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Technical Appendices

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Digital Economy 2003

TECHNICAL APPENDICES

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Digital Economy 2003
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APPENDIX TO CHAPTER I:

Information Technology Producing Industries

The following define industries, sources of data, and describe methods used to assess the economic impacts of Information Technology (IT) producing industries that were presented in Chapter I of the *Digital Economy 2003* (*DE2003*) report.

DEFINING INFORMATION TECHNOLOGY PRODUCING INDUSTRIES

The IT-producing industries selected for the DE2003 report are those that produce, process, or transmit information goods and services as either intermediate demand (inputs to production of other industries) or as final products (goods and services bought by consumers, business investors, government or for exports). The selected IT-producing industries also include those that supply the goods and services necessary for the Internet and electronic commerce (e-commerce) to operate; i.e., they provide the products and services for the Internet infrastructure. IT-producing industries include manufacturers of some general and specialized electronic components, computers and peripheral equipment, specialized measuring and testing instruments, telecommunications equipment, and prepackaged software. IT-producing industries also include computer, software, and telecommunications service providers. (Appendix Table A-1.1)

The IT-producing industries in this chapter follow the definitions in the Office of Management and Budget's 1997 North American Industry Classification System (NAICS).[1] In 2003, for the first time, estimates for GDP by industry time series in the Digital Economy reports were completely based on the NAICS system and did not include industries that resulted from partial 1987 Standard Industrial Classification (SIC) listings.[2] Annual estimates of Gross Domestic Product (GDP) by IT-producing industries were developed for 1996 through 2003.

The industries represented and presented in this report as IT-producing industries do not reflect any official US government list of such industries. These industries do, according to our best judgement, meet the criteria of being IT producers.

MEASURING INFORMATION TECHNOLOGY PRODUCING INDUSTRIES

In Chapter 1 of the *DE2003* report, we refer to an industry's value of production as its Gross Domestic Product (GDP) by industry. In previous Digital Economy reports, we referred to this value of production as its Gross Product Originating (GPO)[3]. GDP by industry and GPO by industry are actually the same measure. Also, in Chapter 1, when we refer to an industry's output, we are really referring to its GDP by industry.

GDP by industry is different from an industry's gross output in that gross output is measured in terms of an industry's sales, revenues or receipts, which includes the industry's costs of production. GDP by industry is an industry's gross output minus its costs of production, often referred to as its intermediate inputs. Intermediate inputs consist of energy, raw materials, semi-finished goods, and services that are purchased from domestic industries or foreign sources and used in production. GDP by industry can also be thought of more directly as the sum of costs incurred by an industry, i.e., compensation of employees, net interest and indirect business taxes and profits. This is an industry's value added.

The sum of GDP by industry for all industries is a measure more consistent with Gross Domestic Income (GDI) than total U.S. GDP. Although the name "GDP by industry" may imply that this is about the value of expenditures, it is really a measure of an industry's income. The sum of GDP for all industries is equal to GDI. GDI measures output as the sum of the costs incurred and incomes earned in the production of GDP.

In concept, GDP and GDI should be equal. In practice, they differ because the estimates of their components are mainly based on different source data. The difference between GDP and GDI is the "statistical discrepancy" in BEA's accounting scheme. In 2003, current dollar GDP was $10,987.9 billion. GDI was $10,987.9 billion. The statistical discrepancy was $17.8 billion. In 2002, GDP was $10,480.8 billion. GDI was $10,558.0 billion. The statistical discrepancy was -$77.2 billion.

In this analysis, the annual growth of the sum of GDP by industry of IT-producing industries is compared to the overall annual growth of GDI and not GDP. Since GDI is slightly larger than GDP, the IT-producing industries contributions to economic growth calculated in this report are conservative. If GDP were used, the contributions would have been slightly larger. See Table 1.1, IT Producing Industries' Contribution to Real Economic Growth, in Chapter 1 of the *DE2003* report.

Conceptually, GDP by industry and value added are the same. In practice, value added for manufacturing industries published by the Bureau of the Census is not consistent with BEA's Gross Product by Industry time series due to accounting differences. BEA subtracts purchases of services, not elsewhere classified (NAICS codes 71151, 51221, 54169,51223, and 541612) from total revenues just as it does for purchases of all other goods and services used in production. Census does not subtract this "other category of purchased services" since it collects manufacturing data on an establishment basis and most purchases of services not elsewhere classified are made and accounted for at the corporate level.

The GDP by industry estimates for the IT-producing industries developed for this report are derived from revenue, receipts, and shipments, whether all of the industry's production was used as an IT good or service. For example, not all semiconductors are used by the computer industry or other IT-producing industries. Semiconductors are also used in automobiles, home appliances, and a variety of other consumer and industrial goods. However, differentiating production into IT-producing and non IT-pro-

ducing is virtually impossible. Thus, the GDP of the semiconductor industry is based on its total annual shipments and costs of production.

Double-counting the value of output is avoided when added across industries by using GDP for IT-producing industries. Adding the gross output across industries would double-count the value of output. For example, the value of shipments of the computer industry, its output, includes the computer industry's expenditures on semiconductors, an intermediate input to computer production. The gross output of the semiconductor industry includes its sales to the computer industry, and all other industries. Adding shipments of the semiconductor industry to the shipments of the computer industry would double count the value of shipments of the semiconductor industry that were used by the computer industry. Adding only the GDP of these industries avoids double-counting since inputs are deleted from the aggregate.

GDP of IT-Producing Industries: 1996-2003

The following is a description of the data and the methods used to derive GDP for IT-producing industries as listed in Appendix Table A-1.2:

In summary between 1997 and 2001, we rely on Census data to derive GDP for IT-producing industries. In 1996, we provide an estimate based on past historical Census time series for these industries. In 2002, we provide estimates of GDP for the IT-producing industries based on published GDP account data and an industry interpretation using input-output economic techniques. For 2003, we relied on the latest estimates of annual GDP growth since we only had, at that time, three-quarters of 2003 GDP data. We then used input-output economic techniques to derive GDP for the IT producing industries.

GDP for Hardware and Communications Equipment IT-Producing Industries, all in manufacturing, were derived from Census data on value of shipments. GDP for these industries was derived by subtracting the cost of materials and the value of purchased services used in production from the value of shipments and then adjusting for inventory change.

In 1999, BEA revised its treatment of Software and software services. Prior to the revision, industry purchases of Software and software services were considered an expense of production. After the revision, they were considered an investment. (The latest comprehensive revisions were published near the end of 2003.[4]) The importance of the 1999 change for Software and software services cannot be understated since they are now considered as a portion of an industry's value added and included in its GDP by industry. Prior to the revision, the purchases of Software and software services were considered an intermediate input to production.

The published data used to estimate GDP for IT-producing industries in the manufacturing sector were from the Census *2001 Annual Survey of Manufactures* and from the more detailed *1997 Economic Census of Manufactures*. The Economic Census reports contain more detailed data, particularly on the cost of materials and purchased services used in production. The more detailed data from the 1997 Economic Census were used to adjust the shipments data for the Annual Survey years, 1998 through 2001 since input data were less detailed.

For 1998 through 2001, GDP by industry for the IT-producing Hardware and Communication equipment industries were estimated from the shipments data in the Annual Survey and then adjusted for inventory change and costs of materials and purchased services estimated from the average relationship of inventory change and materials costs to production in the 1997 Economic Census.

Revisions to GDP by Industry Time Series: 1997-2000

Lead to Significant Differences in IT GDP by Industry In DE2003 vs. DE2002

In the *2001 Annual Survey of Manufactures*, the Census Bureau published a time series of shipments, value added, and costs of materials from 2001 with revisions to previously published data back through 1997. In some cases, this new time series resulted in significant differences between the value of GDP for IT producing industries in *DE2003* and *DE 2002*.

In the *DE2002* report, GDP for computers and equipment and calculating machines in 2000 was $46.2 billion. In *DE2003*, we reported $55.2 billion in 2000 for this IT-producing industry, a 19 percent increase. The estimates of GDP for computers and equipment and calculating machines by industry were revised upward by 55 percent in 1997, 85 percent in 1998, and 61 percent in 1999. On the other hand, downward revisions in other hardware IT-producing industries resulted in the aggregate hardware IT producing industries' GDP being revised upward from 13 to 16 percent between 1997 and 1999, between *DE2002* and *DE2003* reports, and 4 percent lower for 2000.

Another major upward revision to the data occurred in a number of Software and computer services industries. The most recent data for these industries can be found in Census' *2001 Service Annual Survey*. Between 1997 and 2000, the revised GDP by industry series for Software and computer services ranged between a 26 and 30 percent increase between the *DE2002* and *DE2003* reports. Although the GDP for Software and computer services were revised upward, the annual growth rates stayed approximately the same.

In total, between 1997 and 2000, the value of the nominal GDP by industry in *DE2003* report had an average annual increase of 12.7 percent for all IT-producing industries based on the Census revisions, compared to the time series in the *DE2002* report.

One result of these significant revisions for 1997 through 2000 was to prevent us from revising our time series prior to 1996.

Industry data available in the *1997 Economic Census of Manufacture*s include costs of materials, beginning and end of year inventories, and costs of selected purchased services. Purchased services include purchases of software services, repair of buildings, repair of machinery, communications, legal services, accounting and bookkeeping, advertising, and refuse removal. These purchased services, however, represent only a portion of the industry's total purchased services.

Industry spending for IT-producing hardware and communication equipment industries for all other services, other than those reported by the Census, were estimated using the distribution of spending on types of services from BEA's 1997 Benchmark Input-Output (I-O) table. The ratio of the value of purchased services, by industry, to total industry shipments in 1997 was then applied to total annual industry shipments for 1998 through 2001, as reported in the 2001 Annual Survey of Manufacturers.

GDP for wholesale trade of computers and computer equipment (part of NAICS 42143) was added to

the category called IT-producing hardware industries since over half of wholesale trade of computers comes directly from computer manufacturers' branch offices. Although counted by the Census as a wholesale sale and not a manufacturer's shipment, the actual sale is primarily a direct manufacturer's sale.

Annual source data for 1998 through 2001 for wholesale trade of computers and equipment were available through a Census Current Business Report called the *Annual Wholesale Trade Report*. In this report, gross margins (sales less costs of goods sold) by wholesale industries were reported under NAICS 42143, Wholesale sales of Computer & computer peripheral equipment and software.

