

Post-Secondary Education: Education, Training, and Technology Services¹

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Post-secondary education³ (PSE) has been increasingly emphasized in studies of and policies for economic growth and development. Knowledge has become a primary source of economic growth and development, supplementing or even supplanting replacing natural resources and labor-intensive industries.⁴ Knowledge workers, people whose jobs require formal and advanced schooling, are among the fastest growing groups in wealthy countries' workforces [Drucker 1993 and 2002; Nonaka and Takeuchi 1995]⁵.

Universities and colleges, developed from the medieval organizations of cultural conservation, preservation, and knowledge transmission, have added related services to their liberal-arts educational functions. For its part, "industry," defined here as enterprises that produce or supply goods and services for profit, has increased its external links to keep pace with rapid change and complication of the business environment.

These changes have strengthened the link between higher education and economic development. Universities and colleges are recognized as important contributors to national/regional economic development. The cases of MIT and Route 128 and Stanford and Silicon Valley are widely recognized and imitated by many regional economic growth/development policies. While most research on relationships between higher education and industry focus on research-oriented, doctoral-degree-granting universities, this research includes baccalaureate colleges, community colleges, and technical colleges. These lower level colleges and universities comprise the majority of PSE providers, and provide important services to their local and national economies.

POST-SECONDARY EDUCATION IN THE U.S.

On a per capita basis, the U.S. has more universities than most other countries, which have not made as great an investment in their university system [Noll 1998: 10-11]. Government support for fundamental research is fragmented and decentralized in the U.S., emphasizing market-like features of competitive, peer-reviewed research proposals from individual researchers [Noll 1998:16]. In the U.S., approximately 10% of national R&D effort is conducted in federal agencies and installations, and another 5% in national laboratories managed by private companies, universities, or nonprofit research institutions. About two-thirds of the budget for privately managed national laboratories goes to labs that are run by universities [Noll 1998: 17-18]. In addition, private support for universities, whether individual donations or research grants from companies and foundations, is distinctive in the U.S.

European countries emphasize national laboratories, so that research and education are more separated. In rankings of the leading research institutions within a particular field of science and engineering, most of the world leaders in the U.S. are universities, whereas most of the world leaders elsewhere are government research laboratories. In the U.S., about 70% of the authors of scientific and technical publications are affiliated with academic institutions. In Europe, university faculty members frequently have association with research laboratories, but these labs are physically separated from universities and the research typically is identified with a laboratory, not a university. In the U.S., education and research are more integrated, especially in experimental areas of science and engineering that require laboratories. Research and education have strong complementarities. In laboratory sciences, students are crucial to the success of research programs.

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³ Formal education that requires or assumes a high-school diploma, through institutions that grant baccalaureate and/or advanced academic degrees.

⁴ In the last few decades, we have experienced a transformation into "knowledge economy". It is "knowledge"—not labor, machines, land, or natural resources—that is the key economic asset that drives long-run economic performance. At the heart of this phenomenon lies a complex, multifaceted process of continuous, widespread and far-reaching innovation and technical change [Jaffe and Trajtenberg 2002: 1].

⁵ Knowledge workers include high-knowledge workers with considerable theoretical knowledge and learning (e.g., doctors, lawyers, teachers, accountants, chemical engineers, etc.) and knowledge technologists whose manual works are based on a substantial amount of theoretical knowledge. The theoretical knowledge necessary for knowledge workers is acquired through formal education, not through apprenticeship [Drucker 2002: 238-239].

