of these sales are for desktop computers.

The U.S. Bureau of the Census estimates that in 1997, 37.4 million American households, or 36.6 percent, had computers. It is also estimated that 49.8 percent (97,844,500 people) of U.S. people 18 years and over use a computer at work.

CPUs can be purchased by many means—direct from some manufacturers; via Internet resellers, such as Dell; from wholesalers; from retail businesses and from companies that assemble custom computers using separate components per customer request.

The Market Share Reporter provides some information on the relative market share of various "stores." In 1999, they found that consumer electronics stores accounted for 42.3% of new computer sales; PC superstores, 40.0%; and office superstores, 17.7%. It appears, however, that this accounting does not show the share of computers sold via Internet, mail order, or OEM sources.

The Qwest Dex website provided a list of more than 100 Oregon computer dealers, and it is included in Appendix CPU 3. Finally, the Qwest website provided a separate list of used computer dealers, which has been included as Appendix CPU 4. It was not possible to determine which of these new or used equipment dealers are the more significant.

Product Trends

Design for Environment

Design for Environment (DfE) is a concept that is showing progress in the electronics industry. Not simply for computers, but across entire company product lines, DfE establishes standards and procedures for the design of new products. DfE puts environmental considerations on par with other design criteria, such as engineering, materials and manufacturing, cost control, consumer preferences, and serviceability.

Two electronics firms whose DfE programs have been widely reported include Compaq Computers and Hewlett-Packard (HP). A 1997 report by the Center for Clean Products and Clean Technologies at the Univ. of Tennessee provided lengthy descriptions of the Compaq and HP DfE programs.

According to the report, the DfE programs set up by these leading computer companies address several issues including, among others, the following:

- Material selection—reducing toxicity and increasing recyclability
- Material identification
- Design for reuse and upgradeability
- Design for disassembly
- Energy conservation during manufacturing and use
- Packaging waste prevention and recyclability

One of the keys to successful DfE and product stewardship is that companies look at conservation not simply in the product alone, but also in the manufacture of the product and in the servicing and end-of-life management of the product.

Elements involved in the successful implementation of DfE initiatives include:

- Adoption of DfE guidelines as a part of corporate policy
- Cross-functional teams with representatives from engineering, packaging, purchasing, finance and marketing
- Supplier management, including detailed specs and feedback mechanisms

Design for environment initiatives will have a direct impact on the life-cycle management of electronic products, both in extending the life of electronics by making them easy to upgrade, and in making them easy to disassemble and recycle at the end of life.

The Warmer Bulletin reports that Compaq's DfE program has eliminated ozone-depleting CFCs and minimized waste and energy use—saving $60 million in 1995. Xerox's remanufacturing strategy for copiers has saved the company $200 million in materials and parts in under 5 years.

Finally, in the software area, is the emergence of vendors who provide software developed to make older PCs useable for new uses, such as the Internet. One such company, New Deal, Somerville, MA, makes operating system and applications software that runs well on older machines, including 386 and 486 PCs. The system has the look and feel of current programs but isn't as sophisticated, so it doesn't require as much memory. It allows even older computers to be used for Internet applications. New Deals clientele includes small businesses, budget-minded consumers, and people in India, Africa and Latin America. According to New Deal's founder, Clive Smith, "Ninety-five percent of the world doesn't have a computer and 98% aren't on the Internet. They don't need a Ferrari." New Deal will soon begin marketing "green PCs"—refurbished computers with software and modems—for $150-$300.

Electronics will also be at the forefront of initiatives being undertaken at the new Product Stewardship Institute at the University of Massachusetts, Lowell, MA. The national policy center will provide assistance and coordination to the states on a number of key issues involving reuse, recycling, collection, and the economics of product stewardship.

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Quantum Resource Recovery, 503-646-2427. Contact name: Kent Dunn
Computer Drive Connection, Inc., 503-992-0180. Contact name: Brad Franklin
Earth Protection Services, 503-620-2466.
Rhode Island Resource Recovery Corporation
Northeast Recycling Council, 802-254-3636
Waste Management Asset Recovery Group, 510-563-4214. Contact name: Kevin McCarthy
Lane County, 541-682-4339. Contact name: Tanya Baker
Bring Recycling, 541-746-3023. Contact name: Julie Daniel
Goldsmith Group, 317-710-0385. Contact name: Eric Goldsmith
StRUT, 503-251-3771. Contact name: Greg Sampson
BF-2 Metals, 541-683-2511. Contact name: Steve Root
Free Geek, 503-232-9350. Contact name: Phillip Santo
Northwest Microtechnics, 503-697-5010.
Oregon Public Networking, 541-484-9637. Contact name: John Crider