Additional data for wholesale trade of computers and computer equipment in 1997 were available from the Census *1997 Economic Census of Wholesale Trade* and were used to derive the GDP for Wholesale sales of computer equipment (and software). In the 1997 report, data for this industry include a breakdown of sales and purchased operating expenses from merchant wholesalers, manufacturer's sales from branch offices, agents, brokers and commission merchants. This Census report also separates sales and purchased operating expenses for computers into both equipment and software. The ratios of manufacturer's branch office sales to total wholesale sales of computers and computer equipment and its corresponding purchased operating expenses were used to distribute the industry data from the annual report for 1998 through 2001.

GPO for the retail trade of computer equipment and software (NAICS 443120) was derived in much the same way as the wholesale estimates described above. The Census *Annual Retail Trade Report* contains total sales and gross margins. Data on purchased operating expenses, as well as the distribution between equipment and software from the *1997 Census of Retail Trade* were then used to disaggregate the 1998 through 2001 data for the category.

GDP for the computer software and computer services IT-producing industries for the 1998 through 2001 period was derived using the *1997 Census of Service Industries* and the Current Business Report entitled the *Service Annual Survey* for 1998 through 2001. Similar to the derivation of GDP for the wholesale and retail trade of computer equipment and software, the more detailed data on revenue and operating expenses from the 1997 *Census of Service Industries* were used as a pattern to distribute annual sales estimates from 1998 through 2001.

The *1997 Census of Service Industries* includes a Subject Series report called *Sources of Receipts and Revenue* that was used to compute the cost of goods sold. For most Software and computer services IT-producing industries, the cost of *goods* sold was less than 2 percent of total receipts. However, three of the computer services industries derived a significant portion of their revenue from the sale of goods: Office equipment, including computers, rentals and leasing (NAICS 532420), where the cost of goods sold represented 8.6 percent of total receipts; Computer maintenance and repair (NAICS 811212), 7.6 percent; and Computer related services, not elsewhere classified (NAICS 541519), 2.4 percent. The costs of these goods (computers and equipment) were deducted from the total receipts or these service industries to arrive at a gross margin estimate.

The 1997 Census report also provides a Subject Series report called *Capital Expenditures, Depreciable Assets, and Operating Expenses*. This report lists operating expenses for Software and computer service IT-producing industries that were deducted from the remaining revenue to arrive at GDP estimates. The distribution weight of goods sold and operating expenses for 1997 was applied to the 1998 through 2001 annual revenue data to derive the value of GDP for these industries.

GDP for the Communications Services IT-producing industries for 1996 through 2001 was taken directly from the BEA's gross product by industry series for Telephone and telegraph communications (NAICS 513310, 51332, 513330,513340, and 513390). GDP for Cable and other TV services (NAICS 513210 and 513220) were estimated based on data from the *1997 Census of Service Industries* and the Census *Service Annual Survey* for 1998 through 2001. In the *1997 Census of Service Industries* operating expenses for Cable and other pay TV services are provided. These expenses were deducted from the operating revenue to estimate GDP for this industry in 1997. The Census *Service Annual Survey* provided the operating revenue for this industry between 1998 and 2001. The ratio of operating expenses to operating revenue in 1997 was then applied to the 1998 through 2001 revenue estimate to produce an estimate of GDP for this industry through these years.

Real Dollar GDP of IT-Producing Industries

GDP, in nominal dollars, for IT-producing industries was converted to real (chained 1996) dollars, by using, in most cases, the industry implicit price index associated with the industry sector from BEA's Gross Product by Industry Series.[5] (See Appendix Table A-1.3) The implicit price index (current dollar value over constant (chained 1996) dollar value) that was used to deflate an IT-producing industry was the index that was calculated from an aggregate industry. For example, the price indexes used to derive real dollars for the three IT-producing industries that are Instruments industries were derived from the BEA aggregate instrument industry which includes other instrument industries other than the ones to be IT-producing.

Price indexes for computers and semiconductors were handled differently. For the computer, computer equipment, and calculating and office machinery industry, a composite price index was developed using BEA's quality adjusted "hedonic" deflators for computers and computer equipment and an average product industry price index for calculating and office machines.[6] The quality-adjusted deflators for computers relate prices of these products to their performance characteristics and their cost of production. The composite price index used in the *DE2003* report for Computers, computer equipment, and calculating and office machines was as follows:

Price Index: Computers and computer parts, calculating and office machines
NAICS 333311, 3, 334111, 2, 3, 9, 334418

Year	1996	1997	1998	1999	2000	2001	2002	2003
Price Index	1.000	0.774	0.570	0.436	0.379	0.309	0.262	0.221

Total nominal dollar GDP for this IT-producing industry was divided by the index for each of the years to estimate the real chain-weighted dollar GDP. These price indexes were also applied to the branch office sales of manufacturers that were listed by Census as a Wholesale sale of computers.

A hedonic index was also used to deflate Semiconductors. The indexes used were as follows:

Price Index: Semiconductors
NAICS 334413

Year	1996	1997	1998	1999	2000	2001	2002	2003
Price Index	1.000	0.911	0.755	0.647	0.520	0.427	0.431	0.378

The method used to aggregate real (chained 1996 dollars) GDP[7] and contribution to real GDP growth[8] of IT-producing industries follows BEA's chained-dollar procedures.

Estimating IT-Producing Industry GDP for 2002 and 2003

Estimates were made of GDP for each of the IT-producing industries in 2002 and 2003 since source data, Census industry data on revenues and receipts, were not available. For 2002, we used published 2002 GDP and GDP components data from BEA as the starting point to estimate industry GDP. We then used these GDP levels in conjunction with the INFORUM LIFT (for Long-term Interindustry Forecasting Tool) model[9] to translate each of the GDP components into industrial final demands. The model then aggregates final demands across the economy and uses an annual input-output matrix to calculate the output of all the industries in the economy to satisfy final demands. The output estimated by the model was, however, total output (value added and intermediate inputs). This output was transformed into GDP (the value added portion of output) by using the average ratio of GDP by industry for 1999 through 2001 to total industry output to derive the 2002 GDP for the IT-producing industries.

A similar method was used to estimate GDP by industry for 2003, except, that at the time of publication of the *DE2003* report, GDP data from BEA for 2003 were not yet available. At that time, only three-quarters of 2003 GDP data were available. Therefore, it was necessary to obtain a recent estimate of GDP and GDP components for all of 2003. A November 2003 GDP estimate for all of 2003 was obtained from Global Insight. Real GDP growth for 2003 was estimated to grow by 2.9 percent in their November forecast. The same method was then applied as was applied to the 2002 GDP published data using the INFORUM LIFT model. As it turned out, real GDP grew by 3.1 percent in 2003 so that the estimates of GDP by IT-producing industry for 2003 were somewhat conservative.

Thus, we make the crossover from measuring the GDP of IT-producing industries through 2001 using industry income data provided from the Bureau of the Census to using industry final demand (product) data for 2002 and 2003 provided from the Bureau of Economic Analysis in combination with a 2003 projection in combination with an interindustry input-output model to estimate industrial output to fulfill the final demands. Once we have the industrial output estimates for 2002 and 2003, we rely on the past relationships of GDP by industry to total output of that industry to estimate GDP of the IT-producing industries in 2002 and 2003.

The 2002 Economic Census data will start to become available in spring of 2004. At that time, the estimates made from BEA product data and modeling for 2002 will be replaced with new industry income measures from the Census Bureau.

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[1] The *North American Industry Classification System, United States, 1997,* Executive Office of the President, Office of Management and Budget, 1998.

[2] See *The Emerging Digital Economy*, April 1998; *The Emerging Digital Economy II*, June 1999; *Digital Economy 2000*, June 2000; and *Digital Economy 2002*, February 2002, Economics and Statistics Administration, U.S. Department of Commerce.

[3] See McCahill and Moyer's, "Gross Domestic Product by Industry for 1999-2001," Bureau of Economic Analysis, *Survey of Current Business*, November 22, 2002, p.23, Box titled "Gross Domestic Product by Industry, Definition and Relationship to Gross Domestic Product and Other Measures of Output."

[4] See Seskin and Larkin, Improved Estimates of the National Income and Product Accounts for 1929-2002, Results of the Comprehensive Revision, *Survey of Current Business*, February 2004.

[5] BEA's gross product by industry series are published on BEA's web site, http://www.bea.doc.gov.

[6] See Papers and Working Papers from BEA's web site. See Moulton's presentation to the BEA Advisory Board, "The Expanding Role of Hedonic Methods in the Official Statistics of the United States," November 30, 2001.

[7] See McCahill and Moyer's "Gross Domestic Product by Industry for 1999-2001," Bureau of Economic Analysis, *Survey of Current Business*, November 22, 2002, p. 25, Box titled "Nonadditivity of Chained Dollars and "Not Allocated by Industry" in the GDP-by-Industry Accounts.

[8] See Lum and Moyer's "Gross Product by Industry, 1995-97," Bureau of Economic Analysis, *Survey of Current Business,* November 1998, p. 25, Box titled "Using Chained-Dollar Estimates for Computing Contributions to Economic Growth: A Cautionary Note."

[9] See Inforum's web site at http://inforumweb.umd.edu.