Community colleges (so named because their service areas are geographically circumscribed), technical colleges (so named because their focus is on career-oriented technical training culminating in degrees or in non-degree certificates), and junior colleges (so named because they offer few or no degrees beyond the associate level) are important components of the U.S. PSE system. Most, especially those that are government supported (as are most), emphasize three distinct programs:

- 1) Transfer programs that extend educational opportunities, a cost-effective way to serve the increasing number of students wishing to transfer to baccalaureate or research-oriented institutions [Dougherty 2002: 295; Cohen and Brawer 2003: 21-22].
- 2) Workforce development programs, a distinctive niche of community and technical colleges. On average, about three-fifths of community college students are pursuing vocational training for immediate entry into the labor market [Dougherty 2002: 301]. Community colleges are actively involved in four dominant fields: health professions, business, protective services (police and fire), and engineering-related technologies. Programs may be variously geared toward: preparing people for their first job; upgrading the skills of current workers or retraining unemployed workers and welfare recipients for new jobs; or providing specific training courses for employers (contract training, as defined by Dougherty [2002: 302]). (Also see Cohen and Brawer [2003]).
- 3) Continuing education: a service to interested adults (including those outside the labor force).

IT-PRODUCING INDUSTRIES: DEFINITION AND IMPORTANCE

Information Technology (IT)-producing Industries are defined as industry sectors that supply the goods and services that support IT-enabled business processes, internet, and e-commerce [The Emerging Digital Economy II 1999; Digital Economy 2000 and 2003]. IT-producing industries include hardware, software/computer service, communications equipment, and communications services industries, and detailed industry sectors and their SIC and NAICS are listed in Appendix A.

Many information technologies have short life cycles, and producers are intent on quickly getting a product or service to market. Employers often prefer to hire workers skilled in new technologies rather than retrain their current workers [Digital Economy 2000: 45]. With IT skill sets closely linked to specific software and hardware technologies, ever-shortening product life cycles create frequent change in the IT skill mix in demand. Specific technical skills often lose value over time, sometimes in as little as 2 to 3 years. [Education and Training for the Information Technology Workforce 2003: 3]. This means that IT workers must acquire new skills frequently in order to maintain their labor market viability and upward mobility. However, given the frequent changes in technology and difficulties in forecasting future skill needs, workers receive little guidance on what training to acquire for long-term success in the IT field [Education and Training for the IT Workforce 2003: 15].

SERVICES PROVIDED BY PSE INSTITUTIONS

PSE institutions contribute to industrial development and growth in multiple ways including supplying an educated workforce, occupational training, research collaboration, and spin-offs. While the direct purchaser or client may be individual students, IT-producing industry can also be seen as a direct or indirect client.

Universities and colleges provide programs of training and further education for employees of industry. From the industry perspective, rapid technological change and increasing need for diverse skill requirements result in a growing need for external training/retraining of employees as well as internal training. Conventional education is not enough for the learning required for the changes, and formal training needs to be complemented by experiential learning⁶ [Keane and Allison 1999: 897; OECD, 1996].

Given high educational requirements for IT-related jobs and increasing costs for occupational training, universities and colleges are an important provider of occupational training. Firms are willing to interact with universities and colleges to access educational programs [Feller et al. 2002], and various professional degree programs are provided at universities and colleges through building partnerships with industry [Ronalds 1999].

Colleges and Universities as Milieux

At a very general but important level, the faculty, students, and activities of PSE institutions provide an atmosphere of cultural openness and innovation, and a respect for learning, that are attractive to the highly educated professionals required by advanced sectors of the economy [Florida 2002]. Recent alumni often prefer to remain in such places, even when other (especially smaller) cities in the same region face serious out-migration of educated people.

⁶ OECD [1996] has identified that a key component of building an effective knowledge economy will be to provide ladders and bridges across the three main areas of learning (academic, educational, and experimental) *Employment and Growth in the Knowledge Based Society*, OECD: Paris.

Labor Supply

PSE institutions provide disciplined courses of study, culminating in academic degrees and expertise that make graduates more productive in professional contexts. Universities in the U.S. are nearly unique in the degree to which they integrate research with education [Innovation in Information Technology 2003: 20-21; Noll 1998: 18-20]. An educated labor supply is increasingly important for high technology industries, and recruiting and retaining a pool of educated labor is significant for regional economic growth and development. While the presence of strong PSE institutions does not insure that graduates will remain in a given region, other graduates are also drawn toward well-educated places. The longer and more specialized the academic training, the greater the payoff and the necessity for graduates and employers to engage in nationwide or international job searches.