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Share Technology—http://sharetechnology.org/
IBM Computer Recycling—www.ibm.com/ibm/environment/
Compaq Computer Recycling—www.compaq.com
Dell Computer Recycling—www.dell.com/us/en/hied/services/asset
Micron PC Recycling—www.micronpc.com/programs/mpower/ind recycle.html
Electronic Industries Alliance—www.eia.org
Northeast Recycling Council—www.nerc.org/electpolicy
National Safety Council—www.nsc.org/ehc/epr2
NRC Electronics Recycling Initiative—www.nre-recycle.org/programs/electronics
EPA—www.epa.gov
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King County—www.metrokc.gov/swd/CRP.htm
Florida—www.dep.state.fl.us
Northwest Product Stewardship Council—www.govlink.org/nwpsc
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CPU Appendix 1

Computer Manufacturers and Wholesalers in Oregon

Company	*Type*	*M/WS*	*City*	*Phone*
Ctl	Manufacturers CRTs and LCD products in plants in Korea, Malaysia, Inchun; assembles products in Oregon plant	M	Portland	503-230-0549
FEI America Inc	Wholesale of computers/parts	W	Lake Oswego	503-620-8640
Hewitt Rand	Designs, builds and sells workstations	M,WS	Portland	888-446-3748
Horizon Micro Distributors	Wholesale of computers/parts	WS	Tigard	800-288-6253
Intel Corporation	Manufactures CPUs, chipsets, flash memory, embedded control chips and motherboards	M	Hillsboro	800-628-8686
Northwest Computer Accessories, Inc.	Wholesale of computers/parts	WS	Portland	503-232-6324
Bolis Technology	Wholesale of computers/parts	WS	Eugene	541-683-3331
Computech Systems Inc.	Manufactures and wholesales systems including CPUs for personal computer systems	M/WS	Medford	541-734-4380
Corvallis Microtechnology Inc.	Manufactures and wholesales GPS computers - 2nd largest manufacturer of GPS computers in the U.S.	M/WS	Corvallis	541-752-5456
E Com Intl.	Computer Manufacturer or Wholesaler	na	Beaverton	503-671-9900
Eclipse Marketing Inc.	Wholesale of computers/parts	WS	Tigard	503-598-8634
GenTech Computer Systems Inc.	Manufactures (Assembles already manufactured computer parts to make systems) and wholesales computers and computer parts	M/WS	Portland	503-252-6422

GSA	Manufactures (Assembles already manufactured computer parts to make systems) and wholesales computers and computer parts	M/WS	Bend	541-317-0756
Hallmark Computers	Wholesale of computers/parts	na	Beaverton	503-526-6239
Lewis Control Inc.	Manufactures computer control parts for the saw mill industry	M	Cornelius	503-648-9119
Marconi	Manufactures ATM and gigabyte ethernet equipment	M	Portland	503-452-6911
Merit Distributing	Wholesale of computers/parts	WS	Tigard	503-639-4229
Merit Distributing	Wholesale of computers/parts	WS	Portland	888-446-3748
Northwest Micro Inc. Accounting	Manufactures (Assembles already manufactured computer parts to make systems)	M	Beaverton	503-643-3951
Novell	Net services software	WS	Portland	503-293-8346
Practical Computers Inc.	Wholesale of computers/parts	WS		541-726-7789
Radisys Corp	Manufactures CPUs, CRTs and other computer parts	M	Beaverton	503-531-8625
Speaks & Associates	Wholesale of computers/parts	WS	Medford	541-734-9494
Arrow Electronics	Wholesale of computers/parts	WS	Beaverton	503-598-9953
Your Computer Store	Wholesale of computers/parts	WS	Portland	503-761-5570

Notes: M - Manufacturers, WS - Wholesalers, na - not available

CPU Appendix 2

Wholesalers: Computers and Computer Peripherals Equipment
(includes Computer CRTs and CPUs)-5045

National:

SIC Code	*Company Name*	*Address*	*City*	*Zip Code*	*Phone*	*Sales (million $)*	*Number of Employees*
5045	Avent Inc.	80 Cutter Mill Rd.	Great Neck	NY	516-466-7000	5,390	9,400
5045	Tech Data Corp.	5350 Tech Data Drive	Clearwater	FL	813-539-7429	4,599	3,400
5045	Mitsubishi Electronics America	PO Box 6007	Cypress	CA	714-220-2500	4,400	3,000
5045	Merisel Inc.	200 Continental	El Segundo	CA	310-615-3080	4,049	2,300
5045	InaCom Corp.	10810 Farnam Dr.	Omaha	NE	402-392-3900	3,900	2,900
5045	Intelligent Electronics Inc.	411 Eagleview Blvd.	Exton	PA	610-458-5500	3,588	2,600
5045	Hitachi America Ltd.	50 Prospect Ave.	Tarrytown	NY	914-332-5800	3,500	6,000
5045	Comdisco Inc.	6111 N. River Rd.	Rosemont	IL	847-698-3000	2,819	2,400
5045	Hitachi Data Systems Corp.	PO Box 54996	Santa Clara	Ca	408-970-1000	2,000	2,300
5045	CompuCom Systems Inc.	10100 N. Central	Dallas	TX	214-265-3600	1,995	3,700
5045	CHS Electronics Inc.	2153 NW 86th Ave.	Miami	FL	305-716-8273	1,855	2,300
5045	Ingram Book Group Inc.	1 Ingram Blvd	La Vergne	TN	615-793-5000	1,820	2,500
5045	Pioneer-Standard Electronics	4800 E. 131st Street	Cleveland	OH	216-587-3600	1,509	2,100
5045	AmeriData Technologies Inc.	700 Canal Street	Stamford	CT	203-357-1464	1,500	3,500
5045	Lanier Worldwide Inc.	2300 Pklake Dr. NE	Atlanta	GA	404-496-9500	1,270	7,000
5045	Wyle Electronics	15370 Barranca	Irvine	CA	714-753-9953	1,245	1,500
5045	Decision Data Inc.	400 Horsham Rd.	Horsham	PA	215-956-6700	1,240	2,500
5045	Marshall Industries	9320 Telstar Ave.	El Monte	CA	818-307-6000	1,185	1,400

5045	Handleman Co.	500 Kirts Blvd.	Troy	MI	248-362-4400	1,181	3,500
5045	Access Graphics Inc.	1426 Pearl St.	Boulder	CO	303-938-9333	1,032	6,000
5045	Ingram Micro Inc.	1600 E. Andrew Pl.	Santa Ana	CA	714-566-1000	990	2,000
5045	Satellite Information Systems	7464 Arapahoe Rd.	Boulder	CO	303-449-0442	838	<100
5045	Avnet Computer Inc.	3011 S 52nd St.	Tempe	AZ	602-414-6700	800	600

Oregon:

SIC Code	*Company Name*	*Address*	*City*	*Zip Code*	*Phone*	*Sales (million $)*	*Number of Employees*
504503	IBM CORP	15450 SW KOLL PKWY	BEAVERTON	97006	503/626-5700	100 - 500	1,000 - 4,999
504503	SUN MICROSYSTEMS INC	8300 SW CREEKSIDE PL	BEAVERTON	97008	503/641-3151	100 - 500	100 - 249
504503	TIMBERLINE SOFTWARE CORP	15195 NW GREENBRIER PKWY	BEAVERTON	97006	503/690-6775	50 - 100	250 - 499
504506	CHRISTENSON ELECTRIC INC	6235 N BASIN AVE	PORTLAND	97217	503/285-1970	50 - 100	100 - 249
504506	ALLEN/FALK INC	9020 SW GEMINI DR	BEAVERTON	97008	503/646-0533	50 - 100	50 - 99
504509	EPICOR SOFTWARE CORP	8100 SW NYBERG RD	TUALATIN	97062	503/612-2600	50 - 100	50 - 99
504503	MICROSTANDARD DISTRIBUTORS	8082 SW NIMBUS AVE	BEAVERTON	97008	503/643-4886	20 - 50	50 - 99
504506	GRAYBAR ELECTRIC CO	901 NE 60TH AVE	PORTLAND	97213	503/249-1300	20 - 50	50 - 99
504503	AVNET	15580 SW JAY ST # 100	BEAVERTON	97006	503/439-6123	20 - 50	20 - 49
504503	FEI AMERICA INC	PO BOX 72	TUALATIN	97062	503/620-8640	20 - 50	20 - 49
504503	NORTH PACIFIC TECHNOLOGY	333 SE 2ND AVE	PORTLAND	97214	503/234-5000	20 - 50	20 - 49
504503	SUN MICROSYSTEMS INC	8705 SW NIMBUS AVE # 300	BEAVERTON	97008	503/627-0451	20 - 50	20 - 49
504503	SUPERCOM	10140 SW ALLEN BLVD # C	BEAVERTON	97005	503/526-8888	20 - 50	20 - 49
504506	CONVERGENCE COMMUNICATIONS	4386 SW MACADAM AVE	PORTLAND	97201	503/535-9200	20 - 50	20 - 49
504503	BOLIS TECHNOLOGY	995 TYINN ST	EUGENE	97402	541/683-3331	10 - 20	20 - 49
504503	COMPUTER	9315 SW NIMBUS AVE	BEAVERTON	97008	503/646-3733	10 - 20	20 - 49