CHAPTER I
APPENDIX TABLES

Appendix Table A-1.1

Information Technology Producing Industries
1997 NAICS Classification*

Hardware Industries	**1997 NAICS**
Computers and computer equipment and Calculating and office machines	333311, 3, 334111, 2, 3, 9, 334418
Wholesale trade of computers	421430pt
Retail trade of computers	443120pt
Electron tubes	334411
Printed circuit boards	334412
Semiconductors	334413
Passive electronic components	334414, 5, 6, 9
Industrial instruments for measurement	334513
Instruments for measuring electricity	334515
Laboratory analytical instruments	334516
Software/Computer Service Industries	
Computer programming services	541511
Prepackaged software	5112, 334611
Wholesale trade of software	421430pt
Retail trade of software	443120pt
Computer integrated system design	541512
Computer processing, data preparation	5142
Information retrieval services	51419
Computer services management	541513
Computer renting and leasing	532420
Computer maintenance and repair	811212
Computer related services, nec	541519
Communications Equipment Industries	
Household audio and video equipment	334310
Telephone and telegraph equipment	334210
Radio and TV communications equipment	334220, 90
Magnetic and optical recording media	34613
Communications Services Industries	
Telephone and telegraph communications	5133
Cable and other pay TV services	5132

**1997 North American Industry Classification*

Appendix Table A-1.2

Information Technology Producing Industries
Gross Domestic Product by Industry

	1996	1997	1998	1999	2000	2001	2002est.	2003est.
				($millions)				
Total Gross Domestic Product*	**7,780,300.0**	**8,288,600.0**	**8,812,500.0**	**9,313,100.0**	**9,953,100.0**	**10,199,400.0**	**10,555,100.0**	**11,040,634.6**
Year-to-Year GDI Change (%)		**6.5%**	**6.3%**	**5.7%**	**6.9%**	**2.5%**	**3.5%**	**4.6%**
Industry**								
Hardware								
Computers and equipment, calc. machines	51,151.5	56,140.3	66,727.0	62,262.7	54,966.8	46,390.4	43,699.8	46,234.3
Computers and equipment wholesale sales	59,767.0	68,224.1	72,395.8	77,211.5	72,212.3	58,795.6	55,400.9	58,614.2
Computer and equipment retail sales	4,794.1	5,465.7	6,110.2	6,431.1	6,410.0	5,581.3	5,785.2	6,120.7
Electron tubes	1,564.9	1,568.4	1,619.4	1,758.0	1,362.1	1,180.6	1,324.2	1,561.7
Printed circuit boards	5,048.3	5,062.3	5,047.7	5,557.1	6,626.8	4,731.7	5,307.3	6,259.2
Semiconductors	51,601.8	64,135.3	59,977.2	68,021.7	67,896.6	44,118.2	49,485.0	58,360.3
Passive electronic components	15,332.2	12,996.1	12,351.3	12,657.7	14,778.6	11,037.2	12,379.8	14,600.2
Industrial instruments for measurement	3,146.2	4,914.9	4,761.8	4,581.3	4,801.6	4,567.2	4,137.9	4,241.8
Instruments for measuring electricity	5,684.8	8,991.8	8,755.0	9,010.4	10,346.8	8,236.5	7,462.3	7,649.6
Laboratory analytical instruments	3,040.5	4,111.2	4,480.6	4,715.0	4,730.3	4,723.1	4,279.1	4,386.5
Total Hardware	**201,131.5**	**231,610.1**	**242,226.0**	**252,206.5**	**244,131.9**	**189,361.8**	**189,261.4**	**208,028.6**
Software and Computer Services								
Computer programming services	29,412.5	34,967.9	47,654.0	56,405.1	63,261.8	61,145.4	61,818.0	62,693.1
Prepackaged software	47,683.4	52,261.5	61,408.5	69,063.2	75,961.1	77,709.1	78,563.9	80,200.9
Prepackaged software wholesale sales	3,483.8	3,818.2	4,051.7	4,321.2	4,041.5	3,290.6	3,100.6	3,174.6
Prepackaged software retail sales	647.7	710.2	794.0	835.7	832.9	725.3	751.7	769.6
Computer integrated system design	34,039.8	43,940.7	58,225.6	66,114.9	75,136.8	73,733.1	74,544.2	75,600.4
Computer processing, data preparation	23,106.2	24,391.8	26,299.2	30,028.7	33,602.5	37,850.1	38,266.5	38,808.7
Information retrieval services	5,252.9	6,892.9	9,729.7	16,354.3	25,312.6	26,155.7	26,443.4	26,818.1
Computer services management	10,150.4	11,789.0	9,278.9	11,882.5	12,779.5	14,891.0	15,054.8	15,268.1
Office machinery rental and leasing	4,160.1	4,820.9	6,495.8	7,292.2	7,846.8	6,635.5	6,708.5	6,803.6
Computer maintenance and repair	5,941.1	6,631.8	7,961.3	8,480.2	8,494.3	8,652.2	8,747.4	8,871.3
Computer related services, nec	2,460.0	3,385.2	6,060.6	7,496.6	9,330.4	9,548.0	9,653.0	9,789.7
Total Software and Computer Services	**166,338.0**	**193,610.1**	**237,959.3**	**278,274.6**	**316,600.2**	**320,336.0**	**323,651.9**	**328,798.2**
Communications Equipment								
Household audio and video equipment	1,731.2	2,372.8	2,663.0	2,855.0	3,221.2	3,143.0	2,668.4	2,601.4
Telephone equipment, exc. ext. modems	16,958.9	23,766.1	25,415.7	32,744.8	35,843.0	28,005.2	23,776.4	22,087.2
Radio & TV communications equipment	18,016.1	24,273.9	22,839.9	23,122.9	26,756.9	22,751.6	19,316.1	17,943.8
Magnetic and optical and recording media	2,302.1	2,300.2	2,242.3	1,902.5	1,440.6	989.9	840.4	819.3
Total Communications Equipment	**39,008.3**	**52,713.0**	**53,160.9**	**60,625.2**	**67,261.7**	**54,889.7**	**46,601.4**	**43,451.7**
Communications Services								
Telephone and telegraph communications	163,900.0	166,700.0	173,900.0	193,700.0	208,000.0	218,500.0	224,846.0	240,980.0
Cable and other pay TV services	18,665.4	21,490.0	32,216.0	36,876.2	41,819.5	45,823.4	47,211.9	50,616.8
Total Communications Services	**182,565.4**	**188,190.0**	**206,116.0**	**230,576.2**	**249,819.5**	**264,323.4**	**272,057.9**	**291,596.8**
Total IT-Producing Industries	**589,043.2**	**666,123.2**	**739,462.2**	**821,682.5**	**877,813.3**	**828,910.9**	**831,572.6**	**871,875.2**
Share of the Economy	**7.6%**	**8.0%**	**8.4%**	**8.8%**	**8.8%**	**8.1%**	**7.9%**	**7.9%**

*Gross Domestic Product here is Gross Domestic Income.

** See industry classification in Table A-1.1

Sources: Estimates based on BEA and Census data for 1996-2001;
Estimates for 2002 based on BEA data and the U. of MD.
input-output model; estimates for 2003 based on the U. of MD.
input-output model and the Global Insight, Inc. forecast.

Appendix Table A-1.3

Information Technology Producing Industries
Real Gross Domestic Product By Industry

	1996	1997	1998	1999	2000	2001	2002est	2003est
			(Millions of 1996$, except as noted)					
Total Gross Domestic Product*	**7,780,300.0**	**8,130,169.6**	**8,538,937.7**	**8,896,062.5**	**9,311,618.1**	**9,321,613.5**	**9,538,309.5**	**9,814,920.5**
Year-to-Year GDI Change (%)		4.5%	5.0%	4.2%	4.7%	0.1%	2.3%	2.9%
Industry**								
Hardware								
Computers and equipment, calc. machines	51,151.5	72,573.3	117,049.6	142,846.1	145,164.2	149,987.3	167,083.8	209,517.7
Computers and equipment wholesale sales	59,767.0	88,194.2	126,993.6	177,142.3	190,708.6	190,095.2	211,822.6	265,618.6
Computer and equipment retail sales	4,794.1	5,501.1	6,184.4	6,543.2	6,568.2	5,697.5	5,843.6	6,167.5
Electron tubes	1,564.9	1,722.5	2,144.3	2,717.7	2,621.6	2,765.5	3,072.4	4,126.3
Printed circuit boards	5,048.3	5,559.7	6,683.8	8,590.8	12,754.5	11,083.6	12,313.9	16,537.6
Semiconductors	51,601.8	70,436.7	79,417.0	105,155.1	130,680.0	103,343.3	114,814.4	154,195.7
Passive electronic components	15,332.2	14,273.0	16,354.6	19,567.6	28,444.2	25,853.7	28,723.5	38,575.7
Industrial instruments for measurement	3,146.2	4,900.1	4,735.6	4,545.3	4,742.5	4,462.4	3,955.9	4,094.4
Instruments for measuring electricity	5,684.8	8,964.8	8,706.8	8,939.6	10,219.4	8,047.6	7,134.1	7,383.8
Laboratory analytical instruments	3,040.5	4,098.9	4,455.9	4,678.0	4,672.0	4,614.8	4,090.9	4,234.1
Total Hardware	201,131.3	275,491.5	364,104.6	464,501.1	524,504.7	485,611.2	527,628.9	665,419.2
Software and Computer Services								
Computer programming services	29,412.5	34,417.2	46,176.4	53,464.5	58,091.6	56,199.8	55,691.9	56,582.2
Prepackaged software	47,683.4	53,383.0	64,476.7	71,953.2	78,078.2	78,398.3	79,810.3	80,847.7
Prepackaged software wholesale sales	3,483.8	3,900.1	4,254.1	4,502.0	4,154.1	3,319.8	3,149.8	3,200.2
Prepackaged software retail sales	647.7	725.4	833.7	870.7	856.1	731.7	763.6	775.8
Computer integrated system design	34,039.8	43,248.7	56,420.2	62,668.2	68,996.1	67,769.4	67,156.9	68,231.4
Computer processing, data preparation	23,106.2	24,007.7	25,483.7	28,463.2	30,856.3	34,788.7	34,474.3	35,025.9
Information retrieval services	5,252.9	6,784.4	9,428.0	15,501.7	23,243.9	24,040.2	23,822.9	24,204.1
Computer services management	10,150.4	11,603.3	8,991.2	11,263.0	11,735.1	13,686.6	13,562.9	13,779.9
Office machinery rental and leasing	4,160.1	4,745.0	6,294.4	6,912.0	7,205.5	6,098.8	6,043.7	6,140.4
Computer maintenance and repair	5,941.1	6,527.4	7,714.4	8,038.1	7,800.1	7,952.4	7,880.5	8,006.6
Computer related services, nec	2,460.0	3,331.9	5,872.7	7,105.8	8,567.9	8,775.7	8,696.4	8,835.5
Total Software and Services	166,337.9	192,711.1	236,076.0	271,106.7	300,239.0	302,545.4	301,682.2	306,287.8
Communications								
Household audio and video equipment	1,731.2	2,398.6	2,807.3	3,123.1	3,649.4	3,670.3	2,998.2	2,926.3
Telephone equipment, exc. ext. modems	16,958.9	24,024.1	26,792.9	35,820.1	40,607.7	32,703.6	26,715.1	24,845.0
Radio & TV communications equipment	18,016.1	24,537.4	24,077.5	25,294.5	30,313.8	26,568.6	21,703.5	20,184.2
Magnetic and optical and recording media	2,302.1	2,325.2	2,363.8	2,081.2	1,632.1	1,156.0	944.3	921.6
Total Communications Equipment	39,008.3	53,285.2	56,041.5	66,318.9	76,203.0	64,098.6	52,361.0	48,877.1
Telephone and telegraph communications	163,900.0	167,900.0	181,300.0	205,300.0	236,700.0	265,700.0	274,202.4	278,589.6
Cable and other pay TV services	18,665.4	19,824.7	27,417.9	29,859.3	31,419.6	37,714.7	38,921.6	39,544.3
Total Communications Services	182,565.4	187,753.5	204,009.8	235,691.4	267,699.8	303,950.2	313,676.6	318,695.4
Total IT-Producing Industries***	**589,042.9**	**706,414.8**	**848,963.1**	**1,012,026.1**	**1,138,433.4**	**1,149,136.1**	**1,167,284.9**	**1,241,516.3**

*Gross Domestic Product here is Gross Domestic Income.