In addition, many academic programs encourage students to participate in off-campus work experience, and many firms and agencies are eager to hire short-term, student interns to augment and refresh their regular workforces. Pursuing an internship while in school is eased by staying in the same local area as one's school.

Occupational Training and Education

PSE institutions provide programs of training and "further education" for current employees. From the industry perspective, rapid technological change and increasing need for diverse skill requirements result in a growing need for external training/retraining of employees as well as internal training. Given high educational requirements for IT-related jobs and increasing costs for occupational training, universities and colleges are an important provider of occupational training. Firms are willing to interact with universities and colleges to access educational programs [Feller et al. 2002], and various professional degree programs are provided at universities and colleges through building partnerships with industry [Ronalds 1999]. Smaller employers are much less likely to provide formal worker training (general or specific, on- or off-site⁷), because of tighter operating budgets, working capital, and staffing schedules, as well as generally lower wages that do not encourage long worker tenure [Carnevale and Goldstein 1983; Holtman and Idson 1991; Barron et al. 1997; Harrison and Weiss 1998].

Collaborative Research

Universities and colleges contribute to basic research awareness and insight for industry partners [Hall et al. 2000]. They can focus on long-term research that IT companies are not expected to take to a significant extent [Innovation in Information Technology 2003: 12-14]⁸. Corporate R&D is largely focused on product and process development, and it is often difficult for corporations to justify funding long-term, fundamental research whose results are hard to be captured by their investors. "The results of long-term, fundamental research tend to be published openly and thus to become generally known; they tend to have broad value; the most important may be unpredictable in advance; and they become known well ahead of the moment of realization as a product, so that many parties have the opportunity to incorporate the results into their thinking. In contrast, applied research for product and process development can be performed in a way that can be more easily captured by investors: it can be done under wraps, and it can be moved into the marketplace more quickly and predictably" [Innovation in Information Technology 2003: 13-14].

Collaborative research is the most widely known mode of interaction between industry and universities/colleges, and technology transfer from universities/colleges to industry is measured by patent, license, and invention disclosure. Collaborative research includes co-authoring research papers, contract research with individual investigators, consulting by faculty, and certain group arrangements for industry problems, and support and use of research equipment. Universities and colleges also provide sites at which researchers from competing companies can come together to explore technical issues [Innovation in Information Technology 2003: 21].

Entrepreneurial spin-offs

A growing number of universities and colleges have become involved in and encouraged the incubation of spin-off companies [Florida 1999; Shaping the Future 2001]. Spin-off functions of the higher education systems have been spotlighted due to their direct contribution to local employment growth and commercialization of academic research (e.g., Steffensen et al. [1999]). Successful stories of university spin-offs are widely recognized (e.g., Lycos from Carnegie Mellon University), and relatively more case studies focus on spin-offs, research parks, and business incubators centered on universities and colleges than on other PSE establishments (e.g., Lilischkis [1999]).

⁷ Using 1987-92 annual responses from the U.S. National Longitudinal Survey of Youth (thus, getting respondents who were 22-39 over the study period), Veum [1997] found establishment size and firm size to be highly significant determinants of workers' having received on-site, formal training, but not of off-site training.

⁸ "Long-term" research refers to a long time horizon for the research effort and for its impact to be realized. Examples of innovations that required long-term research include speech recognition, packet radio, computer graphics, and internetworking [Innovation in Information Technology 2003: 9].

RESEARCH OBJECTIVES AND DESIGN

Given these varied types of services provided by PSE institutions, the ways in which they serve both individual students, governments, and industrial clients, and thus, their roles in regional economic development, it is worthwhile to study the geographical extent and influences of these services. This paper reports on a study of IT-producing firms' use of and interaction with PSE institutions. How distinct are the types, degree, and geography of services provided by different types of PSE institutions? Does geographic distance inhibit different types of interaction differently? Do firms' type and degree of interaction vary by size, sector, or region?

