

Science and Technology Salaries: Trends and Details, 1995-2005

ABSTRACT

Data from Current Population Surveys (CPS) indicate that during the past decade, trends in the salaries of scientific, technological, engineering and mathematical (STEM) workers have mirrored movements in pay for the entire U.S. labor force. Between 1995 and 2005, both groups obtained inflation-adjusted improvements of about six percent in their purchasing power. These changes tended to peak around 2002, and since that time, the value of base pay in most occupations has leveled off or diminished slightly.

This report provides detailed information on base pay for all years from 1995 to 2005 for 15 major STEM occupations plus selected non-STEM com-

parison groups. Data for some, but not all, of these years are also provided for some additional STEM professions, and results from other detailed compensation surveys are used to illustrate additional uses of salary statistics. An appendix is included that explains how the federal statistics have been applied, including comments on changes in the Standard Occupational Classification (SOC) codes adopted by the CPS in 2003.

This is the fifth report in a series on recent trends in the STEM professions. All of these materials, including detailed data archives, are available on the World Wide Web at <http://www.cpst.org>.

Exhibit 1 on the next two pages of this report provides information on salary trends from 1995 through 2005 for 28 scientific and technical occupations, plus a selection of broader STEM divisions and non-STEM comparison groups. The data for broad STEM divisions (such as "All engineers") include both the subgroups listed in the table and additional professions that are too small to support separate salary estimates of their own (e.g., agricultural engineering). Estimates for some of the STEM occupations are not available for all 11 years in the time series. The main reason for missing data is a major revision in 2003 in the occupational classification systems used by the U.S. government to collect these numbers; for details, see the appendix at the end of this report.

All of the numbers in this exhibit have been converted to constant 2005 dollars, to eliminate effects of inflation on compensation scales, and so most of the trend lines for the past decade are nearly flat (see Exhibit 2 on page 4). Overall, changes in the compensation of people in science

and technology resemble those for the U.S. labor force as a whole. When allowance is made for the effects of rises in the cost of living, the entire U.S. workforce, including those in the STEM professions, obtained small gains in actual purchasing power of about six percent over the 10-year period. Of course, pay scales for most STEM occupations are well above those for the entire U.S. labor force. For all workers, median salaries during the decade range from \$31,500 to \$34,500 per annum, but the medians for people in the professions run from \$47,000 to \$49,500, and those for the combined set of all STEM workers range from \$53,000 to \$58,000. Medians, or 50th percentiles, are preferred measures of central tendency for statistics on income, because they are not influenced by extreme values at the top or the bottom of a distribution of dollars.

In many STEM occupations, pay is closer to the scales for all professionals. The main cause of higher salaries for all STEM workers combined is that the higher rates are concentrated in the two largest sets of STEM specialists: mathematical and computer scientists, with values between \$54,500 and \$61,000 during the decade, and engineers, where the medians range between \$61,500 and \$65,500. In most cases, improvements in buying power peaked during the initial years of this century, and since then the purchasing power of these salaries has tended to remain flat or to decline slightly. One notable change in the relative levels of pay across different occupations did occur during the decade: overall median salaries for management and executive occupations began to exceed those for people in the professions. Growth in the pay of chief executives has not slowed down at all.

These data measure typical market values for salaries obtained by people in different occupational groups. Notice the recent trend of leveling off or small drops
(text continues on page 4)

New Developments at CPST

We would like to thank the Alfred P. Sloan Foundation for agreeing to extend the STEM Workforce Data Project through the end of 2007, and to support a conference that will examine the policy implications of data on the U.S. STEM workforce.

Dr. Lisa Frehill, CPST's new executive director, has joined the project. Her predecessor, Eleanor Babco, who retired at the beginning of 2006, continues to serve as one of the project's principal investigators.