**See industry classification in Table A-1.1

***Real chain weighted 1996 dollars are not directly additive.

Sources: Estimates derived from BEA and Census data;
Estimates for 2002 based on BEA data and the U. of MD.
input-output model; estimates for 2003 based on the U. of MD.
input-output model and the Global Insight, Inc. forecast.

APPENDIX TO CHAPTER II

Information Technology Workers in the Digital Economy

This appendix contains supplemental data, data sources and estimation methodologies for Chapter II: Information Technology Workers and the Digital Economy in *Digital Economy 2003* (*DE2003*). Readers should note methodological changes have been substantive and therefore estimates provided in Digital Economy 2003 are not comparable to those reported in previous Digital Economy or Emerging Digital Economy publications. The specific changes are discussed in this appendix.

IT-PRODUCING INDUSTRIES

Re-Defining IT Industries According to the North American Industrial Classification System

The publication of *The Emerging Digital Economy* in 1998 marked the beginning of the Department's series of reports on the "digital economy." The authors sought to develop a way of measuring the importance of the digital economy and electronic commerce to the U.S. economy. After consulting with industry and government experts, the authors settled on a list of "information technology producing industries" defined as those industries that produce equipment and/or provide services that would enable electronic commerce. These industries broadly include industries that produce computing and communications equipment (including the IT infrastructure) and industries that provide computing and communications services. Over time, the IT producing-industry definition has been refined in response to reader comments and changes in the Government's industry classification system. For example, after the publication of the Emerging Digital Economy, the Census Bureau suggested removing the radio and television broadcasting industry part of the Communications sector. Whenever possible, after making a definitional change, the authors provided readers with a revised historical series of data.

Since the original list of IT-producing industries was created in 1998, the Federal government has replaced its industry classification system. The previous classification system, the Standard Industrial Classification (SIC) system was last revised in 1987 and it grouped industries according to what was produced. The North American Industrial Classification System (NAICS) groups industries according to similar production processes, thus providing a better disaggregation among services industries. For example, under the SIC system, manufacturers of telephones and providers of telephone services were both classified under the same industry, SIC 48-Communications. NAICS, however, classifies telecom equipment manufacturing as part of NAICS 334-Computer and Other Electronic Manufacturing and includes telephone services as part of NAICS 571-Telecommunications services, a subset of NAICS 57- the Information sector.

Federal statistical agencies are gradually transitioning to NAICS. The Census Bureau led the effort in collecting and publishing much of the data used in this report according to the 1997 NAICS. The Bureau of Labor Statistics is in the process of converting to NAICS; however, they decided go directly to the most recent version of NAICS, which was released in 2002. Census, however, has not converted to the 2002 NAICS. As a result, there are some inconsistencies in industry definitions among Chapter I, which uses the 1997 NAICS, and Chapter II, which uses the 2002 NAICS.

The conversion to 2002 NAICS resulted in the disaggregation of several industries, which in turn, allowed for the removal of some non-IT producing industries that were previously grouped with IT-producing industries. The following non-IT producing industries were excluded:

NAICS Code	Industry Title
333311	Automatic Vending Machine Manufacturing
334514	Totalizing Fluid Meter and Counting Device Manufacturing
334518	Watch, Clock, and Part Manufacturing
339942	Lead Pencil and Art Good Manufacturing
485310	Taxi Service
812990	All Other Personal Telecom Services

The following new or revised industries were added:

NAICS Code	Industry Title
333295	Semiconductor Machinery Manufacturing
335921	Fiber Optic Cable Manufacturing
518112	Web Search Portals
811213	Communications Equipment Repair and Maintenance

Box 2.1 contains the revised list of IT-producing industries according to the 2002 edition of NAICS. IT-producing industries are grouped into four major IT sectors: Computer Hardware, Software and Computer Services, Communications Equipment and Communications Services.

Measuring IT-Industry Employment

The primary source of industry employment data used in *DE2003* is the Current Employment Statistics (CES) survey, which is conducted monthly on a sample of nonfarm establishments by the Bureau of Labor Statistics (BLS) in cooperation with State Employment Security Agencies.[1] These data, presented in Appendix Tables 2.1 and 2.2, are available monthly and annually from the BLS website. (http://www.bls.gov/ces/home.htm) The term "all private industries" includes employees except those in the agricultural and government sectors. CES estimates include all full-time, part-time and temporary workers on the payroll during the survey period and exclude self-employed workers, unpaid family workers, workers in private households and agriculture. Workers reported on the payroll of more than one establishment are counted at each establishment. BLS revised the CES industry employment data historically to 1993, according to the 2002 NAICS.

The BLS Covered Employment and Wages (CEW) survey is a secondary source of industry employment used in *DE2003*.[2] The CEW or ES202 program is a Federal-State cooperative program that counts all employees covered by unemployment insurance programs. The State Employment Security Agencies compile the data reported by employers. Like the CES data, CEW employment estimates exclude proprietors and unincorporated self-employed workers, unpaid family members, and some types of

Box 2.1
Information Technology-Producing Industries
(2002 NAICS)

NAICS Code	Computer Hardware
334111	Electronic Computers
334112	Computer Storage Devices
334113	Computer Terminals
334119	Other Computer Peripheral Equipment
423430	Computer and Software Wholesalers (part)
443120	Computer and Software Stores (part)
334411	Electron Tubes
334412	Bare Printed Circuit Boards
334413	Semiconductor and Related Devices
334414	Electronic Capacitors
334417	Electronic Connectors
334418	Printed Circuit Assembly
334415,6,9	Miscellaneous Electronic Components
334513	Industrial Process Control Instruments
334515	Electricity Measuring and Testing Equipment
334516	Analytical Laboratory Instruments
333295	Semiconductor Machinery
333313	Office Machinery Manufacturing

NAICS Code	Software and Computer Services
511210	Software Publishers
518111,2	Internet Service Providers and Web Search Portals
518210	Data Processing, Hosting, and Related Services
423430	Computer and Software Wholesalers (part)
443120	Computer and Software Stores (part)
541511	Custom Computer Programming
541512	Computer Systems Design
541513	Computer Facilities Management
541519	Other Computer Related Services
532420	Office Machinery and Equipment Rental and Leasing
811212	Computer and Office Machine Repair and Maintenance

	Communications Equipment
334210	Telephone Apparatus
334310	Audio and Video Equipment
334220	Broadcast and Wireless Communications Equipment
335921	Fiber Optic Cables
334611	Software Reproducing
334613	Magnetic and Optical Recording Media

	Communications Services
517110	Wired Telecommunications Carriers
517212	Cellular and Other Wireless
517310	Telecommunications Resellers
517510	Cable and Other Program Distribution
517410,910	Satellite and Other Telecommunications
811213	Communications Equipment Repair and Maintenance

domestic and farm workers.[3] Quarterly and annual estimates are available on the BLS website (http://www.bls.gov/cewhome.htm). CEW data are also published annually in *Employment and Wages, Annual Averages.* As described in the next section, CEW employment data were used to estimate IT industry employment when CES data either were not available at the six-digit NAICS level or several industries were grouped together within the CES database.

Readers will note that wholesale and retail sellers of computers and software (NAICS 423430 and 443120) are listed twice, under Computer hardware and Software and services. Employment in the two industries is divided according to the distribution of nominal value added as determined in Chapter I (Appendix Table 1.2). For the computer hardware and software wholesale trade industry, 95 percent of employment is allocated to computer hardware and 5 percent to software and computer services for each year. Employment in the computer hardware and software stores (retail trade) industry is allocated 88 percent to computer hardware and 12 percent to software and services. Note: In previous analyses, the 95 percent hardware-5 percent software distributions were used for both wholesale and retail trade industries.

Data users should note that the sum of employment in manufacturing industries (computer hardware and communications equipment) and services industries (software and services and communications services) in Appendix Table 2.2 do not match the sums of IT-manufacturing and IT-services groups in Appendix Table 2.1, because as explained above, wholesale and retail trade of computers and software (two services industries) are divided among the computer hardware sector and the software and computer services sector.

Methodologies for Estimating Unreported IT Industry Employment

- If industry employment is reported as a combined industry within the CES database and all the industries within that combined group are IT-producing industries, employment is reported in *DE2003* for that combined industry. That is to say, the estimates are reported directly from the BLS CES database, without adjustments. For example, NAICS industries 518111 and 518112, Internet service providers and Web search portals are reported as a single industry in the CES database and are reported as a single industry in Appendix Tables 2.1 and 2.2.