We selected three MSAs based on characteristics of IT-producing industries and universities/colleges located in each area: Seattle, WA; Portland, OR; and Champaign-Urbana, IL (see the list of constituent counties, in Appendix B). According to Markusen's typology [1996] with reference to firm size, interconnection, and local vs. non-local embeddedness, Seattle, WA represents a hub-and-spoke configuration of IT-producing industries—dominated by one or several large and vertically integrated firms surrounded by suppliers. Portland, OR is a satellite platform dominated by large, externally owned and headquartered firms. Champaign-Urbana, IL has relatively small IT-producing industry sectors and is a good example of a university-centered IT complex.

IT-producing companies were selected by SIC as defined in Appendix A. Using an industrial directory, we identified 3752 establishments in the Seattle MSA, 2298 in the Portland MSA, and 248 in the Champaign MSA. In order to compare three case study areas, the same number of IT-producing establishments were selected by stratified selection in each MSA. From three classes by size of establishments⁹ and from four groups by SIC (hardware, software, communication equipment, and communication service), 744 firms were selected by the same proportion of each size class and sectoral group within the identified population of each MSA.

A total 80 IT-producing establishments responded to the on-line survey questionnaire (response rate = 10.8%), between January and May 2004. Tables 1-3 show the composition of the respondents by MSAs, size of establishments, and SIC groups.

Table 1: Respondents' size, by MSA

Size	Seattle		Portland		Champaign		Total	
Micro-small (1-9)	18	48.6%	14	48.3%	10	71.4%	42	52.5%
Small (10-99)	11	29.7%	5	17.2%	1	7.1%	17	21.3%
Large (100+)	4	10.8%	10	34.5%	1	7.1%	15	18.8%
N/A	4	10.8%	0	0.0%	2	14.3%	6	7.5%
Total	37	100.0%	29	100.0%	14	100.0%	80	100.0%

Table 2: Respondents' sector, by MSA

SIC	Seattle		Portland		Champaign		Total	
Hardware	4	10.8%	8	27.6%	2	14.3%	14	17.5%
Software	29	78.4%	20	69.0%	12	85.7%	61	76.3%
Communication equipment	1	2.7%	0	0.0%	0	0.0%	1	1.3%
Communication service	2	5.4%	1	3.4%	0	0.0%	3	3.8%
N/A	1	2.7%	0	0.0%	0	0.0%	1	1.3%
Total	37	100.0%	29	100.0%	14	100.0%	80	100.0%

Table 3: Respondents' size, by sector

	Hardware		Software		Communication equipment		Communication service		N/A	Total	
Small (1-99)	7	50.0%	54	88.5%	0	0.0%	1	33.3%	0	62	77.5%
Medium (100-499)	4	28.6%	4	6.6%	1	100.0%	1	33.3%	0	10	12.5%
Large (500+)	3	21.4%	2	3.3%	0	0.0%	0	0.0%	0	5	6.2%
N/A	0	0.0%	1	1.6%	0	0.0%	1	33.3%	1	3	3.8%
Total	14	100.0%	61	100.0%	1	100.0%	3	100.0%	1	80	100.0%

⁹ When classifying IT-producing companies by size, the categories were applied to each establishment, not to the entire companies if they were multi-locational operations.

FINDINGS

Technical employee recruitment, by degree level

First, in terms of recruitment/hiring of technical workers at each degree level, the survey responses indicate that IT-producing establishments are more likely to recruit and hire technical workers from within the same MSAs than from beyond.¹⁰ However, the degree of dependence on graduates of local institutions does decline at higher degree levels. 86 percent hired the largest portion of technical workers with a vocational certificate from institutions in the same MSA, and 97 percent hired most of their associate-degree holders from the local MSA. 74 percent of respondents replied primarily on the local MSA for bachelor's degree holders; 65 percent for master's or professional degree holders; and 52 percent for doctoral degree holders.

Technical employee recruitment, by establishment size and relative location

We then analyzed responses to questions regarding where establishments recruited their technical employees, by size of establishment. The results from contingency table analyses below show that there exist statistically significant relationships between size of establishments and proximity of their technical-employee recruiting for workers with baccalaureate, master's, or professional degrees. In these cases, large establishments are more likely to have interactions with universities or colleges outside of the same MSAs where they are located than small establishments. Hiring by small establishments are more likely to be bound within the same MSAs.