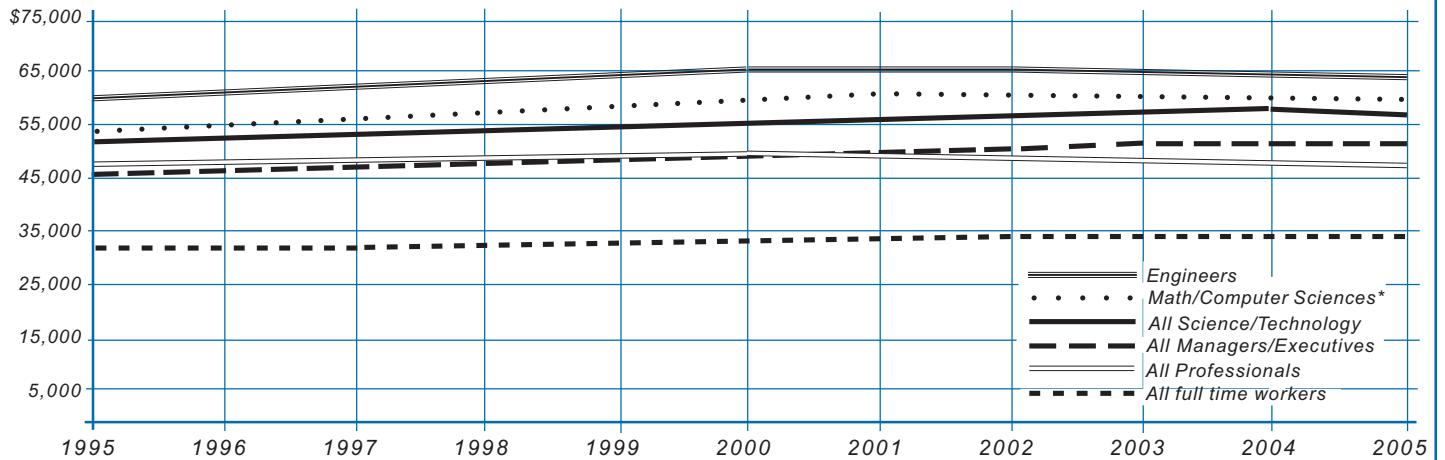
Exhibit 1: Median Annual Salaries for Full-Time STEM Workers, in Constant 2005 Dollars, 1995-2005

Occupations	1995	1996	1997
Comparative aggregates and occupations:			
<i>All employed persons, 16 years and over</i>	\$32,000	\$31,500	\$32,000
<i>All managerial and professional occupations</i>	47,000	46,500	46,500
<i>All executive, administrative, and managerial occupations</i>	45,500	45,000	46,000
<i>Chief executives</i>			
<i>Computer and information systems managers</i>			
<i>Engineering managers</i>			
<i>All professional occupations</i>	48,000	47,000	47,500
<i>Lawyers</i>	75,000	74,500	74,000
<i>Physicians and surgeons</i>	76,000	73,500	71,000
<i>Secondary school teachers</i>	45,000	45,000	46,000
STEM totals:			
<i>All combined</i>	53,000	53,000	53,500
<i>All other than social scientists</i>	53,500	53,500	54,000
<i>All other than technicians</i>	56,500	56,500	57,500
<i>All other than social scientists or technicians</i>	57,500	57,500	58,000
STEM subgroups and selected occupations:			
<i>Life, physical, and social scientists and technicians</i>	46,000	44,000	45,500
<i>Natural scientists</i>	51,000	49,500	51,000
<i>Selected specialties:</i>			
<i>Biological and life scientists</i>	47,000	45,000	42,500
<i>Chemists and materials scientists (except biochemists)</i>	52,500	55,000	57,000
<i>Medical scientists</i>	46,000	42,500	41,000
<i>Social scientists and urban planners</i>	46,000	43,500	46,500
<i>Selected specialties:</i>			
<i>Economists</i>	50,000	46,500	53,500
<i>Market and survey researchers</i>			
<i>Psychologists</i>	41,000	41,000	41,000
<i>Science technicians</i>	36,500	33,500	33,000
<i>Selected specialties:</i>			
<i>Biological technicians</i>	27,500	31,500	30,500
<i>Chemical technicians</i>	45,500	39,000	39,000
<i>Mathematical and computer scientists (including programmers)</i>	54,500	55,000	56,000
<i>Selected specialties:</i>			
<i>Computer scientists and systems analysts</i>	58,000	57,500	58,000
<i>Computer software engineers</i>			
<i>Computer support specialists</i>			
<i>Database administrators</i>			
<i>Network and computer systems administrators</i>			
<i>Network systems and data communications analysts</i>			
<i>Operations and systems researchers and analysts</i>	50,500	53,000	55,000
<i>Computer programmers</i>	49,500	50,000	53,000
<i>Engineers and engineering technicians</i>	55,000	54,500	54,500
<i>Engineers</i>	61,500	61,500	62,000
<i>Selected specialties:</i>			
<i>Aerospace engineers</i>	65,000	71,000	70,500
<i>Chemical engineers</i>	70,500	65,500	64,500
<i>Civil engineers</i>	56,000	57,000	60,000
<i>Computer hardware engineers</i>			
<i>Electrical and electronics engineers</i>	63,500	64,500	62,500
<i>Industrial engineers</i>	56,000	54,500	55,000
<i>Mechanical engineers</i>	61,500	62,000	61,500
<i>Engineering Technicians</i>	40,000	39,000	39,000
<i>Selected specialties:</i>			
<i>Electrical and Electronics Technicians</i>	41,000	39,500	41,500
<i>Drafters</i>	40,500	39,000	37,500
<i>Surveying and Mapping Technicians</i>	36,000	30,000	37,000