- If a CES combined industry group includes one or more non-IT industries, the CEW employment distribution for that industry group is used to disaggregate the industries.[4] For example, employment in industry 532490 as reported by CES, actually includes two industries, 532420, Office machinery and equipment rental and leasing (an IT-producing industry) and 532490, Other commercial and industrial machinery and equipment rental and leasing (a non IT-producing industry). Since CEW employment estimates are available for both industries separately, that distribution is used to estimate the IT-producing part (532420). ESA's estimated employment for industry 532420 is computed as:

  532420est. = CEW(532420/(532420+532490)) * CES(532490)
  where CES(532490) = 532420 + 532490

- If an unreported IT industry could be computed as a residual (subtracting the available IT industries from a more highly aggregated IT industry), then the residual estimate is reported. If the residual resulted in a combined IT-producing industry group, then employment is reported for the combined industry group. For example, employment estimates are available for CES 6-digit

industries: 517110, 517210, 517410 and 517510 and CES 4-digit industry 5171. The residual industry is a combined industry that includes Satellite communications (517410) and Other telecommunications (517910). Thus ESA's estimated employment for the Satellite and other telecommunications industry group is computed as:

CES(517410,517910) = CES(5171- 517110-517210-517410-517510)

- When CES data are not available at the 6-digit NAICS level and a residual cannot be computed, the CEW distribution is applied to the CES 4-digit industry. For example, the Software reproducing industry (334611) is not available in the CES database; however employment for industry 3346 is available. ESA's estimated employment in the Software reproducing industry is computed as:

  334611est. = CEW(334611/3346) * CES(3346)

Measuring IT-Producing Industry Wages

Average annual wages reported in *DE2003* are collected through the BLS CEW or ES202 program and include gross wages and salaries, bonuses, stock options, tips, severance pay, and other gratuities. In some cases, wages include the value of meals and lodging and in some states, contributions to 401K plans.[5] Employer contributions to benefits and pension plans are among the items excluded. These estimates along with CEW industry employment were used to compute annual wages per worker in 2001 and 2002.[6] (See Appendix Table 2.3) BLS has not developed a historical revision of CEW estimates according to the 2002 NAICS, therefore only two years of data are available. BLS cautions about making comparisons across industries using annual average wages since they are affected by the proportion of full-time to part-time workers in an industry as well as the ratio of high- versus low-skilled occupations. For example, average annual wages in an industry with a large number of part-time workers will be lower than in an industry with a concentration of full-time workers.

Average annual wages for combined industries (Internet service providers & Web search portals, Satellite and Other telecommunications and Miscellaneous components industries) reflect the relative weighting of employment of each separate industry. Estimates of annual wages per worker include all occupations in each industry and should not be confused with earnings for specific occupations, which are discussed in the next section. Total wages paid by each IT-producing industry are not reported in *DE2003*.

IT-RELATED OCCUPATIONS

Defining IT-Related Occupations

IT-related occupations, as defined in this analysis, cover occupations not only involved in conducting electronic commerce, but in maintaining the infrastructure that enables it. Thus, the *DE2003* definition of IT occupations is broader than the "core" IT occupations; *i.e.*, computer scientists, engineers, programmers and systems analysts used by the Department's Technology Administration, the National Science Foundation, the Information Technology Association of America and others. Occupations considered to be essential to IT and to electronic commerce were selected based on consultations with BLS employment experts.

The 1998 change to the Standard Occupational Classification system resulted in a larger number of IT-related occupations specifically among computer-related occupations (from 4 to 11). The revision also disaggregated some other occupations. For example, mail and duplicating machine occupations were separated into mail and mail handling and office machine operators. Thus in *DE2003*, the list of IT-related occupations now excludes mail and mail handlers. Box 2.2 contains the list of IT-related occupations used in *DE2003* and Appendix Table 2.6 describes the duties of each occupation.

Box 2.2
IT-Related Occupations,
by Education and Training Intensity

SOC Code	HIGH
11-3021	Computer and Information Systems Managers
11-9041	Engineering Managers
15-1011	Computer and Information Scientists, Research
15-1021	Computer Programmers
15-1031	Computer Software Engineers, Applications
15-1032	Computer Software Engineers, Systems Software
15-1041	Computer Support Specialists
15-1051	Computer Systems Analysts
15-1061	Database Administrators
15-1071	Network and Computer Systems Administrators
15-1081	Network Systems and Data Communications Analysts
17-2061	Computer Hardware Engineers
17-2071	Electrical Engineers
17-2072	Electronics Engineers, Except Computer
17-3023	Electrical and Electronic Engineering Technicians
	MODERATE
43-9021	Data Entry Keyers
49-2011	Computer, Automated Teller, and Office Machine Repairers
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment
49-9051	Electrical Power-Line Installers and Repairers
49-9052	Telecommunications Line Installers and Repairers
51-2022	Electrical and Electronic Equipment Assemblers
51-2023	Electromechanical Equipment Assemblers
51-9141	Semiconductor Processors
	LOW
43-2011,21	Communications Equipment Operators
43-3021	Billing and Posting Clerks and Machine Operators
43-9011	Computer Operators
43-9071	Office Machine Operators, Except Computer

Source: ESA in consultation with BLS.

Measuring IT-Related Occupational Employment

Occupational employment used in *Digital Economy 2003* are from the BLS Occupational Employment Survey (OES), a semi-annual survey conducted in three year cycles to count full- and part-time wage and salary workers in nonfarm industries.(http://www.bls.gov/oes/home.htm) Self-employed owners and partners in unincorporated firms, household workers and unpaid family workers are excluded.

The 2002 OES data reflects a change to NAICS and also marks the first time survey has been conducted semi-annually. Total employment in an occupation is counted across all industries in which that occupation was reported. Employees in IT occupations are employed across all industries, including Government. Appendix Table 2.4 shows employment in IT-related occupations from 1999 to 2002, the longest period for which consistent occupational categories are available.

Education and Training Requirements by Occupation

The Bureau of Labor Statistics classifies occupations into 1 of 11 categories that describe the education and training needed by most workers to become fully qualified. *Note that these education and training categories were not intended to be measured as skills.* The eleven categories include occupations that require training ranging from short-term on-the-job training to a first professional degree. Box 2.3 shows the 11 BLS categories and how they correspond to the three levels of training intensity presented in Appendix Tables 2.4 and 2.5. A complete description of the BLS education and training categories can be found on the BLS website. (http://www.bls.gov/emp/noeted/empnumb.htm)

Box 2.3

Concordance of BLS and ESA Education and Training Requirement Levels

BLS Categories	ESA Intensity Levels
First professional degree	High
Doctoral degree	High
Master's degree	High
Work experience, plus a bachelor's or higher degree	High
Bachelor's degree	High
Associate's degree	High
Post-secondary vocational training	Moderate
Work experience in a related occupation	Moderate
Long-term on-the-job training	Moderate
Moderate-term on-the-job training	Low
Short-term on-the-job training	Low

IT Occupational Wages

Occupational wages also are collected as part of the Occupational Employment Statistics (OES) survey. Wages are straight time, gross pay excluding premium pay (overtime, non-production bonuses, benefits, etc.). Since the survey is based on a three-year sample and BLS converted to NAICS for 2002, SIC and NAICS-based survey data had to be combined. Mean wage estimates from 1999 to 2002 for each IT-related occupation are available in Appendix Table 2.5 and on the OES website (http://www.bls.gov/oeshome.htm).

IT Occupational Unemployment Rates

Figure 2.4 in Chapter 2 of *Digital Economy 2003* compares unemployment rates in computer and related occupations with all professional specialty occupations and the average for all occupations. Unemployment rates by occupation were derived from unemployment and labor force statistics collected as part of the Current Population Survey (CPS), a joint Bureau of the Census and BLS venture to collect household demographic data. In contrast to the OES survey, the CPS survey data counts each household member who either worked or had a job (even if not at work) during the sample period. The CPS survey *includes* paid employees that worked in their own business or profession or on their own farm or worked 15 hours or more as unpaid workers in a family-operated enterprise. Also, workers are counted only once, regardless of the number of jobs they may hold. Since these estimates are from a household survey, they are not directly comparable to the OES estimates, which are from an establishment survey. The unemployment rate is computed as the share of the civilian labor force that is unemployed. Occupational classifications for unemployment rates are limited. For more information, see http://www.bls.gov/cps/.

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[1] See Bureau of Labor Statistics Handbook of Methods, Chapter 2, Employment, Hours, and Earnings from the Establishment Survey. (http://www.bls.gov/opub/hom/homch2_a.htm)

[2] In September 2003, BLS changed the name of the survey from Covered Employment and Wages (CEW) to Quarterly Census of Employment and Wages. The DE2004 appendix will reference the new name since it will contain data from 2003 (when the name changed occurred).

[3] See Bureau of Labor Statistics, *Handbook of Methods*, Chapter 5, Employment and Wages Covered by Unemployment Insurance. (http://www.bls.gov/opub/hom/homch5_a.htm)

[4] Because of the recent NAICS revision and limited availability of historical CEW data, the 2002 employment distribution was applied to each year of the period.

[5] See Bureau of Labor Statistics, *Handbook of Methods*, Chapter 5.

[6] In previous Digital Economy Reports, when CEW total annual wages were reported, annual wages per worker were computed using CES employment and CEW wage data. In this report, annual wages per worker are reported directly from the CEW survey.