	TECHNOLOGY LINK CORP						
504506	URS DATA COMMUNICATIONS	123 NE 7TH AVE	PORTLAND	97232	503/236-2050	10 - 20	20 - 49
504503	ABLE COMPUTER SYSTEMS INC	7905 SW CIRRUS DR	BEAVERTON	97008	503/626-9953	10 - 20	10 - 19
504503	COMPUTER MEDICS NORTHWEST	223 NE RUSSELL ST	PORTLAND	97212	503/281-2524	10 - 20	10 - 19
504503	IET NW	16650 SW 72ND AVE	TIGARD	97224	503/603-9888	10 - 20	10 - 19
504503	NORTHWEST COMPUTER ACCESSORIES	2135 SE 6TH AVE	PORTLAND	97214	503/232-6324	10 - 20	10 - 19
504506	NETWORKS	5558 SE INTERNATIONAL WAY	MILWAUKIE	97222	503/786-9000	10 - 20	10 - 19
504506	STRUCTURED COMMUNICATION SYSTS	4382 SE INTERNATIONAL WAY # C	MILWAUKIE	97222	503/656-3530	10 - 20	10 - 19
504507	STORAGE TECHNOLOGY CORP	10260 SW GREENBURG RD # 400	PORTLAND	97223	503/293-3589	10 - 20	10 - 19
504503	CTL-COMPUTER TECHNOLOGY LINK	PO BOX 14848	PORTLAND	97293	503/230-0549	10 - 20	5 - 9
504506	MATRIX COMMUNICATIONS	4243 SE INTERNATIONAL WAY # C	PORTLAND	97222	503/654-3000	5 - 10	50 - 99
504507	POWER MAC PAC	12310 NE WHITAKER WAY	PORTLAND	97230	503/256-5210	5 - 10	20 - 49
504503	NORTHWEST MICRO INC	6250 SW ARCTIC DR	BEAVERTON	97005	503/626-2555	5 - 10	10 - 19
504506	BEJED INC	4824 NE 42ND AVE	PORTLAND	97218	503/281-8153	5 - 10	10 - 19
504506	PROCOM COMMUNICATIONS INC	PO BOX 22288	PORTLAND	97269	503/233-8037	5 - 10	10 - 19
504503	ASI CORP	7291 SW TECH CENTER DR	TIGARD	97223	503/443-4800	5 - 10	5 - 9
504503	DIGI INTERNATIONAL	14780 SW OSPREY DR	BEAVERTON	97007	503/521-8730	5 - 10	5 - 9
504503	EMC CORP	10260 SW GREENBURG RD	PORTLAND	97223	503/293-8450	5 - 10	5 - 9
504503	INTERNET TECHNOLOGY INC	10200 SW ALLEN BLVD # E	BEAVERTON	97005	503/644-4156	5 - 10	5 - 9
504503	MAX COMPUTER STATION	18210 SE BURNSIDE ST # G	PORTLAND	97233	503/665-7189	5 - 10	5 - 9
504503	MERIT DISTRIBUTING	7244 SW DURHAM RD	TIGARD	97224	503/639-4229	5 - 10	5 - 9

504503	PENSTOCK ECR	8313 SW CIRRUS DR	BEAVERTON	97008	503/644-0800	5 - 10	5 - 9
504503	RAL MEDIA PRODUCTIONS	809 SW CANYON DR	REDMOND	97756	541/923-4616	5 - 10	5 - 9
504503	SPEAKS & ASSOC	943 AUTOMATION WAY # F	MEDFORD	97504	541/734-9494	5 - 10	5 - 9
504503	VO2MAX	899 SE GLENWOOD DR # E1	BEND	97702	541/318-1044	5 - 10	5 - 9
504506	CASCADE TELECOMMUNICATION	345 NE CLAY AVE	BEND	97701	541/388-5158	5 - 10	5 - 9
504506	DOW JONES NEW SVC	6400 SW CANYON CT	PORTLAND	97221	503/292-0513	5 - 10	5 - 9
504506	NETWORK SERVICES	317 SW ALDER ST	PORTLAND	97204	503/224-2022	5 - 10	5 - 9
504506	STAR ELECTRONICS	827 NE A ST	GRANTS PASS	97526	541/474-0548	5 - 10	5 - 9
504503	CORVALLIS MICROTECHNOLOGY	413 SW JEFFERSON AVE	CORVALLIS	97333	541/752-5456	2.5 - 5	20 - 49
504503	POLARIS COMMUNICATIONS INC	10200 SW ALLEN BLVD # A	BEAVERTON	97005	503/643-1533	2.5 - 5	20 - 49
504506	WELBURN ELECTRIC INC	PO BOX 329	PHOENIX	97535	541/535-3727	2.5 - 5	20 - 49
504503	VALLEY EQUIPMENT CO	PO BOX 12849	SALEM	97309	503/364-4491	2.5 - 5	10 - 19
504503	AMAZING ENTERPRISES	6327 SW CAPITOL HWY # 129	PORTLAND	97201	503/636-1199	2.5 - 5	5 - 9
504503	CIRRUS LOGIC INC	6650 SW REDWOOD LN	TIGARD	97224	503/620-5547	2.5 - 5	5 - 9
504503	JPI CO	10110 SW NIMBUS AVE # B10	PORTLAND	97223	503/598-0500	2.5 - 5	5 - 9
504503	N STORE TECHNOLOGIES	8625 SW CASCADE AVE # 270	BEAVERTON	97008	503/526-9191	2.5 - 5	5 - 9
504503	PICOJET INC	3155 SW 234TH AVE	HILLSBORO	97123	503/356-9196	2.5 - 5	5 - 9
504503	PRACTICAL COMPUTERS INC	1200 MOHAWK BLVD # D	SPRINGFIELD	97477	541/726-7789	2.5 - 5	5 - 9
504503	R SQUARED	2092 NW ALOCLEK DR # 513	HILLSBORO	97124	503/533-0517	2.5 - 5	5 - 9
504506	ICM-COMMUNICATIONS	12300 SE MALLARD WAY # 250	PORTLAND	97222	503/353-3086	2.5 - 5	5 - 9
504503	HORIZON MICRO DISTRIBUTORS	803 SW CIRRUS DR	BEAVERTON	97008	503/469-0147	2.5 - 5	1 - 4
504503	IMPERIAL DIRECT	55 NW 3RD ST	GRESHAM	97030	503/618-9162	2.5 - 5	1 - 4