NOTES: empty cells = data unavailable. Source: U.S. Bureau of Labor Statistics, special aat-39 data series for median weekly earnings of full-time wage and salary workers by detailed occupation and sex, adjusted to yield full-year equivalents (weekly earnings times 52 weeks), then converted to constant 2005 dollars and rounded to the nearest \$500. For details, see the appendix at the end of this report and the data archive for this project at <http://www.cpst.org>.

1998	1999	2000	2001	2002	2003	2004	2005
\$32,500 47,500 47,000	\$33,500 48,500 48,500	\$34,000 49,500 49,500	\$34,000 49,500 49,500	\$34,500 50,000 50,000	\$34,000 49,000 53,000 86,000 77,500 82,000	\$34,500 49,500 52,000 89,500 77,500 97,000	\$34,000 48,500 52,000 95,500 74,500 93,000
47,500 75,500 72,000 46,000	49,000 71,000 77,000 46,000	49,000 77,000 79,000 46,000	49,000 80,000 72,000 44,500	49,500 84,000 83,500 45,000	46,500 86,000 77,500 47,000	47,500 84,000 89,000 47,500	47,000 83,500 80,500 45,500
54,000 54,500 58,000 58,500	55,500 56,000 59,000 60,000	56,000 56,500 59,500 60,500	57,000 57,000 60,500 61,500	57,500 58,000 61,000 62,000	56,500	58,000	56,500
46,500 51,500 46,000 55,000 47,000	47,000 53,000 46,500 59,000 44,000	48,500 54,000 47,000 55,500 45,500	47,500 51,500 42,500 54,500 46,500	47,500 54,000 52,500 57,000 54,500	49,000 48,000 52,500 47,500	51,500 50,000 56,500 55,000	50,000 46,500 58,500 48,500
47,000 56,000 42,500	45,000 52,500 41,000	48,500 51,500 45,500	50,000 54,000 47,000	45,500 48,000 43,000	 46,500 55,000	 50,500 54,500	 52,000 50,000
34,500 30,000 38,500	35,500 30,500 41,500	35,500 29,500 43,000	36,000 30,500 43,500	37,000 34,000 38,500	 45,000	 44,500	 36,500
57,000 59,500	58,500 61,500	58,000 59,500	60,000 63,000	61,000 63,500	58,000 55,000 68,500 41,500 59,000 54,000 57,500 56,500 59,000	60,000 55,000 72,500 45,000 59,500 56,000 55,000 58,000 60,000	59,000 56,500 73,000 43,000 58,000 55,000 65,000 65,500
54,500 52,500	52,500 54,500	52,500 55,500	53,500 54,500	54,000 57,500	56,500 59,000	58,000 60,000	65,000 56,500
55,000 62,000 71,000 63,500 60,000 66,000 55,500 62,000	56,500 63,500 73,000 77,000 59,000 65,500 59,000 63,000	57,500 65,000 75,000 71,500 60,000 67,500 55,500 66,500	57,500 65,500 71,500 77,500 59,500 67,500 60,500 65,000	58,500 65,500 77,000 74,000 59,500 69,000 58,500 65,500	58,000 64,000 75,000 69,000 63,500 60,000 73,500 59,500 64,500	59,000 65,000 72,500 65,500 61,000 71,500 68,500 62,000 64,000	57,500 63,500 71,000 59,000 73,000 70,000 60,500 65,500
39,500 40,000 40,000 41,500	40,500 42,000 40,500 34,000	41,000 42,000 41,000 37,500	41,000 41,500 40,500 38,000	42,500 45,000 40,500 39,500	42,500 42,000 36,000	43,000 41,500 36,000	41,000 40,000 38,000

Exhibit 2: Trends in Annual U.S. Base Salaries, in Constant 2005 Dollars, 1995-2005*



* For sources of these data, including precise values for each of the line graphs in this chart, see Exhibit 1 on pages 2 and 3. In all years, data for Math and Computer Science includes information on computer programmers.