CHAPTER II
APPENDIX TABLES

l troni puter		89.	175.	166.	165.	172.	.	171.	168.	159.	138.	-1.	-5.	- .
ter tor i		34.	35.	37.	.	39.	39.	40.	38.	37.	32.	.	- .	-11.
ter t rminal		24.	24.	25.	.	26.	26.	25.	25.	23.	21.	.	- .	-10.
Other put r peripheral equi t		57.	61.	65.	.	77.	78.	72.	70.	66.	57.	.	- .	-13.
l tron t		24.	24.	24.	.	21.	20.	20.	20.	19.	16.	-2.	-6.	- .
re pri t d circuit oards		96.	102.	115.	123.	132.	.	126.	139.	120.	83.	.	-13.	- .
i t r rel ted de		10.	217.	231.	255.	272.	.	268.	289.	292.	254.	.	1.	- .
l troni itors		16.	16.	18.	.	17.	15.	15.	16.	14.	11.	.	-14.	- .
l troni t r		15.	15.	17.	.	20.	20.	21.	24.	23.	18.	.	- .	-23.
ri ted cir it li		52.	53.	55.	.	60.	62.	61.	64.	60.	51.	.	- .	-15.
i ll el troni ponent	334415,6,	03.	105.	109.	111.	115.	.	116.	121.	115.	96.	.	- .	-16.
l tri l r riable i trument		59.	61.	63.	.	65.	67.	68.	70.	67.	61.	.	- .	- .
l tri it and signal t ting i tr ent		69.	68.	68.	.	72.	72.	65.	65.	65.	54.	-0.	-1.	- .
nal ti al laborator i tr ent		38.	36.	36.	.	36.	37.	36.	35.	35.	33.	-1.	-0.	-5.
i t r inery		18.	19.	22.	.	24.	25.	23.	24.	23.	19.	.	- .	-15.
Offi iner		14.	14.	15.	.	16.	16.	15.	15.	14.	12.	.	- .	-13.
ftwar reprodu i		20.	21.	23.	.	25.	26.	26.	28.	27.	25.	.	- .	- .
agneti nd opti al rec rdi edi		5.	.	6.	.	6.	.	7.	.	7.	.	4.	-4.	-6.
l phone apparat		92.	92.	93.	.	100.	.	101.	106.	97.	70.	.	- .	-27.
r t and wirel uni t equi t		93.	100.	110.	112.	113.	.	104.	107.	102.	89.	.	- .	-13.
udio and vi equi ent		57.	57.	53.	.	52.	53.	52.	52.	47.	41.	-1.	-9.	- .
iber opti able m f turi		14.	15.	15.	.	16.	16.	17.	20.	20.	15.	.	- .	-25.
ired t l i ati rri r		24.	621.	611.	603.	629.	.	688.	719.	732.	662.	.	1.	-9.
llul r and other wir l rr r		47.	60.	75.	.	111.	.	134.	155.	171.	168.	18.	.	- .
l uni ti r ll rs		70.	171.	171.	171.	181.	.	200.	213.	214.	185.	.	0.	- .
ble and other rogr di tribut		75.	80.	86.	.	96.	.	110.	123.	129.	128.	.	5.	-0.
t llit and other t l i at r	517410,	15.	15.	16.	.	19.	20.	20.	21.	25.	28.	.	18.	4.
ftwar publi rs		25.	136.	157.	174.	195.	.	235.	260.	268.	256.	11.	.	- .
l web searc port l	518111,	39.	41.	48.	.	70.	86.	132.	194.	176.	142.	25.	-9.	- .
t proc ing and rel t rv		23.	226.	242.	252.	268.	.	307.	315.	316.	305.	.	0.	-3.
t puter progr ing s rv		99.	220.	255.	286.	331.	.	464.	540.	562.	511.	15.	.	- .
ter t ign s r		90.	209.	242.	285.	343.	.	468.	502.	520.	462.	14.	.	-11.
ter f iliti ent r		51.	51.	52.	.	55.	58.	63.	64.	64.	58.	.	- .	- .
Other put r-relat rvi		43.	49.	60.	.	96.	.	136.	146.	150.	130.	18.	.	-13.
ter ftwar whol aler		22.	223.	233.	249.	273.	.	319.	315.	295.	265.	.	- .	-10.
ter ftwar r t rs		36.	143.	155.	167.	186.	8.	212.	216.	202.	183.	6.	-6.	-9.
Offi ine rental l i		10.	10.	11.	.	12.	12.	12.	13.	12.	13.	.	- .	0.
ter offi i e repair		39.	41.	44.	.	51.	51.	51.	47.	48.	46.	.	1.	-3.
uni ti i ent repair and l		18.	18.	19.	.	20.	20.	20.	19.	20.	19.	.	1.	-3.
			3.	5.	6.	8.	7.	6.	6.	- .	-10.			

Appendix Table 2.2:
IT-Producing Industry Employment, 1993-2002

	2002 NAICS Code	Employment (000s)										Average Annual Rate of Growth (%)		
		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	93-00	00-01	01-02
Computer Hardware														
Electronic computers	334111	189.0	175.9	166.2	165.7	172.6	178.3	171.3	168.6	159.3	138.4	-1.6	-5.5	-13.1
Computer storage devices	334112	34.6	35.5	37.7	38.5	39.6	39.0	40.5	38.0	37.0	32.8	1.3	-2.6	-11.4
Computer terminals	334113	24.2	24.7	25.8	26.1	26.8	26.6	25.5	25.2	23.8	21.3	0.6	-5.6	-10.5
Other computer peripheral equipment	334119	57.9	61.6	65.8	74.3	77.8	78.4	72.8	70.1	66.1	57.2	2.8	-5.7	-13.5
Computer and software wholesalers	423430	211.0	211.2	221.1	236.0	258.9	287.0	302.0	298.4	280.0	251.4	5.1	-6.2	-10.2
Computer and software retailers	443120	120.4	127.3	137.7	148.1	164.8	175.3	187.8	191.4	178.9	162.0	6.8	-6.5	-9.5
Electron tubes	334411	24.8	24.5	24.0	22.9	21.9	20.7	20.6	20.4	19.1	16.2	-2.8	-6.4	-15.2
Bare printed circuit boards	334412	96.7	102.0	115.3	123.8	132.1	134.0	126.5	139.5	120.2	83.9	5.4	-13.8	-30.2
Semiconductors and related devices	334413	210.5	217.0	231.5	255.5	272.9	279.9	268.0	289.2	292.1	254.8	4.6	1.0	-12.8
Electronic capacitors	334414	16.4	16.7	18.2	17.4	17.0	15.9	15.2	16.9	14.4	11.0	0.4	-14.8	-23.6
Electronic connectors	334417	15.3	15.9	17.3	18.5	20.3	20.4	21.9	24.2	23.7	18.1	6.8	-2.1	-23.6
Printed circuit assemblies	334418	52.7	53.8	55.2	56.9	60.0	62.0	61.8	64.4	60.8	51.2	2.9	-5.6	-15.8
Miscellaneous electronic components	334415,6,9	103.0	105.5	109.5	111.6	115.6	116.9	116.5	121.7	115.1	96.2	2.4	-5.4	-16.4
Industrial process variable instruments	334513	59.6	61.1	63.3	65.2	65.6	67.2	68.9	70.1	67.4	61.2	2.3	-3.9	-9.2
Electricity and signal testing instruments	334515	69.6	68.0	68.0	71.0	72.0	72.5	65.2	65.8	65.1	54.8	-0.8	-1.1	-15.8
Analytical laboratory instruments	334516	38.6	36.8	36.0	36.5	36.9	37.3	36.5	35.7	35.4	33.6	-1.1	-0.7	-5.2
Semiconductor machinery	333295	18.1	19.3	22.4	24.3	24.9	25.2	23.1	24.7	23.2	19.6	4.5	-6.1	-15.5
Office machinery	333313	14.7	14.9	15.6	15.8	16.2	16.1	15.4	15.3	14.7	12.7	0.6	-3.9	-13.6
Total Computer Hardware		**1,357.2**	**1,371.7**	**1,430.6**	**1,508.2**	**1,595.9**	**1,652.8**	**1,639.5**	**1,679.6**	**1,596.4**	**1,376.4**	**3.1**	**-5.0**	**-13.8**
Software and Computer Services														
Software publishers	511210	125.9	136.8	157.2	174.8	195.2	214.9	235.0	260.6	268.9	256.0	11.0	3.2	-4.8
ISPs and web search portals	518111,2	39.7	41.2	48.6	59.6	70.4	86.4	132.2	194.3	176.8	142.1	25.5	-9.0	-19.6
Data processing and related services	518210	223.4	226.9	242.6	252.0	268.4	282.8	307.1	315.7	316.8	305.3	5.1	0.3	-3.6
Computer and software wholesalers	423430	11.9	11.9	12.5	13.3	14.6	16.2	17.0	16.8	15.8	14.2	5.1	-6.2	-10.2
Computer and software retailers	443120	15.7	16.6	18.0	19.4	21.5	22.9	24.5	25.0	23.4	21.2	6.8	-6.5	-9.5
Custom computer programming services	541511	199.4	220.6	255.7	286.4	331.8	388.6	464.2	540.0	562.9	511.8	15.3	4.2	-9.1
Computer systems design services	541512	190.1	209.4	242.6	285.2	343.2	408.1	468.7	502.9	520.3	462.4	14.9	3.5	-11.1
Computer facilities management services	541513	51.8	51.4	52.8	54.5	55.4	58.6	63.9	64.9	64.6	58.4	3.3	-0.5	-9.6
Other computer-related services	541519	43.6	49.9	60.2	75.3	96.3	119.6	136.1	146.5	150.1	130.1	18.9	2.5	-13.3
Office machine rentals and leasing	532420	10.5	10.6	11.0	11.5	12.0	12.8	12.9	13.1	12.9	13.0	3.3	-1.5	0.6
Computer and office machine repair	811212	39.9	41.4	44.6	48.2	51.2	51.4	51.0	47.7	48.3	46.6	2.6	1.3	-3.5
Total Software and Computer Services		**951.9**	**1,016.7**	**1,145.7**	**1,280.2**	**1,460.0**	**1,662.2**	**1,912.6**	**2,127.5**	**2,160.8**	**1,961.0**	**12.2**	**1.6**	**-9.2**
Communications Equipment														
Telephone apparatus	334210	92.4	92.0	93.8	96.2	100.8	105.6	101.6	106.5	97.2	70.6	2.0	-8.7	-27.4
Broadcast and wireless communications equip	334220	93.3	100.2	110.6	112.4	113.8	110.8	104.4	107.3	102.5	89.1	2.0	-4.5	-13.1
Audio and video equipment	334310	57.2	57.6	53.8	52.9	52.0	53.2	52.4	52.1	47.4	41.6	-1.3	-9.0	-12.2
Fiber optic cable manufacturing	335921	14.7	15.4	15.8	15.9	16.4	16.9	17.9	20.4	20.2	15.1	4.8	-1.2	-25.1
Software reproducing	334611	20.3	21.8	23.7	24.8	25.4	26.3	26.9	28.2	27.1	25.3	4.8	-4.1	-6.4
Magnetic and optical recording media	334613	5.4	5.7	6.2	6.5	6.7	6.9	7.1	7.4	7.1	6.7	4.8	-4.1	-6.4
Total Communications Equipment		**283.3**	**292.8**	**304.0**	**308.8**	**315.1**	**319.7**	**310.3**	**322.0**	**301.5**	**248.4**	**1.8**	**-6.4**	**-17.6**
Communications Services														
Wired telecommunications carriers	517110	624.5	621.9	611.1	603.2	629.9	652.1	688.1	719.2	732.2	662.4	2.0	1.8	-9.5
Cellular and other wireless carriers	517212	47.4	60.3	75.9	92.5	111.0	121.1	134.3	155.7	171.0	168.7	18.5	9.8	-1.3
Telecommunications resellers	517310	170.5	171.8	171.2	171.6	181.3	188.7	200.2	213.6	214.1	185.7	3.3	0.2	-13.3
Cable and other program distribution	517510	75.8	80.4	86.6	94.6	96.9	102.4	110.9	123.0	129.2	128.0	7.2	5.0	-0.9
Satellite and other telecommunications service	517410,910	15.1	15.3	16.5	17.5	19.3	20.4	20.5	21.2	25.2	28.9	5.0	18.9	14.7
Communications equipment repair and leasing	811213	18.1	18.2	19.2	20.3	20.9	20.8	20.6	19.8	20.1	19.4	1.3	1.5	-3.1
Total Communications Services		**951.4**	**967.9**	**980.5**	**999.7**	**1,059.3**	**1,105.5**	**1,174.6**	**1,252.5**	**1,291.8**	**1,193.1**	**4.0**	**3.1**	**-7.6**
ALL IT-PRODUCING INDUSTRIES		**3,543.8**	**3,649.0**	**3,860.8**	**4,096.9**	**4,430.4**	**4,740.3**	**5,037.0**	**5,381.6**	**5,350.4**	**4,779.0**	**6.2**	**-0.6**	**-10.7**
(year to year rate of change)			3.0%	5.8%	6.1%	8.1%	7.0%	6.3%	6.8%	-0.6%	-10.7%			
ALL PRIVATE INDUSTRIES		**91,855**	**95,016**	**97,866**	**100,169**	**103,113**	**106,021**	**108,686**	**110,996**	**110,707**	**108,886**	**2.7**	**-0.3**	**-1.6**
IT share of all private industries		3.9%	3.8%	3.9%	4.1%	4.3%	4.5%	4.6%	4.8%	4.8%	4.4%			