504503	TRINITY TECHNOLOGIES INC	6443 BEAVERTON HILLSDALE # 320	PORTLAND	97221	503/291-1333	2.5 - 5	1 - 4
504506	CMS ENTERPRISES INC	17233 SE DIVISION ST	PORTLAND	97236	503/761-3910	2.5 - 5	1 - 4
504506	QUALITY MOBILE COMMUNICATIONS	4018 NE 112TH AVE # D6	PORTLAND	97220	503/240-8525	2.5 - 5	1 - 4
504507	RADIO SHACK	1023 MAIN ST	SWEET HOME	97386	541/367-4231	2.5 - 5	1 - 4
504507	RADIO SHACK	250 NE 3RD ST	PRINEVILLE	97754	541/447-5128	2.5 - 5	1 - 4
504503	NORTHWEST COMPUTER SUPPORT	4660 PORTLAND RD NE # 101	SALEM	97305	503/463-4555	1 - 2.5	5 - 9
504506	DAVIDSON & ASSOC INC	800 WILLAMETTE ST # B50	EUGENE	97401	541/343-0508	1 - 2.5	5 - 9
504506	DURACOM INC	4130 SW 117TH AVE	BEAVERTON	97005	503/646-8418	1 - 2.5	5 - 9
504507	BITS & PC'S COMPUTERS	4555 LIBERTY RD S # 180	SALEM	97302	503/364-2487	1 - 2.5	5 - 9
504507	COMPUTER SOLUTIONS	2609 SE 122ND AVE	PORTLAND	97236	503/761-6300	1 - 2.5	5 - 9
504503	AB MOORE ENTERPRISES INC	7923 N SEWARD AVE	PORTLAND	97217	503/285-5848	1 - 2.5	1 - 4
504503	AMT INC	10260 SW NIMBUS AVE # M7A	TIGARD	97223	503/620-8979	1 - 2.5	1 - 4
504503	C D ROM WAREHOUSE	7901 SW NIMBUS AVE	BEAVERTON	97008	503/526-8626	1 - 2.5	1 - 4
504503	COMPU TECH SYSTEMS INC	1246 S RIVERSIDE AVE	MEDFORD	97501	541/734-4380	1 - 2.5	1 - 4
504503	GSA	4660 MAIN ST # 120	SPRINGFIELD	97478	541/736-9256	1 - 2.5	1 - 4
504503	GSA	1470 NE 1ST ST # 900	BEND	97701	541/317-0756	1 - 2.5	1 - 4
504503	INTERNATIONAL BUSINESS CO	10700 SW BEAVERTON HILLSDALE	BEAVERTON	97005	503/671-9104	1 - 2.5	1 - 4
504503	NOVELL INC	10220 SW GREENBURG RD # 100	PORTLAND	97223	503/293-8346	1 - 2.5	1 - 4
504506	TELCOM DESIGN & SVC	4440 SW CORBETT AVE	PORTLAND	97201	503/226-7577	1 - 2.5	1 - 4
504507	GROVER CONSULTING SVC	PO BOX 766	BAKER CITY	97814	541/523-4567	1 - 2.5	1 - 4
504506	WIRELESS PROFESSIONAL COMM	21785 SW TUALATIN VALLEY # P	BEAVERTON	97006	503/848-0160	.5 - 1	5 - 9
504507	TELXON CORP	4500 KRUSE WAY	LAKE OSWEGO	97035	503/699-7350	.5 - 1	5 - 9
504503	C & L TERMINALS INC	PO BOX 14944	PORTLAND	97293	503/231-0333	.5 - 1	1 - 4