(text continued from page 1)

in the gains in purchasing power obtained earlier in the decade. One wonders if data for 2006 and 2007 will revert back to the favorable compensation trends experienced during the dot-com / telecommunications bubbles, or instead continue to signal possible stagnating or declining real values of pay for at least some people in STEM professions. Certainly there are signs that prowess in science and technology is not an especially respected element of current U.S. culture. In some business circles, technical proficiency seems to have become regarded as a commodity that can be easily acquired whenever necessary from just-in-time contractors.

Levels of concern have been rising about current business trends and other pressures that could constrain scientific and technical salaries, such as possible consequences of outsourcing, offshoring, and the employment of foreign workers in the USA. Despite all this, overall levels of employment in STEM professions have held up in recent years. Some observers of the scene say that the numbers may be propped up by guest workers and may obscure serious problems of underemployment among experienced natives. For more information, see the first and fourth reports in this series; for a look at the policy debates, compare the web sites www.ita.org/policy/immigration/ and <http://heather.cs.ucdavis.edu/ita.html>.

As noted in the introduction to this report, one broad occupational group with earnings estimates that did not level off or decline after the turn of the

century was the set of executives, administrators, and managers, where the value of median salaries ranged from \$45,000 to \$53,000 per annum during the decade. Within STEM professions, **electrical and electronics engineers** may also seem to be an exception to the general leveling-off trends, but changes in U.S. occupational coding systems that were applied to these data after 2002 have had such strong influences on the composition of this group that these changes in definitions are a more plausible reason for the jump in the general levels of estimated EE earnings for 2003 and beyond.

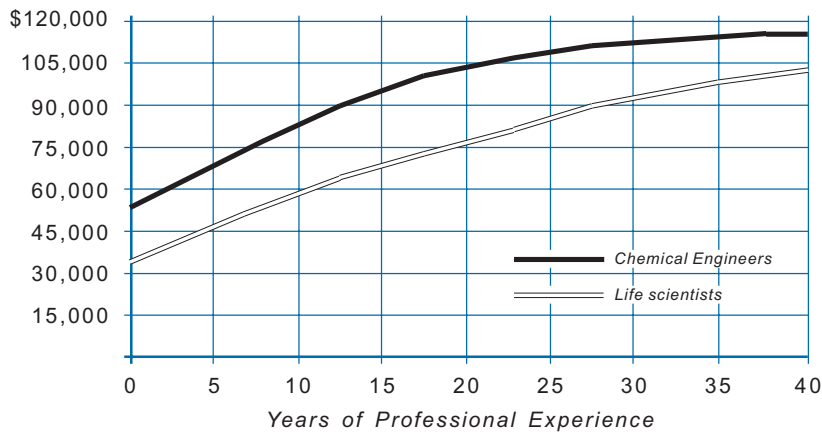
The introduction also noted that among broad types of STEM occupations, earnings are highest for engineers and mathematical and computer scientists. Significant variations can be observed in levels of earnings within each of these two general groups. Recently, **aerospace, computer, and electrical and electronics engineers** have reported higher median salaries than other engineering specialties. At the same time, salaries of **chemical engineers**, who have been among the more highly paid engineers in the past, are now headed down. Within mathematical and computer sciences, **computer software engineers** report notably higher earnings than other occupations in the broad math and computer science group, while **computer support specialists** report much lower levels of pay.