Source: Estimates derived from BLS Current Employment Statistics survey data.

Appendix Table 2.3:
Average Annual Wages Per Worker, by IT Industry, 2001-2002

Rank (2002)	NAICS Code	IT-Producing Industries	Annual Average Wages 2001	2002	Change 2001-02	%Change 2001-02
		Average All Private Industries	**$36,160**	**$36,520**	**$360**	**1.0%**
		Average All IT-Producing Industries	**$68,330**	**$67,440**	**-$890**	**-1.3%**
1	511210	Software Publishers	$104,810	$99,440	-$5,370	-5.1%
2	334111	Electronic Computer Manufacturing	$95,050	$93,020	-$2,030	-2.1%
3	334611	Software Reproducing	$89,570	$92,260	$2,690	3.0%
4	333295	Semiconductor Machinery Manufacturing	$86,320	$85,470	-$850	-1.0%
5	423430	Computer and Software Wholesalers	$88,530	$84,840	-$3,690	-4.2%
6	334112	Computer Storage Device Manufacturing	$82,270	$82,810	$540	0.7%
7	334113	Computer Terminal Manufacturing	$81,410	$82,610	$1,200	1.5%
8	541511	Custom Computer Programming Services	$77,540	$76,080	-$1,460	-1.9%
9	334413	Semiconductor and Related Device Manufacturing	$78,820	$75,870	-$2,950	-3.7%
10	541512	Computer Systems Design Services	$75,950	$75,070	-$880	-1.2%
11	334515	Electricity and Signal Testing Instruments	$70,240	$73,900	$3,660	5.2%
12	334210	Telephone Apparatus Manufacturing	$70,740	$72,940	$2,200	3.1%
13	518111,12	ISPs and Web Search Portals	$83,090	$69,270	-$13,820	-16.6%
14	334119	Other Computer Peripheral Equipment Manufacturing	$67,190	$68,770	$1,580	2.4%
15	334516	Analytical Laboratory Instrument Manufacturing	$64,700	$64,980	$280	0.4%
16	517410,910	Satellite and Other Telecommunications Services	$60,830	$64,280	$3,450	5.7%
17	541519	Other Computer Related Services	$65,750	$64,200	-$1,550	-2.4%
18	334220	Broadcast and Wireless Communications Equipment	$61,240	$63,010	$1,770	2.9%
19	517110	Wired Telecommunications Carriers	$59,270	$60,810	$1,540	2.6%
20	541513	Computer Facilities Management Services	$63,620	$60,770	-$2,850	-4.5%
21	532420	Office Machinery and Equipment Rental and Leasing	$58,600	$59,860	$1,260	2.2%
22	333313	Office Machinery Manufacturing	$57,630	$59,850	$2,220	3.9%
23	334411	Electron Tube Manufacturing	$58,220	$59,350	$1,130	1.9%
24	517310	Telecommunications Resellers	$55,110	$56,790	$1,680	3.0%
25	518210	Data Processing, Hosting, and Related Services	$55,650	$55,820	$170	0.3%
26	517212	Cellular and Other Wireless Telecommunications	$56,970	$54,330	-$2,640	-4.6%
27	334513	Industrial Process Control Instruments	$52,290	$53,500	$1,210	2.3%
28	443120	Computer and Software Retailers	$53,700	$52,870	-$830	-1.5%
29	335921	Fiber Optic Cable Manufacturing	$48,060	$51,630	$3,570	7.4%
30	334613	Magnetic and Optical Recording Media Manufacturing	$49,660	$49,590	-$70	-0.1%
31	334310	Audio and Video Equipment Manufacturing	$46,790	$48,850	$2,060	4.4%
32	334418	Printed Circuit Assembly	$47,950	$48,010	$60	0.1%
33	811213	Communication Equipment Repair and Maintenance	$43,800	$44,650	$850	1.9%
34	334415,6,9	Misc. components	$43,990	$43,820	-$170	-0.4%
35	811212	Computer and Office Machine Repair and Maintenance	$44,210	$43,770	-$440	-1.0%
36	517510	Cable and Other Program Distribution	$42,560	$43,430	$870	2.0%
37	334417	Electronic Connector Manufacturing	$39,550	$42,790	$3,240	8.2%
38	334412	Bare Printed Circuit Board Manufacturing	$38,680	$40,020	$1,340	3.5%
39	334414	Electronic Capacitor Manufacturing	$35,040	$37,750	$2,710	7.7%

Source: Estimates derived from BLS Covered Employment and Wages data.

Appendix Table 2.4:
Employment, by IT Occupation, 1999-2002

SOC Code	Occupation	1999	2000	2001	2002	Percent change 1999-2000	Percent change 2000-2001	Percent change 2001-2002	Education/ training requirement*
	Total	**6,237,460**	**6,469,860**	**6,151,170**	**5,953,470**	**3.7%**	**-4.9%**	**-3.2%**	**--**
11-3021	Computer and Information Systems Managers	280,820	283,480	267,310	264,790	0.9	-5.7	-0.9	High
11-9041	Engineering Managers	248,210	242,280	214,760	205,390	-2.4	-11.4	-4.4	High
15-1011	Computer and Information Scientists, Research	26,280	25,800	25,620	24,410	-1.8	-0.7	-4.7	High
15-1021	Computer Programmers	528,600	530,730	501,550	457,320	0.4	-5.5	-8.8	High
15-1031	Computer Software Engineers, Applications	287,600	374,640	361,690	356,760	30.3	-3.5	-1.4	High
15-1032	Computer Software Engineers, Systems Software	209,030	264,610	261,520	255,040	26.6	-1.2	-2.5	High
15-1041	Computer Support Specialists	462,840	522,570	493,240	478,560	12.9	-5.6	-3.0	High
15-1051	Computer Systems Analysts	428,210	463,300	448,270	467,750	8.2	-3.2	4.3	High
15-1061	Database Administrators	101,460	108,000	104,250	102,090	6.4	-3.5	-2.1	High
15-1071	Network and Computer Systems Administrators	204,680	234,040	227,840	232,560	14.3	-2.6	2.1	High
15-1081	Network Systems and Data Communications Analysts	98,330	119,220	126,060	133,460	21.2	5.7	5.9	High
17-2061	Computer Hardware Engineers	60,420	63,680	67,590	67,180	5.4	6.1	-0.6	High
17-2071	Electrical Engineers	149,210	162,400	151,300	146,180	8.8	-6.8	-3.4	High
17-2072	Electronics Engineers, Except Computer	106,830	123,690	123,210	126,020	15.8	-0.4	2.3	High
17-3023	Electrical and Electronic Engineering Technicians	242,160	244,570	220,800	194,960	1.0	-9.7	-11.7	High
43-9021	Data Entry Keyers	520,220	458,720	405,000	376,970	-11.8	-11.7	-6.9	Moderate
49-2011	Computer, Automated Teller, and Office Machine Repairers	130,090	142,390	143,810	135,380	9.5	1.0	-5.9	Moderate
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	172,700	192,470	210,650	195,680	11.4	9.4	-7.1	Moderate
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	71,530	81,760	77,780	82,320	14.3	-4.9	5.8	Moderate
49-9051	Electrical Power-Line Installers and Repairers	99,090	96,200	99,140	96,040	-2.9	3.1	-3.1	Moderate
49-9052	Telecommunications Line Installers and Repairers	158,990	168,480	168,260	156,160	6.0	-0.1	-7.2	Moderate
51-2022	Electrical and Electronic Equipment Assemblers	387,430	367,150	302,530	267,030	-5.2	-17.6	-11.7	Moderate
51-2023	Electromechanical Equipment Assemblers	69,830	72,550	63,930	57,500	3.9	-11.9	-10.1	Moderate
51-9141	Semiconductor Processors	42,110	67,000	51,060	43,630	59.1	-23.8	-14.6	Moderate
43-2011,21	Communications Equipment Operators	299,390	295,250	285,160	273,310	-1.4	-3.4	-4.2	Low
43-3021	Billing and Posting Clerks and Machine Operators	551,410	492,040	480,610	491,000	-10.8	-2.3	2.2	Low
43-9011	Computer Operators	198,500	186,460	177,990	172,640	-6.1	-4.5	-3.0	Low
43-9071	Office Machine Operators, Except Computer	101,490	86,380	90,240	93,340	-14.9	4.5	3.4	Low

High: Associate degree, bachelor's degree or work experience plus a bachelor's degree or higher
Moderate: long-term on-the-job training, work experience in a related occupation or post secondary vocational training
Low: short to moderate-term on-the-job training

*The grouping of education and training categories into high, moderate and low requirement levels reflects the author's interpretation of training intensity. BLS classifies occupations into 11 categories that describe education and training needed by most workers to become fully qualified. A description of these education and training categories can be found at http://www.bls.gov/emp/noeted/empnumb.htm.