504503	GENESIS COMPUTER SYSTEMS	6173 WELDON PL SW	ALBANY	97321	541/917-1808	.5 - 1	1 - 4
504503	LAW CYPRESS DISTRIBUTING	4370 NE HALSEY ST # 118	PORTLAND	97213	503/249-2101	.5 - 1	1 - 4
504506	SJI CORP	1600 SW 4TH AVE # 870	PORTLAND	97201	503/221-1525	.5 - 1	1 - 4
504507	CYBER SHOPPE	130 E 2ND ST	PRINEVILLE	97754	541/416-8944	.5 - 1	1 - 4
504507	T S COMPUTERS	1924 BROADWAY ST # D	BAKER CITY	97814	541/523-7889	.5 - 1	1 - 4
504503	FORE SYSTEMS INC	10260 SW GREENBURG RD # 400	PORTLAND	97223	503/243-4626	< .5	1 - 4
504507	ENU INC	4912 NE 122ND AVE	PORTLAND	97230	503/261-1122	< .5	1 - 4

CPU Appendix 3

Computer Dealers in Oregon

Company	*Address*	*City*	*Phone*
Atwin Computer Service Inc	1389 Lancaster Dr NE	Salem	503-399-7967
101 Computer Center	3601 Highway 101 N.	Gearhart	503-717-1601
A Prompt Computer	701 E 3rd St.	McMinnville	503-434-1174
A+ Computers	210 Liberty St. SE		503-375-3139
Aaron Embree & Associates	PO Box 944	Silverton	503-873-6377
ABACUS Computers Inc	498 Church St. NE	Salem	503-362-8921
ABEL Computing Inc.	410 W 13th	Eugene	541-343-3638
Absolute Systems	140 NE 1st Ave.	Mill City	503-897-3901
Abtech Computers	17300 SW Upper Boones Ferry Rd.	Portland	503-670-7900
Access Computer	4918 River Rd. N	Salem	503-304-9490
Action Business Systems	151 E Olive	Newport	541-265-8226
Adept Computer Services Inc.	1325 W 7th	Eugene	541-343-9393
Advanced Business Systems	4509 S 6th St	Klamath Falls	541-884-6492
Advanced Computer Systems	42645 Rhody Ln	Port Orford	541-332-1503
Advanced Digital Technology		Coos Bay	541-269-1010
Advanced Digital Transport Systems	5575 SE Alexander St. Suite 300	Hillsboro	503-848-6400
Advanced Mobile Communications	1055 Hwy 395 S, Ste 313	Hermiston	541-567-7655
Advanced P C			541-923-6055
Adya Computer Systems	10260 SW Nimbus Ave.	Tigard	888-464-2392
AEC Inc.	20752 E Cannon Rd	Brightwood	503-622-3158
After Hours Computers	608 1/2 N Main Street	Milton-Freewater	541-938-6883
Alchemy Marketing Inc	1315 Adams Ave	La Grande	541-962-0315
Allen's 101 Computers	180 Michigan Ave. SE	Bandon	541-347-7507
Alman Macintosh Services			541-736-0500
Alpha 2 Omega Computers	2826 Three Mile Road	The Dalles	541-298-7222
Amdahl Corporation	10260 SW Greenburg Rd, Suite 400	Portland	503-293-8446
American Microtech	26015 Ballston Rd	Sheridan	503-843-4884
Ampersand	3535 Commercial SE		503-362-7075