Internship programs, by establishment size

Large establishments are more likely to offer student internship programs than small establishments. 8 out of 15 (53.3%) respondents with 100 or more than 100 employees offered student internship programs while 9 out of 40 (22.5%) responded establishments with less than 10 employees and 4 out of 17 (23.5%) responded establishments with 10 to 99 employees do. The results of the contingency table analyses show that statistically significant differences of the likelihood to offer student internship programs exist among establishments with different sizes (confidence level = 0.10).

Internship programs, by relative location

The survey results indicate that IT-producing establishments generally hire student interns from universities or colleges located in the same MSAs.¹¹ However, respondents were more likely to hire interns from local technical or community colleges, and to go somewhat further afield to identify interns from 4-year colleges or universities.

Table 4: Regional sources of student interns

	Number of establishments that hired interns from 2-year community or technical colleges located (Q18)		Number of establishments that hired interns from 4-year colleges or universities located (Q19)	
No interns	32		21	
In the same MSA	9	75.0%	14	60.9%
In the rest of the same state	2	16.7%	5	21.7%
In the rest of the same division	0	0.0%	0	0.0%
In the rest of the U.S.	0	0.0%	2	8.7%
In foreign countries	1	8.3%	1	4.3%
Evenly distributed	0	0.0%	1	4.3%
In other regions	0	0.0%	0	0.0%
N/A	36		36	
Total	80		80	
No. of responses	12	100.0%	23	100.0%

¹⁰ The question posed was "Choose a geographic area from which your company has recruited/hired the largest or the second largest portion of technical workers with a degree at each level," with the possible responses being the same metropolitan area, the same state, the same region of the country, within the U.S., or from abroad.

¹¹ The relevant questions were worded "Student interns from 2-year community or technical colleges are primarily from colleges located in..." and "Student interns from 4-year colleges or universities are primarily from colleges or universities located in..."

Internship programs, by relative location and establishment size

Geographies of student internship programs are examined by asking the location of universities and colleges from which interns that IT-producing establishments hire came. Large establishments hire a higher proportion of student interns from outside the same MSA where they are located than expected while small establishments are more dependent on 4-year universities or colleges within the same MSAs than the rest of the regions as a source of their student interns. The results from contingency table analyses show that there exists a statistically significant relationship between size of establishments and physical proximity of the 4-year universities or colleges from which they hired student interns whereas no relationship is found in case of 2-year community or technical colleges.

Occupational training, by MSA

The survey results from IT-producing establishments show that there is a statistically significant relationship among the three MSAs in the likelihood of providing training for their employees (Table 5). The respondent IT-producing establishments in Seattle MSA (27 out of 37, or 73.0%) and those in Portland (18 out of 27, or 66.7%) are more likely to provide training for employees while those in Champaign MSA (4 out of 14, or 28.6%) are less likely to provide employee training.

Table 5: Responses to the question “Does your company provide training for employees?”

Q24	Seattle		Portland		Champaign		Total	
Yes	27	73.0%	18	66.7%	4	28.6%	49	62.8%
No	10	27.0%	9	33.3%	10	71.4%	29	37.2%
N/A	0		2		0		2	
Total	37		29		14		80	
No. of responses	37	100.0%	27	100.0%	14	100.0%	78	100.0%

Occupational training, by establishment size

While the responses reported in Table 5 could reflect the fact that Champaign has a higher proportion of small respondents (fewer than 10 employees) than Seattle or Portland, our comparison of responses does not show any significant increase in the propensity to use training programs (provided by 2-year community colleges and by 4-year colleges and/or universities) with the increasing size of establishments.

Occupational training, by relative location

Respondents are more likely to use training programs provided by universities or colleges within the same MSA than by those in more distant geographic areas. All 16 respondents that have used training programs provided by 2-year community or technical colleges referred to institutions in the same MSA. Eighteen of the 19 respondents that have used training programs provided by 4-year universities or colleges referred to institutions within the same MSA.