Source: Estimates derived from Bureau of Labor Statistics Occupational Employment Statistics survey data.

Appendix Table 2.5:
Wages, by IT Occupation, 1999-2002

SOC Code	Occupation	1999	2000	2001	2002	Percent change 1999-2000	Percent change 2000-2001	Percent change 2001-2002	Education/ training requirement*
	All IT Occupations	**$43,543**	**$47,328**	**$49,549**	**$51,195**	**8.7%**	**4.7%**	**3.3%**	
11-3021	Computer and Information Systems Managers	74,430	80,250	83,890	90,440	7.8	4.5	7.8	High
11-9041	Engineering Managers	81,560	85,450	88,900	95,740	4.8	4.0	7.7	High
15-1011	Computer and Information Scientists, Research	67,180	73,430	76,970	80,520	9.3	4.8	4.6	High
15-1021	Computer Programmers	54,960	60,970	62,890	63,690	10.9	3.1	1.3	High
15-1031	Computer Software Engineers, Applications	65,780	70,300	72,370	73,800	6.9	2.9	2.0	High
15-1032	Computer Software Engineers, Systems Software	66,230	70,890	74,490	75,840	7.0	5.1	1.8	High
15-1041	Computer Support Specialists	39,410	39,680	41,920	42,330	0.7	5.6	1.0	High
15-1051	Computer Systems Analysts	57,920	61,210	63,710	64,900	5.7	4.1	1.9	High
15-1061	Database Administrators	52,550	55,810	58,420	59,090	6.2	4.7	1.2	High
15-1071	Network and Computer Systems Administrators	50,090	53,690	56,440	57,620	7.2	5.1	2.1	High
15-1081	Network Systems and Data Communications Analysts	55,710	57,890	60,300	61,380	3.9	4.2	1.8	High
17-2061	Computer Hardware Engineers	66,960	70,100	74,310	76,150	4.7	6.0	2.5	High
17-2071	Electrical Engineers	61,520	66,320	68,630	70,470	7.8	3.5	2.7	High
17-2072	Electronics Engineers, Except Computer	63,410	66,490	69,710	71,610	4.9	4.8	2.7	High
17-3023	Electrical and Electronic Engineering Technicians	39,390	41,210	43,220	44,220	4.6	4.9	2.3	High
43-9021	Data Entry Keyers	21,070	22,170	22,740	23,190	5.2	2.6	2.0	Moderate
49-2011	Computer, Automated Teller, and Office Machine Repairers	31,290	32,860	34,120	34,800	5.0	3.8	2.0	Moderate
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	41,130	42,520	44,360	45,550	3.4	4.3	2.7	Moderate
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	36,160	37,190	39,110	40,770	2.8	5.2	4.2	Moderate
49-9051	Electrical Power-Line Installers and Repairers	43,490	44,490	45,840	47,170	2.3	3.0	2.9	Moderate
49-9052	Telecommunications Line Installers and Repairers	35,790	38,050	39,030	39,560	6.3	2.6	1.4	Moderate
51-2022	Electrical and Electronic Equipment Assemblers	21,840	22,950	23,900	24,630	5.1	4.1	3.0	Moderate
51-2023	Electromechanical Equipment Assemblers	23,830	24,560	26,080	26,520	3.1	6.2	1.7	Moderate
51-9141	Semiconductor Processors	27,540	27,170	28,170	29,140	-1.3	3.7	3.4	Moderate
43-2011,21	Communications Equipment Operators	20,970	22,100	23,030	23,220	5.4	4.2	0.8	Low
43-3021	Billing and Posting Clerks and Machine Operators	23,880	25,480	26,340	27,120	6.7	3.4	3.0	Low
43-9011	Computer Operators	28,170	29,430	30,780	31,640	4.5	4.6	2.8	Low
43-9071	Office Machine Operators, Except Computer	21,510	22,400	23,470	23,400	4.1	4.8	-0.3	Low

High: Associate degree, bachelor's degree or work experience plus a bachelor's degree or higher
Moderate: long-term on-the-job training, work experience in a related occupation or post secondary vocational training
Low: short to moderate-term on-the-job training

*The grouping of education and training categories into high, moderate and low requirement levels reflects the author's interpretation of training intensity. BLS classifies occupations into 11 categories that describe education and training needed by most workers to become fully qualified. A description of these education and training categories can be found at http://www.bls.gov/emp/noeted/empnumb.htm.

Source: Estimates derived from Bureau of Labor Statistics Occupational Employment Statistics survey data.

Appendix Table 2.6:
Information Technology-Related Occupations

Occupation	Description of Duties
Engineering managers	Plan, direct, or coordinate activities in such fields as architecture and engineering or research and development in these fields.
Computer and information systems managers	Plan, direct, or coordinate activities in such fields as electronic data processing, information systems, systems analysis, and computer programming.
Computer and information scientists, research	Conduct research into fundamental computer and information science as theorists, designers, or inventors. Solve or develop solutions to problems in the field of computer hardware and software.
Computer programmers	Convert project specifications and statements of problems and procedures to detailed logical flow charts for coding into computer language. Develop and write programs to store, locate, and retrieve data and information. May program web sites.
Computer software engineers, applications	Develop, create, and modify general computer applications software or specialized utility programs. Analyze user needs and develop software solutions. Design software or customize software for client use. May analyze and design databases within an application area.
Computer software engineers, systems software	Research, design, develop, and test operating systems-level software, compilers, and network distribution software for a variety of computing applications (medical, industrial, military, general). Set operational specifications and formulate and analyze software requirements.
Computer support specialists	Provide technical assistance to computer system users. Answer questions or resolve computer problems for clients in person or via telephone. May provide assistance in the use of computer hardware and software, including printing, installation, word processing, electronic mail, and operating systems.
Computer systems analysts	Analyze science, engineering, business, and all other data processing problems for application to electronic data processing systems. Analyze user requirements, procedures, and problems to automate or improve existing systems. May analyze or recommend commercially available software.
Database administrators	Coordinate, test and implement changes to computer databases using database management systems. May plan, coordinate, and implement security measures to safeguard computer databases.
Network and computer systems administrators	Install, configure, support, monitor and maintain an organization's local area network (LAN), wide area network (WAN), and Internet system. May supervise network support and client server specialists and plan, coordinate, and implement network security measures.
Network systems and data communications analysts	Analyze, design, test, and evaluate network systems, such as local area networks (LAN), wide area networks (WAN), Internet, intranet, and other data communications systems. Research and recommend network and data communications hardware and software. Include telecommunications specialists who deal with the interfacing of computer and communications equipment. May supervise computer programmers.
Computer hardware engineers	Research, design, develop, and test computer or computer-related equipment for commercial, industrial, military, or scientific use. May supervise the manufacturing and installation of computer or computer-related equipment and components.
Electrical engineers	Design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, military, or scientific use.
Electronics engineers, except computer	Research, design, develop, and test electronic components and systems for commercial, industrial, military, or scientific use. Design electronic circuits and components for use in fields such as telecommunications, aerospace guidance and propulsion control, acoustics, or instruments and controls.

Appendix Table 2.6

Information Technology Related Occupations contd.

Occupation	Description of Duties
Electrical and electronic engineering technicians	Apply electrical and electronic theory, usually under the direction of engineering staff, to design, build, repair, calibrate, and modify electrical components, circuitry, controls, and machinery for subsequent evaluation and use by engineering design staff.
Data entry keyers	Operate data entry device, such as keyboard or photo composing perforator. Duties may include verifying data and preparing materials for printing.
Computer, automated teller, and office machine repairers	Repair, maintain, or install computers, word processing systems, automated teller machines, and electronic office machines, such as duplicating and fax machines.
Telecommunications equipment installers and repairers, except line installers	Set-up, rearrange, or remove switching and dialing equipment used in central offices. Install and repair telephones and other communication equipment.
Electrical and electronics repairers, commercial and industrial equipment	Repair, test, adjust, or install electronic equipment, such as industrial controls, transmitters, and antennas.
Electrical power-line installers and repairers	Install or repair cables or wires used in electrical power or distribution systems. May erect poles and light or heavy duty transmission towers.
Telecommunications line installers and repairers	String and repair telephone and television cable, including fiber optics and other equipment for transmitting messages or television programming.
Electrical and electronic equipment assemblers	Assemble or modify electrical or electronic equipment, such as computers, test equipment telemetering systems, electric motors, and batteries.
Electromechanical equipment assemblers	Assemble or modify electromechanical equipment or devices, such as servomechanisms, gyros, dynamometers, magnetic drums, tape drives, brakes, control linkage, actuators, and appliances.
Semiconductor processors	Perform any or all of the functions in the manufacture of electronic semiconductors, including loading semiconductor material into furnace; sawing formed ingots into segments; cleaning, polishing, and loading wafers into series of special purpose furnaces, chemical baths, and equipment used to form circuitry.
Communications equipment operators	Provide information by accessing alphabetical and geographical directories. Assist customers with special billing requests, such as charges to a third party and credits or refunds for incorrectly dialed numbers or bad connections. Operate telephone business systems equipment or switchboards to relay incoming, outgoing, and interoffice calls.
Billing and posting clerks and machine operators	Compile, compute, and record billing, accounting, statistical, and other numerical data for billing purposes. Prepare billing invoices for services rendered or for delivery or shipment of goods.
Computer operators	Monitor and control computer and peripheral electronic data processing equipment to process business, scientific, engineering, and other data according to operating instructions. May set controls on computer and peripheral devices. Monitor and respond to operating and error messages.

Source: Bureau of Labor Statistics, Occupational Employment Statistics Program. http://www.bls.gov/oes/