

# Core Occupations of the U.S. Information Technology Workforce

## **Data on the Information Technology Workforce**

The purpose of the IT Workforce Data Project is to identify and disseminate trustworthy statistics on information technology workers in the United States. This report, the first of a series to be released during early 1999, provides a general overview of the IT workforce. Additional reports will assess production of academic degrees in IT disciplines, data on foreign-origin workers, and indicators of demand for people with IT skills.

In addition to printed reports, results from this project are available at the United Engineering Foundation's web site at [www.uefoundation.org](http://www.uefoundation.org).

Queries about the IT Workforce Data Project are welcome. Contact Richard Ellis: (717) 532-3966 or email to [ellis@cvns.net](mailto:ellis@cvns.net).

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Information technology (IT) is "the study, design, development, implementation, support, or management of computer-based information systems."<sup>1</sup> In practice, IT includes all production and all applications of hardware and software. Leadership in information technology is commonly believed to be essential for the health of the U.S. economy. IT industry associations have been saying that this leadership is threatened by shortages of qualified workers.<sup>2</sup>

The industry utilizes a very broad range of skills. For example, hardware manufacturing relies on mechanical, chemical, and other engineering skills as well as the services of electrical and electronic engineers. Although a list of all the occupations involved in IT would be quite large, observers of the industry agree that a small set of fields — computer scientists, computer engineers, systems analysts, and programmers — constitutes the "core" of the information technology workforce.<sup>3</sup> In the United States at the beginning of 1999, these four core IT occupations employed over 2.2 million people.

## **Counting IT workers**

The U.S. government is the authoritative source of statistics on the labor force. Three independent estimates of the number of core IT workers are available from federal sources:

- The most up-to-date data (through 1998) are provided by the *Current Population Survey* (CPS), a joint project of the U.S. Bureau of Labor Statistics (BLS) and the Bureau of the Census. Information comes from monthly surveys of 47,500 households.
- BLS's *Industry/Occupation Matrix* is a major source of data for the biennial *U.S. Occupational Outlook Handbook*. Assembled from surveys of establishments, the matrix contains employer-based estimates of occupation by industry. It is the only well-established source for forecasts of occupational trends. The most recent edition of the matrix was released in late 1997 and provides data for 1996 plus projections to 2006.
- SESTAT, the Scientists and Engineers Statistical Data System, is a project of the National Science Foundation. Updated every two years, SESTAT is scheduled to add new data from 1997 during the next few months, but when the work for this report was done, the most recent numbers were those for 1995. SESTAT contains information on many characteristics of IT workers, and supports the production of special tabulations for specific research projects.

<sup>1</sup> Information Technology Association of America (ITAA), cited in Carolyn M. Vereri, "Here Today, Jobs of Tomorrow: Opportunities in Information Technology," *Occupational Outlook Quarterly* 42:3 (Fall, 1998), pp. 44-57.

<sup>2</sup> For example, see *Help Wanted: The IT Workforce Gap at the Dawn of a New Century* and *Help Wanted 1998: A Call for Collaborative Action for the New Millennium*, both from the Information Technology Association of America (Arlington, Virginia, 1997 and 1998).

<sup>3</sup> All of the previously cited materials use this definition of the core IT professions. A slightly broader set of occupations is discussed in Vereri's text, *op.cit.*, but her statistics are for the "core" fields only.

Data on core IT occupations from all three of these sources are presented in the exhibit below. The first section of this table compares results from the CPS in 1995 (annual estimates are averages of the twelve monthly figures) with NSF's SESTAT data for the same year. For the computer scientists, computer engineers, and systems analysts, agreement between the two sources is good, especially when differences between these data bases are considered. Information in the CPS comes from face-to-face interviews with one representative at each household, who supplies information on occupations for everyone at that location. Thus some of the data are second-hand. The personnel who conduct the CPS are trained to deal with this problem, but Census staff acknowledge that they might get different information if they were able to talk directly to every jobholder.