The influence of changes in 2003 in the federal occupation codes used for these surveys of earnings was noted above for the profession of electrical and electronics engineering. The definitions of other STEM occupations

are also likely to have changed so much that estimates of their earnings have been affected. More than half of the persons formerly grouped with **operations and systems researchers** have been reclassified into other occupations, mostly as **computer systems analysts**, and this change is likely to be an explanation for the rise in median levels of pay for operations researchers. About 17 percent of those who were formerly grouped with **psychologists** are now classed as counselors or social workers, professions that are likely to be lower paid, and this may explain a rise in levels of median pay for psychologists in 2003 and beyond.

Definitions of other STEM specialties have been changed in the new set of occupational codes, but in those cases, reported median salaries have not been so greatly affected. Over three quarters of the people classed as **economists** in earlier versions of the federal occupational coding system are now assigned to a new set of **market and survey researchers**, but estimates of general salary levels have not been greatly changed, at least for the large market research group. One cannot know what results now apply to the economists themselves, who are too few in numbers in these federal samples to support separate estimates of their pay. Outside STEM professions, some of the people who were formerly classed as secondary school teachers are now treated as special educators, coaches, middle school teachers, or other types of specialized educators, so the revised set of secondary teachers is more homogeneous; again, however, this does not seem to have led to large effects on estimates of median earnings.

Exhibit 3: Median Salaries in 2005 of Chemical Engineers and Life Scientists, by Levels of Experience



Source: adapted from Tables 2-68 and 3-15 in CPST, *op. cit.* Original data sources are the American Institute of Chemical Engineers, *AIChE 2005 Salary Survey*, and Abbott, Langer & Associates, *Compensation of Life Scientists in the United States of America, 2005*. Curves are smoothed to allow for effects of sampling errors within experience categories.

Looking at Earnings In More Detail

The numbers in Exhibit 1 are less satisfactory as useful benchmarks for individuals. As with averages or other measures of central tendency, they only describe hypothetical “typical cases” that are not likely to provide a good match to the specific circumstances that need to be considered in assessments of most actual salary situations. A practitioner may be younger than most, or older, or located in an especially costly metropolitan area. Training varies, as does demand for different specialties and skills. Because so many factors can influence what people are paid, seekers of data on compensation want information that is detailed and up-to-date. Students want to know which career choice will match their skills and provide good income. Experienced people seek information that can help them negotiate effectively in performance reviews. Salary administrators look for data on scales of pay for very specific kinds of people.

Most federal sources of information on salaries must deal with the entire labor force, and it is not possible for such broad projects to assemble data on all of the detailed conditions influencing pay that users may seek. For STEM workers, the SESTAT data system maintained by the National Science Foundation provides somewhat better resources for examinations of compensation, but since the turn of the century, updates of SESTAT have been infrequent. The STEM Workforce Data Project will issue a report on SESTAT in 2007.

The best sources of more detailed information on STEM compensation are dedicated surveys, often sponsored by professional and technical societies or by industry associations, that deal with more narrowly specified professions or employment sectors. Every two years, the Commission on Professionals in Science and Technology releases a good digest of findings from these surveys (*Salaries of Scientists, Engineers and Technicians*, Washington, D.C., CPST; the 21st edition was released in November 2005 and includes data for that year). This section of the present report draws upon these kinds of sources to illustrate some additional aspects of data on pay.

Maturity curves. Experience is one obvious factor influencing pay. A common tool used to express relationships between experience and salaries is the maturity curve, which plots the distribution of compensation across years of service. Exhibit 3, above, provides two simple examples of maturity curves, one for **chemical engineers**, the other for **life scientists**. Although overall pay scales are considerably higher for the engineers, in other respects the two curves display some similar characteristics. Levels of pay rise most rapidly in the early years of practice and begin to level off for the most experienced people.

Exhibit 3 changes the focus of data on earnings from measures that apply only to large groups—for example, overall salary medians for entire occupations—to numbers for specific categories of people in these occu-

pations, such as rates for persons with different amounts of experience. Many studies of the earnings of STEM professionals provide similar details, for persons with particular kinds of degrees, professional specialties, job duties, supervisory responsibilities, employer types, or geographic locations.

Some studies of compensation for selected professions or industries also provide information on earnings other than base salaries, which are only one of many possible sources of income for people in the STEM occupations. Other forms of compensation include several kinds of bonuses, stock options, income from patents, self-employment earnings or other kinds of supplementary income (significant for academics whose base pay is likely to reflect nine-month contracts and who may take on extra teaching or consulting assignments during the summer), and social security or other retirement pay from previous jobs (significant for retired military personnel, who may keep working for many more years). Only the most detailed sources of data on technical compensation, such as the membership surveys done since 1972 by IEEE-USA, the U.S. branch of the international Institute of Electrical and Electronics Engineers, cover all these sources of overall compensation.