Applied Information Services Inc	12950 SW Pacific Hy	Tigard	503-639-0777
Aprovision	5319 SW Westgate Dr., Ste 168	Portland	503-292-6336
Archival Associates	1890 SW 3rd St	Corvallis	541-754-9422
Arrowhead Industries	11 SE 3rd Ave	Ontario	541-889-1169
Autumn Computer Systems	800 NW Starker Ave. Suite 17	Corvallis	541-753-8813
Avalon Technology Group	0607 SW Idaho St	Portland	503-246-3630
BA Computers	642 NE 1st	Bend	541-388-8559
Basin Multimedia Magic	3146 S 6th St	Klamath Falls	541-884-9552
Beaver State Computer Services	1305 Adams Ave.	La Grande	541-963-2630
BECCO Inc.	607 Railroad	Brooklings	541-469-2113
Bellevue Computer Inc.	1865 NW 9th St.	Corvallis	541-757-3487
Best Buy	11703 NE Glen Widing Dr.	Portland	503-253-1177
Best Little Computer Store	Hwy. 11	Milton-Freewater	541-938-7569
Best Little Computer Store		Milton-Freewater	800-850-7569
Bit's & PC's Computers	4555 Liberty Rd.		503-364-2487
BKS Computers	1745 Lancaster Drive NE		503-375-3107
Blue Mountain Computer	115 E. Main St.	Enterprise	541-426-4784
Bohdan Associates	9130 SW Pioneer Ct	Willsonville	503-682-7670
Brad's Computer Connection	340 S Fleishauer Ln	McMinnville	503-434-6136
Brandon Computer	RR 1 Box 904	Brandon	541-347-3209
Brightstone Macintosh Consulting & Sales	2325 NE Davis	Portland	503-235-1964
BroTek Computer Solutions	373 NE Greenwood Ave.	Bend	541-382-9499
Business Systems From Sasse	900 SE Wilson Ave.	Bend	541-389-7799
Byte Size Solutions, Inc	815 NW 9th St.	Corvallis	541-752-6649
C.S.I. Computer Division	419 SE Main St.	Roseburg	541-672-6631
Capitol Computer Exchange	1095 Liberty St. NE		503-391-7873
Cascade Chips	61445 South Highway 97	Bend	541-382-6650
Castle Computers	3570 W 11th	Eugene	541-465-8888
C-Delta Industries	1133 S Riverside Ave.		541-245-2539
Century Computers	205 SE 181st Ave	Portland	503-669-3462
Cityview TV & Computer Inc.	2352 W 11th	Eugene	541-683-3518
Cityview TV & Computer Inc.	933 NW Circle Blvd	Corvallis	541-738-2524
Clackamas Computers	15791 SE 90th Ave.	Clackamas	503-650-0379
Clark's Computer Service	215 E. Powell Blvd.	Gresham	503-492-7153
CMI Business Systems	1020 Knutson Ave.	Medford	541-772-9174

CNS	Wickiup Junction La	Pine	541-536-1603
ColorXCorp	9900 SW Hall Blvd.	Portland	503-892-9859
Colt Computer Systems			503-540-0823
Compaq Computer Corp			800-345-1518
Compatability Plus	1410 Main St.	Springfield	541-726-2409
Compu Com Systems Inc.	5 Centerpointe Dr. #550	Lake Oswego	503-684-4919
CompuCare	2544 Shasta Way	Klamath Falls	541-882-3285
CompUSA	1780 N. Jantzen Beach Center	Portland	503-240-4900
CompUSA	10355 SW Cascade	Tigard	503-684-1662
CompuSense	2065 NW 34th St.	Lincoln City	541-996-3313
Comp-U-Talk Inc	2561 Broadway St	North Bend	541-756-8770
CompuTech Systems Inc.	206 S. Central	Medford	541-734-4380
Computek	1615 SW Jefferson	Portland	503-274-4384
Computek West	14246 SW 133rd Ave	Tigard	503-684-3044
Computer & Software Factory Outlet	5835 NE 122d	Portland	503-257-8151
Computer & Software Factory Store	5835 NE 122nd	Portland	360-737-0927
Computer 7	498 Columbia Ave.	Nyssa	541-372-3361
Computer 7	498 Columbia Ave.	Nyssa	541-372-3361
Computer Base	2003 NW	Monroe	541-737-2259
Computer Broker	400 Virginia Ave. #101	North Bend	541-756-0240
Computer Concepts	25102 SW Ladd Hill Rd	Sherwood	503-625-5501
Computer Connection	PO Box 7136	Salem	503-304-4554
Computer CRT Inc.	8366 SW Nimbus	Beaverton	503-626-6939
Computer Drive Connection	537 N 10th Ave.	Cornelius	503-992-0177
Computer Exchange The	311 SW Jefferson Ave.	Corvallis	541-752-1839
Computer Guy The	1612 SW Emigrant Ave.	Pendleton	541-276-5463
Computer Medics NW LLC	223 NE Russell	Portland	503-281-2524
Computer Merchant The	1625 SE Woodward	Portland	503-731-6090
Computer Peddler	4029 State St. NE		503-375-7737
Computer Power	740 Avenue H	Seaside	503-738-9648
Computer Renaissance	2265 Lancaster Dr. NE	Salem	503-585-0936
Computer Renaissance	1011 Valley River Way		541-338-4445
Computer Restore	1031 SE Mill St.	Portland	503-233-7879
Computer Savior	2006 First St.		503-842-3637
Computer Shack			541-476-5484
Computer Solution NW	2609 SE 122d	Portland	503-761-6300
Computer Store The	61 W 8th	Eugene	541-343-1434