Methods for collecting SESTAT's data are different. NSF conducts three separate surveys using a mix of mailed questionnaires and telephone interviews: the National Survey of College Graduates, additional National Surveys of Recent College Graduates, and the Survey of Doctorate Recipients. Data from these separate studies are then com-

bined to yield estimates for the entire scientific and engineering workforce. Unlike the CPS, everyone in the SESTAT data base has been contacted directly, so information about their occupations is never filtered through intermediaries like other household members.

There are some gaps in SESTAT's coverage of IT workers. The data exclude persons who have neither a U.S. bachelor's degree nor experience before 1990 in a science or engineering job. They also omit those with nonscience or nonengineering bachelor's degrees earned after 1993 and who did not have jobs in science or engineering before April of that year. SESTAT's numbers do include 23,000 computer science professors.

NSF does not consider programmers to be scientists or engineers, so SESTAT yields only a partial count of those workers, limited to people with a bachelor's or higher degree (and as noted above, not everyone with those degrees is included). For this reason, the CPS data are better than SESTAT for estimates of the number of programmers.

The next section of the table compares CPS data for the following year, 1996, with BLS Industry/Occupation Matrix results for that year. Fewer computer scientists, computer engineers, or systems analysts are reported

by the establishment surveys done for the matrix than by the household interviews conducted for the CPS. At least a portion of this difference may be due to the use of a separate job title in the establishment surveys, grouped with managerial and administrative occupations, for engineering, science, and computer systems managers. In 1996, 343,000 persons were classed in this group by their employers. Some IT professionals who think of themselves as computer scientists or other "core" IT workers, or who might be reported in those occupations by other household spokespersons in the CPS interviews, may be counted by their employers as technical managers.

The CPS and BLS matrix data for 1996 are in close agreement on the number of programmers. In general, we think the Current Population Survey statistics are a good indicator of the size of the core IT workforce.

### *Growth of the core occupations*

The third part of the table provides CPS data for 1998. The average for the first three quarters of the year is our best estimate (as of the time this report was prepared in December, 1998) of the eventual annual twelve-month average for the year. The most recent monthly results, for November,

## *Estimates of the Number of Core IT Workers in the U.S.*

*NOTE: all figures rounded to nearest 1,000*

<i>Year and Source</i>	<i>Computer Scientists, Computer Engineers, &amp; Systems Analysts</i>	<i>Programmers</i>	<i>Total</i>	<i>Notes</i>
<i>1995: Current Population Survey</i>	<i>933,000</i>	<i>553,000</i>	<i>1,486,000</i>	
<i>1995: SESTAT (NSF)</i>	<i>910,000</i>	<i>205,000</i>	<i>1,115,000</i>	<i>College graduates only. Programming is not treated as an S&amp;E field by NSF. Includes 23,000 computer science professors</i>
<i>1996: Current Population Survey</i>	<i>1,093,000</i>	<i>561,000</i>	<i>1,654,000</i>	
<i>1996: BLS Industry/Occupation Matrix</i>	<i>934,000</i>	<i>568,000</i>	<i>1,502,000</i>	<i>343,000 engineering, science, &amp; computer systems managers are grouped with Managers &amp; Administrators. See text</i>
<i>1998: Current Population Survey (average, first three quarters)</i>	<i>1,482,000</i>	<i>602,000</i>	<i>2,084,000</i>	
<i>1998: Current Population Survey (latest results for November)</i>	<i>1,549,000</i>	<i>668,000</i>	<i>2,217,000</i>	
<i>2006: BLS Industry/Occupation Matrix</i>	<i>1,937,000</i>	<i>697,000</i>	<i>2,634,000</i>	<i>498,000 engineering, science, &amp; computer systems managers are grouped with Managers &amp; Administrators</i>

1998, are the source of our estimate of “over 2.2 million people” in core IT occupations by early 1999.