Occupational training, by establishment size and relative location

Given the overwhelming reliance on local training programs, it is not surprising that the size of establishments does not have a relationship with the locations of universities or colleges whose training programs the establishments use. All of the respondents answered that they used training programs provided by 2-year community or technical colleges within the same MSAs where they are located regardless of size of establishments. In case of 4-year universities or colleges, all of the respondents except one small establishment used training programs provided by 4-year universities or colleges located in the same MSA. The small establishment is a branch operation of a large foreign company, and most of their employees have been trained in the country where the company’s headquarters is located.

Collaborative research, by establishment size

A higher proportion of responding establishments with 100 or more employees (6 out of 15, or 40.0%) have collaborated with colleges or universities on research projects, than establishments with fewer than 10 employees (6 out of 41, or 14.6%). The results of the contingency table analysis show that there exist statistically significant differences of the likelihood to collaborate with colleges or universities on research projects among small and medium-sized establishments (1-99) and large establishments (100+). We found no relationship between size of establishments and the likelihood to take technical advice from faculty members from colleges or universities.¹²

A higher proportion of the large establishments responded they have used equipment and/or facilities of colleges or universities (5 out of 15, or 33.3%) than the mid-sized establishments (1 out of 17, or 5.9%), or the small establishments

¹² The question was worded “Has your company taken technical advice from faculty members (including casual/informal advice and formal consultations) from colleges or universities during the last 12 months?”

(2 out of 41, or 4.9%). The results of contingency table analysis below show that there are statistically significant differences to use equipment and/or facilities of colleges or universities among large and small establishments.

Concerning technology licensing, it is difficult to find any distinctive trends across different size of establishments because only 3 establishments from 80 respondents answered they have licensed technologies developed at colleges or universities.

Entrepreneurial spinoffs, by region

Overall, 19.0% of the responding establishments have entrepreneurial origins from local colleges or universities (see Table 6).¹³ Respondents in Champaign MSA were more likely to have entrepreneurial origins from local colleges or universities (6 out of 14 establishments, or 42.9%) compared to those in Seattle MSA (7 out of 37, or 18.9%) and in Portland (2 out of 29, or 7.1%). Access to UIUC is one of the important reasons for IT establishments in Champaign to be located there and one of the few locational advantages of IT establishments in Champaign. From interviews, we understand that entrepreneurs of IT establishments in Champaign often have private connections with UIUC (e.g., spouses or family members of UIUC faculty members or employees who should locate their workplace in Champaign).

Table 6: Respondents whose companies had entrepreneurial origins in local universities

	Seattle		Portland		Champaign		Total	
Yes	7	18.9%	2	7.1%	6	42.9%	15	19.0%
No	30	81.1%	26	92.9%	8	57.1%	64	81.0%
N/A	0	100.0%	1	100.0%	0	100.0%	1	100.0%
Total	37		29		14		80	

CONCLUSIONS

This research was based on a survey of managers of companies whose major products can be considered information technology, and a perspective that views these firms as “clients” of post-secondary education institutions in their local regions and beyond. From this perspective, these companies make very distinct uses of different types of PSE institutions, in terms of the types of services and their geographic extent.

The services provided by community and technical colleges are more localized than the interns, recruits, training, and collaborations between baccalaureate colleges and especially research universities.

The results from the survey partly support the suggestion that larger IT-producing establishments make more use of the range of services provided by PSE institutions. The tendency for IT-producing establishments to benefit from colleges or universities by means of labor supply and research collaboration increases with the growing size of establishments. Larger establishments hire larger numbers of technical workers trained at colleges or universities and especially have higher degree of interactions with graduate-level educational organizations (higher proportion of technical workers with a master’s or professional and a doctoral degree among their total employees) than small establishments. Larger establishments more frequently collaborate with colleges or universities in research projects and take technical advice from faculty members at colleges or universities than small establishments. In terms of occupational training, however, size of establishments does not seem to have any relation with the likelihood for IT-producing establishments to use colleges or universities to train their employees. Finally, entrepreneurial origins from colleges or universities are not related to the current size of establishments.