Substantial variations in the pay of people with otherwise similar characteristics. In a discussion of recent data on the pay of **mechanical engineers**, CPST’s latest report on STEM salaries notes that Abbott, Langer & Associates’ 2005 salary survey for this profession yields estimates of median incomes of \$88,000, “with 10 percent of mechanical engineers earning less than \$55,000 and 10 percent earning more than \$139,731” (*ibid.*, p. 122). These wide ranges of pay for otherwise similar kinds of people are common in salary surveys of STEM professionals, and persist down to the level of groups that are closely matched with respect to their degrees, professional responsibility, experience, and more.

Exhibit 4 on the following page provides some specific examples of this tendency for large disparities in compensation. What are the reasons for these differences in the pay of similar kinds of people? Some of these variations are due to other influences on earnings which can be measured with surveys but cannot be added to tabulated presentations of data without exceeding limits imposed by the need

Exhibit 4: Selected Examples of the Persistence of Wide Variations in Pay Within Highly Matched Subsets of STEM Occupational Groups

Group	Lowest Decile	Median	Highest Decile	Source
1. Non-supervisory engineers with BS degrees, employed in 1998 by private consulting and engineering services companies:				<i>Engineers' Salaries: Special Industry Report, 1998 (Washington, D.C.: Engineering Workforce Commission of the American Association of Engineering Societies). Smooth-curve data from p. 184.</i>
<i>All levels of experience</i>	\$38,000	\$55,900	\$81,150	
<i>Less than one year of experience</i>	30,350	35,350	42,200	
<i>9-11 years of experience</i>	43,050	53,650	65,400	
<i>24-26 years of experience</i>	53,600	71,850	91,500	
2. Chemists with doctoral degrees, working in industry in 2000:				<i>Industrial Chemists 2000 (Washington, D.C.: American Chemical Society, 2001), p. 43.</i>
<i>5-9 years of experience</i>	55,500	69,000	80,500	
<i>10-14 years of experience</i>	59,300	73,550	91,000	
<i>15-19 years of experience</i>	63,000	81,000	106,000	
<i>20-24 years of experience</i>	68,959	90,350	125,000	
3. Electrical and electronics engineers with masters degrees, working in the computer industry in 2001:				<i>IEEE-USA Salary and Fringe Benefit Survey, 2001 Edition (Piscataway, N.J.: Institute of Electrical and Electronics Engineers, 2001), p. 3-17.</i>
<i>0-9 years of experience</i>	47,000	76,100	120,000	
<i>10-19 years of experience</i>	65,000	96,000	150,968	
<i>20-29 years of experience</i>	77,000	100,850	161,000	

to have sufficient numbers of cases for the computation of reliable estimates of details. Examples of such additional factors include geographic variations in pay scales, differences in job duties and responsibilities, and differences between large and small employers. Even if all those kinds of factors could also be controlled and included in a single comprehensive tabulation of salaries for at least many of the specific situations of interest posed by users, the results would require space the size of a telephone book to present and would still fail to allow for a host of additional influences on pay that most surveys cannot capture at all, notably differences in the sheer skill of particular individuals, differences in negotiating skills, and plain luck, either good or bad.

Note what these large variations in the salaries of otherwise similar people mean: the top performers in almost any STEM specialty can match or exceed the earnings of run-of-the-mill people in other fields that may seem to offer higher pay. For those who are so inclined, this can be a potent justification, supportable with hard data, for the notion that a good career strategy is simply to find something that you like to do and which you are able to do reasonably well.

Because most serious seekers of intelligence on STEM compensation need to allow for a number of distinct factors that influence pay, the most advanced systems now available for the presentation of data on STEM salaries do not rely on tabulated sets of results at all. Instead, they use mathematical models, based on statistical regression methods, to estimate ranges of pay for people in specific employment situations. Initially developed at IEEE-USA, these tools use data on many different factors influencing salaries, including experience, degrees, detailed specialties, job duties, employer sizes and types, and geographic locations. They then generate a set of results for the specified employment situation as a whole (see Exhibit 5 on page 7 for an example).