The last part of the table supplies BLS matrix projections for the core IT fields in 2006. The Bureau believes that computer scientists, computer engineers, and systems analysts will be the three fastest growing occupations in the nation. They are also expected to be among the fields that will generate the largest absolute numbers of new jobs during the ten-year period projected by BLS — over a million new positions by 2006. Much of this growth has already been realized since these forecasts were made in 1997.

At the same time, BLS projects only minor growth for programmers. The forecast of 697,000 people employed in this occupation in 2006 is only 23 percent higher than the Bureau’s estimation of actual employment in this field in 1996. These expectations of very rapid growth for the “higher” IT professions, but much slower growth for the programmers, are consistent with historical trends for these occupations, summarized in the graph at the right. Since 1983, the numbers of computer scientists, computer engineers, and systems analysts counted by the CPS have increased 537 percent (using the average for the first three quarters of 1998 as a stand-in for the eventual final figure for the entire year, which will be even higher). During the same period, growth for programmers has been much slower, only 36 percent. What accounts for this discrepancy between programmers and the other core IT occupations?

### Why growth in programming is slow

The disconnect between demand for programmers and that for other kinds of IT specialists is acknowledged by the industry. To illustrate, a recent trade publication<sup>4</sup> reports that “An August survey of 100 contracting and consulting firms by the Information Technology Association of America (ITAA) showed that the ‘overwhelming majority’ have more programmers than they can use.” The report notes that demand is for project managers, not “worker bees,” and it observes that “The supply of year 2000 programmers has been bigger than expected because many corporations outsourced coding to

offshore companies, vendors developed year 2000 tools that automated much of the coding process, and schools and training facilities graduated a bumper crop of programmers geared to the job.”

These remarks suggest some of the reasons why growth is slow for the programmers. Higher-level computer scientists design software, identifying key variables, specifying program modules for manipulations of data, and determining flows of operations and linkages needed to carry out a set of desired tasks. Once this work has been done, lower-level coding can be broken up into many separate pieces and farmed out, and increasingly that work is going to inexpensive job shops in places like Bangalore, India.

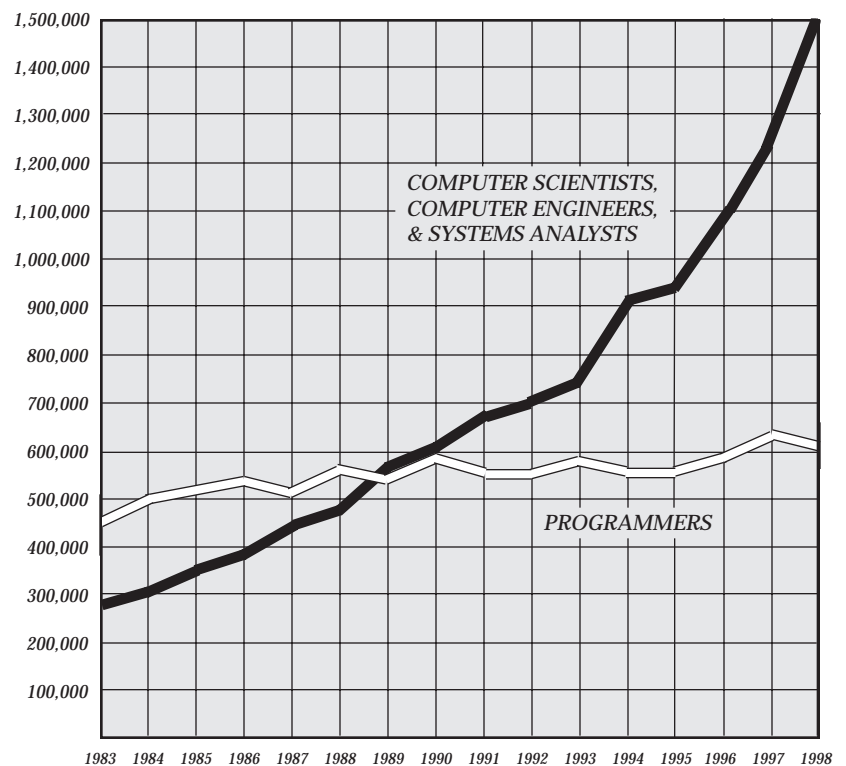
Furthermore, programming is itself being automated, as illustrated by the year 2000 tools mentioned in the news report cited above. Tools such as CASE (Computer Aided Software Engineering) allow practitioners to concentrate on the special aspects of software development projects, eliminating much of the drudgery associated with the creation of programs. The use of similar tools in