The smallest of the three metropolitan areas studied, which also had the smallest IT-producing sector, exhibited a lower propensity to work with the local community college and university to provide continuing occupational training. However, the local IT-producing sector has closer entrepreneurial ties to the local research university than in the other two regions studied.

Overall, the research findings support the oft-cited assertions that universities support economic development, and that this support is fairly localized. The findings suggest that lower- and non-degree-granting institutions (community, junior, community, and four-year colleges) play large roles, as do the doctoral and research universities more often studied in the academic economic development literature. It will be important to survey the PSE institutions in order to understand the nature, impact, and geographic extent of their services to individuals and IT-producing companies.

¹³ The question was worded “Does your company, specifically this local operation, have entrepreneurial origins in faculty members, graduate students, undergraduate students, or recent alumni from local colleges or universities?”

APPENDIX A
Information Technology-Producing Industries

Industry group	Title of industry	SIC	1997 NAICS
Hardware Industries	Computers and computer equipment and calculating and office machines	3571, 3572, 3575, 3577 (part), 3578, 3579 (part)	333311, 333313, 334111, 334112, 334113, 334119, 334418
	Wholesale trade of computers	5045 (part)	421430 (part)
	Retail trade of computers	5734 (part)	443120 (part)
	Electron tubes	3671	334411
	Printed circuit boards	3672	334412
	Semiconductors	3674	334413
	Passive electronic components	3675, 3676, 3677, 3678, 3679 (part), 3661 (part)	334414, 334415, 334416, 334419
	Industrial instruments for measurement	3823	334513
	Instruments for measuring electricity	3825 (part)	334515
	Laboratory analytical instruments	3826	334516
Software/ Computer Service Industries	Computer programming services	7371	541511
	Prepackaged software	7372	5112, 334611
	Wholesale trade of software	5045 (part)	421430 (part)
	Retail trade of software	5734 (part)	443120 (part)
	Computer integrated systems design	7373	541512
	Computer processing, data preparation	7374	5142
	Information retrieval services	7375	51419
	Computer services management	7376	541513
	Computer renting and leasing	7377	532420
	Computer maintenance and repair	7378	811212
Computer related services, etc.	7379	541519	
Communications Equipment Industries	Household audio and video equipment	3651, 3679 (part)	334310
	Telephone and telegraph equipment	3661 (part), 3577 (part), 3679 (part)	334210
	Radio and TV communications equipment	3663, 3679 (part), 3699	334220, 334290
	Magnetic and optical recording media	3695, 3577 (part)	334613
Communication Services Industries	Telephone and telegraph communications	481, 4822, 4899	5133
	Cable and other pay TV services	4841	5132

Source: Digital Economy 2000 and 2003, SIC codes are added from The Emerging Digital Economy II, 1999¹⁴.

¹⁴ Two IT-producing industry sectors included in The Emerging Digital Economy II [1999], Radio broadcasting and Television broadcasting, were moved into IT-using industry category in the later volume of Digital Economy [2002 and 2003] and are not included in this table.

APPENDIX B
2003 Combined/Metropolitan Statistical Areas

Seattle-Tacoma-Olympia, WA Combined Statistical Area

Bremerton-Silverdale, WA Metropolitan Statistical Area
Kitsap County, WA
Oak Harbor, WA Micropolitan Statistical Area
Island County, WA
Olympia, WA Metropolitan Statistical Area
Thurston County, WA
Seattle-Tacoma-Bellevue, WA Metropolitan Statistical Area
Seattle-Bellevue-Everett, WA Metropolitan Division
King County, WA
Snohomish County, WA
Tacoma, WA Metropolitan Division
Pierce County, WA
Shelton, WA Micropolitan Statistical Area
Mason County, WA

Portland-Vancouver-Beaverton, OR-WA Metropolitan Statistical Area

Clackamas County, OR
Columbia County, OR
Multnomah County, OR
Washington County, OR
Yamhill County, OR
Clark County, WA
Skamania County, WA

Champaign-Urbana, IL Metropolitan Statistical Area

Champaign County, IL
Ford County, IL
Piatt County, IL

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