Computer Store The	10115 SW Nimbus	Tigard	541-754-0811
Computer Store The	700 NE Multnomah	Portland	503-238-1200
Computer Systems West Inc.	78 Centennial Loop, Suite E.	Eugene	541-342-4153
Computer World	2107 Highway 101 N	Florence	541-997-9616
Computer-Lab	2476 Williams Hwy	Grants Pass	541-479-0806
Computerland	1936 12th St.	Hood River	541-386-9311
Connecting Point Computer Centers	514 NW Franklin	Bend	541-385-6757
Connecting Point Computer Centers	545 Stevens St.	Medford	541-773-9861
Daisy Business Systems	28 S Peach St	Medford	541-773-2142
Data Tek	100 Depot St.	Rogue	541-582-0085
Davis Computer Services Inc.	2101 Main St. #18		541-523-0270
Delta Computer	1440 SE Powell Bv	Portland	503-232-5292
Demar Associates	5600 SW Artic Dr. #110	Beaverton	503-848-8084
Design Systems	1180 S Main St	Lebanon	541-451-5611
Digital Magic	137 First Street	Myrtle Creek	541-863-3886
DSI Computers	145 NE Revere Ave.	Bend	541-382-1536
Egghead.com	www.egghead.com		
FEI America Inc.	6265 SW Lakeview Blvd.	Lake Oswego	503-620-8640
Infogroup Northwest	2225 Coburg Rd		541-485-0155
Infosys Technologies	248 Hayes Ave.	Cottage Grove	541-942-3899
Interactive Computing		Ashland	541-482-1448
MacGraphics	208 NW 6th St.		541-476-1711
Maverick Computers	222 Fir St.	La Grande	541-963-7712
McLoughlin Computer Center	3637 NE Sandy Blvd	Portland	503-231-0454
MicroAge Computer Centers	875 Wilson St.		541-343-9210
MicroAge Computer Centers	900 Main St.	Klamath Falls	541-882-9603
MPH Computing-Cyber Exchange	11904 NE Halsey St.	Portland	503-257-7308
Northwest Micro Inc.	6250 SW Artic Dr.	Beaverton	503-626-2555
Office Equipment Company	2300 Oakmont Way Ste 100		541-342-3325
Pacific Information Systems	10230 SW Hall Blvd.	Portland	503-244-2100
Power Mac Pac	12310 NE Whitaker Way	Portland	503-256-5210
PowerMax - The Mac Experts			800-844-3599
Precision Computers Inc .	1111 SE Stephens	Portland	503-234-4553
Sears Roebuck & Co	Bend River Mall	Bend	541-388-5746
Sears Roebuck & Co	827 Lancaster Dr. NE		503-363-9191
TJ's Computers LLC	P.O. Box 5667	Beaverton	503-356-1908
TTJ Computer Services Inc.	1836 Lancaster Dr. NE	Salem	503-363-2693
User Friendly Computer Services		Portland	503-259-2888
Valley Software Co	1328 NW 6th St.	Grants Pass	888-541-4710

CPU Appendix 4

Used Computer Dealers in Oregon

Company	*Address*	*City*	*Phone*
AAA Cash Now	2929 SE Powell Blvd.	Portland	503-231-4775
Ace Buyers	3144 W 11th	Eugene	541-344-8871
Ace Buyers	823 Highway 99N	Eugene	541-688-8888
Ace Buyers	3697 Franklin Bv.	Eugene	541-726-1735
Ace Buyers	2530 Pacific Blvd SE	Albany	541-926-7199
Associated Buyers	443 NE Stephens		541-673-0123
Capitol Computer Exchange	1095 Liberty St NE		503-391-7873
Cash House	1250 Ferry St. SW	Albany	541-928-6668
Computer Drive Connection	537 N 10th Ave.	Cornelius	503-992-0177
Computer Renaissance	2265 Lancaster Drive NE	Salem	503-585-0936
Computer Renaissance	1011 Valley River Way		541-338-4445
Computer Restore	1031 SE Mill St	Portland	503-233-7879
Computer Warehouse	2126 Main St.	Springfield	541-736-3997
Custom Business Systems	1950 Winchester Ave.	Reedsport	541-271-3681
Demar Associates	5600 SW Artic Dr #110	Beaverton	503-646-9931
Exchange HQ.Com	326 SE Morrison	Portland	503-231-2739
FlashBack Computers	1713 Camino Dr.	Forest Grove	503-359-4418
J&M Computers Co	PO Box 5893	Charleston	541-888-6552
Maverick Enterprises	220 Fir St.	La Grande	541-963-7712
Pacific Computers & Info. Systems	12725 SW 66th Ave.	Portland	503-684-5066
Ready Access Memory Inc-RAM	1160 N Park Ave.	Eugene	541-461-2046
Stuff	9800 SE 82d Ave.	Portland	503-775-2056
Techmedic Computers	2125 W 7th	Eugene	541-484-3603
Technology Suppy Service Inc.	936 SE 34th	Portland	503-236-2641
Wholesale Computers	952 Chickadee Ct. NE	Salem	503-391-5753