other branches of engineering has greatly reduced the need for support from draftsmen and other technicians. With computer-aided design, a single professional can do work that once required whole teams of people. This applies to software engineering just as it does to other types of practice.

Tools like CASE create pressures from above that reduce the need for programmers, so that more senior people can use automated systems to create code instead of passing much of this work to lower-level assistants. Continued development of other kinds of tools creates similar pressures on programmers from below. Some recent comments on the profession from BLS illustrate this trend: “Advanced programming languages and new object-oriented programming capabilities are increasing the efficiency and productivity of both programmers and users. The transition from a mainframe environment to a primarily PC-based environment has blurred the once rigid distinction between the programmer and the user. Increasingly, adept users are taking over many of the tasks previously performed by programmers. For

## Growth in Core IT Occupations, 1983-1998

Source: Current Population Survey annual averages (first three quarters for 1998)



<sup>4</sup> Kathleen Melymuka, “Millennium Superstars,” *Computerworld*, October 5, 1998.

example, the growing use of packaged software, like spreadsheet and data base management packages, allows users to write simple programs to access data and perform calculations.”<sup>5</sup>

Programming remains at the heart of all IT work and it is not going to disappear as a profession. Demand for IT specialists is so strong that growth is still forecast for programmers despite effects of outsourcing and automation. Needs for “worker bees” may be diminishing, but interest in the queens and kings of programming is as great as ever. At the top of the field are the gifted practitioners described by Randall E. Stross: “The best programmers are not marginally better than merely good ones. They are an order of magnitude better, measured by whatever standard: conceptual creativity, speed, ingenuity of design, or problem-solving ability.”<sup>6</sup> At this level, programming is an elite profession.

It is also a field that is remarkably indifferent to formal education. As Clifford Adelman of the U.S. Office of Educational Improvement puts it, “The computer field has honored competence, content and creativity more than credentials.”<sup>7</sup> The latest editions of the *U.S. Occupational Outlook Handbook* rightly advise that college degrees have become a standard requirement for programmers, but nevertheless newspaper reports continue to tell us about practitioners without degrees, in their twenties or even their teens, making \$50,000 a year or more.<sup>8</sup>

Demand for software development skills is so strong that data on the placement of recent college graduates show that programming talent is what many employers seek when they hire computer scientists, electrical engineers, or math majors. These workers

may not be called programmers, but programming is a large part, in some cases the most crucial part, of what many of them have been hired to do.<sup>9</sup>

### Where core IT people work, and other demographic traits of the workforce

The BLS Industry/Occupation Matrix provides data on the sectors where IT specialists work (see table, below). Automation has spread throughout the economy and these workers are found everywhere, not just in the IT industry itself. The workforce is concentrated, however, in computer and data processing services, a single industry category that employs more of these people than does all of manufacturing. Like the fields on which it depends, this is the fastest growing employment sector in the nation. Other sectors with large shares of IT workers include finance, wholesale and retail trade, and government.