Literally thousands of employment situations can be tested by these systems. Outputs include percentile range data, which can be used to make allowances for otherwise unmeasured influences on pay, such as the skill of a jobholder, relative to his or her peers. Advanced versions of these systems, such as the set of salary comparators used by the American Chemical Society (ACS), include separate estimation models for recent graduates and academic chemists as well as basic salary com-

parison tools for people employed by industry or government. The ACS systems are web-based and are available only to the society's members. IEEE-USA supports a similar service which does not include separate models for academics, but does generate results for "income from primary sources" (which includes bonuses and self-employment income) as well as estimates for base salaries alone. Other wrinkles are possible; for example, similar approaches can probably be used to generate highly customizable results tailored to the needs of industry compensation analysts. So far as we know, no other systems like these are yet in operation, but sooner or later, we believe they will become a standard.

Appendix: Technical Notes

The STEM Workforce Data Project has made repeated use of a set of special tables, prepared by the U.S. Bureau of Labor Statistics, which merge results from monthly Current Population Surveys (CPS) into sets of annual estimates. One of these, the "aat39" series, is a source of data on earnings. Copies of these materials, along with a spreadsheet that provides precise details for all manipulations of the data, are archived at the STEM Workforce Data Project web

Exhibit 5: Example of Results From the 2002 Version of the American Chemical Society's Salary Comparator

(Note: this content taken directly from the final web page generated in a run of this system.)

Results: You tested the following employment situation:	Factor	Adjustment
Position: Non-academic	(None)	(None)
Experience (Years Since Bachelor's Degree): 2	(None)	(None)
Gender: Female	0.9208	(- 7.9%)
Highest Degree: Bachelor's	1.0000	(+ 0.0%)
Current Specialty: Agricultural/food chemistry	1.0000	(+ 0.0%)
Work Function: Analytical services, other than forensics	0.9401	(- 6.0%)
Employer Type: Agricultural chemicals manufacturing	1.0000	(+ 0.0%)
Employer Size: Less than 50	0.8462	(-15.4%)
Location: Boston Metro Area	1.0917	(+ 9.2%)

Note: adjustments are not applicable for the Position and Experience variables; the comparison system generates unique base pay figures for these conditions. Those estimates are then modified as needed to allow for other factors. Many specified factors will conform to general trends for chemistry as a whole. When this is the case, the situation will not call for statistically significant changes in estimated salaries.

Estimated Salary Range for This Situation:

High Decile	90th Percentile	\$ 49,970
	80th Percentile	\$ 44,849
	70th Percentile	\$ 41,499
	60th Percentile	\$ 38,852
Median (midpoint)	50th Percentile	\$ 35,384
	40th Percentile	\$ 34,231
	30th Percentile	\$ 32,047
	20th Percentile	\$ 29,652
Low Decile	10th Percentile	\$ 26,616
	Hourly Equivalent	Median Value

pages at <http://www.cpst.org> and may be downloaded by any reader of this report. The statistics were originally acquired from the Bureau's FTP web site (note that the usual "http" prefix does *not* apply to this URL: <ftp://ftp.bls.gov/pub/special.requests/lf/>).

A single monthly round of the CPS does not yield a large enough pool of cases to support estimates of the characteristics of workers in most STEM occupations, but if data for a full year of these monthly surveys are merged, the resulting dataset yields information on many more professions. Sampling for the CPS uses rotating panels of respondents who participate in more than one monthly round of the project, so the gain in the size of the database is well short of the 12-times jump that would be expected if entirely new samples were drawn for each monthly survey. The gain in numbers of available cases is still not large enough to support the generation of detailed salary results for many smaller STEM professions. That limitation is understandable. Most federal occupational surveys must cover the entire U.S.

labor force and must do this in ways that use tax dollars efficiently.

The merged CPS data provide estimates of median weekly earnings for full-time wage and salary workers. This excludes self-employed and part-time people, further reducing the size of datasets. Smaller occupations are especially subject to sampling errors, and so occasional departures from overall trends that might look like significant changes in pay may just be artifacts of the technical limitations of survey research; it is always best not to make too much of small exceptions to more general trends. As noted above, further adjustments of these weekly earnings data were carried out, converting them to annual salary equivalents stated in constant 2005 dollars.