Using Current Population Survey data for the 2,084,000 persons in the core IT professions in 1998 (again, using the average for the first three quarters of the year):

- 73 percent of these workers are men, compared to a little more than half of the entire civilian labor force.
- On the average, they are 37 years old — younger than the U.S. labor force as a whole.
- They are highly educated. Just six percent have only a high school diploma. 26 percent, mostly programmers, have associate or other two-year vocational degrees. 48 percent have bachelor’s degrees; 19 percent have master’s, doctorate, or other graduate degrees.

The next report in this series will examine the education of core IT workers in more detail. Less than half of them have completed formal training at the bachelor’s level in appropriate IT disciplines, even when minor areas of concentration are counted as well as the major fields associated with each degree. Of all those people who do have this kind of training, more than a third are *not* IT workers.

<sup>9</sup> See Weatherall, *op. cit.*, and also his similar 1998 report, “The Strongest Market in Years for New Graduates,” *ENGINEERS* 4:2 (April, 1998), pp. 2-9.

<sup>5</sup> “Computer Programmers,” *U.S. Occupational Outlook Handbook 1998-99* (Washington: U.S. Department of Labor, 1998).

<sup>6</sup> *The Microsoft Way* (Boston: Addison-Wesley, 1996), p. 39, cited in Robert K. Weatherall, “A Booming Market for New Graduates,” *ENGINEERS* 3:2 (April, 1997), p. 11.

<sup>7</sup> *Leading, Concurrent, or Lagging: The Knowledge Content of Computer Science in Higher Education and the Labor Market* (Washington: U.S. Department of Education, 1997), p. 40.

<sup>8</sup> For example, see Peter Behr, “Getting It Right on the Money,” *Washington Business*, September 21, 1998, p. 12.

## Employment Sectors for Core IT Workers

NOTE: rounded to nearest 1,000. Due to rounding, components may not sum to totals

Employment Sector	Computer Scientists and Systems Analysts	Computer Engineers	Programmers	Total
<b>Manufacturing:</b>				
Electrical & Electronic plus Precision Instruments	26,000	38,000	13,000	77,000
Computers & Office Equipment	16,000	15,000	14,000	45,000
Chemicals, Drugs, Plastics & Petroleum Products	19,000	3,000	6,000	28,000
Aerospace & Shipbuilding	15,000	4,000	7,000	25,000
All Other Durable Goods	26,000	7,000	14,000	48,000
All Other Nondurable Goods	30,000	1,000	14,000	44,000
<b>Subtotal, Manufacturing</b>	<b>132,000</b>	<b>69,000</b>	<b>67,000</b>	<b>268,000</b>
<b>Services:</b>				
Computer & Data Processing	136,000	76,000	192,000	404,000
Finance, Insurance & Real Estate	82,000	4,000	78,000	165,000
Wholesale & Retail Trade	61,000	—	41,000	102,000
Engineering & Research/Testing Laboratories	18,000	21,000	21,000	59,000
Management & Accounting	21,000	11,000	20,000	52,000
Health	26,000	2,000	11,000	38,000
Communications & Broadcasting	13,000	3,000	10,000	26,000
Electric & Gas Utilities	11,000	1,000	4,000	16,000
All Other Services & Utilities	70,000	12,000	69,000	151,000
<b>Subtotal, Services</b>	<b>437,000</b>	<b>129,000</b>	<b>447,000</b>	<b>1,013,000</b>
<b>Government:</b>				
Federal (including Postal Service)	59,000	3,000	8,000	70,000
State & Local	46,000	—	26,000	72,000
<b>Subtotal, Government</b>	<b>105,000</b>	<b>3,000</b>	<b>34,000</b>	<b>141,000</b>
<b>All Employment Sectors Combined</b>	<b>674,000</b>	<b>201,000</b>	<b>548,000</b>	<b>1,422,000</b>
Self Employed	44,000	15,000	20,000	79,000
<b>Total</b>	<b>718,000</b>	<b>216,000</b>	<b>568,000</b>	<b>1,502,000</b>

Source: Bureau of Labor Statistics, Industry/Occupation Matrix, baseline data for 1996