These CPS data are the only source of comparative information on STEM salaries for every year from 1995 to 2005. The largest problem with their use is related to a change in the CPS in 2003, when a new system of occupational definitions was adopted for these surveys.

The Federal SOC Codes. The U.S. government encourages the use of

a uniform set of vocational definitions called the Standard Occupational Classification (SOC) for all its data collection and statistical activities. It also maintains similar systems for industry classifications, and related systems are used to handle other requirements, such as classifications of academic specialties. All these coding schemes must be constantly revised to keep up with changes in the culture and economy. For example, new kinds of occupations are introduced (computing is an obvious illustration), while others decline, like the care and housing of horses, once one of the largest vocations in the nation.

Minor adjustments of the SOC are adopted by individual agencies fairly frequently, and major, government-wide revisions are released every decade. The most recent major revision was developed during the 1990s and was phased into use in specific federal surveys around the start of the 21st Century. The CPS was one of the last large projects to shift over to the new occupational codes.

For STEM professions, the impact of the changed occupational codes has been significant. Many major improvements have been made, including refinements in the general accuracy of these coding systems as well as more obvious changes like the addition of new occupational titles, and on the whole the revised categories are a much better fit to the current American labor market.

The STEM occupation most affected by the change in coding systems is **electrical and electronics engineering**. The size of this group has been cut roughly in half, with large numbers of people reassigned to computer science. Major effects of changes in SOC codes on earnings estimates are apparent for other STEM specialties and have already been noted above. The only line of data in Exhibit 1 that is completely unaffected by the change in occupational codes is the total for **all employed persons**.

In some cases, groups reported by only one of these two coding systems could be reconstructed to provide similar statistics for the years covered by the other system. Complete details on these and other manipulations of the federal data are

available in the spreadsheet mentioned earlier and posted at the STEM Workforce Data Project's archive web pages at <http://www.cpst.org>. A complete review of all of the changes in SOC codes between the older and newer sets of occupational definitions, covering more than 50 STEM professions, has been prepared for this project and will be included in a separate "white paper" we are preparing on federal STEM statistics.

Some smaller STEM occupations were unaffected by the change in SOC codes, but none of these were large enough to support estimates of pay for Exhibit 1. Many of the other occupations in the exhibit are generally comparable, although improvements in handling the details of occupational assignments have led to small differences between the composition of these groups in 1995-2002 and that in 2003-2005. Occupations with these kinds of fine-scale adjustments include **aerospace engineers; biological scientists; chemists and material scientists; chemical engineers** (note that data for this group are not sufficient to generate earnings estimates for 2005); **chemical technicians; civil engineers; industrial engineers; lawyers** (not a STEM field; it and a few other occupations are included in Exhibit 1 in order to provide convenient comparisons); **mechanical engineers;** and **physicians and surgeons** (also a comparison group). Revisions in the new occupational definitions changed assignments for 10 to 15 percent of the cases for **drafters; medical scientists; and surveying and mapping technicians**. For **psychologists**, improvements in SOC assignments lead to a reduction of about 17 percent in the total size of the group; in the case of **secondary school teachers** (another comparison group), the number of cases has been reduced by over 20 percent. Changes of these magnitudes can have serious effects on estimates of median earnings and were discussed separately above.

The components of some of the aggregated STEM datasets have been changed sufficiently by the new SOC codes that the composition of the aggregated summary groups in 2003-2005 also differs significantly from earlier years. These groups include the summary lines for **executive, administrative, and managerial occupations** and

to the earlier category of **engineering technicians**, but its equivalent can be calculated.

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The revised SOC changes the way that STEM professions are grouped. Separate aggregates for **natural scientists** and **social scientists and urban planners** have been replaced by a new combined **life, physical, and social sciences** aggregate that also includes science and engineering technicians. Due to this change, data for **all STEM occupations combined** can be derived for the entire time series, but separate information for all technicians or all social scientists is not available in the published BLS results for 2003-2005, and so earnings estimates cannot be provided for other overall summary STEM datasets that do not include these two newly added groups of interest.

Data on **electrical and electronics engineering technicians** are available only for 1995-2002; in the new SOC, these workers have been combined with others in a group of **engineering technicians other than drafters**. Many other occupational titles are newly defined for the revised SOC and so no equivalents exist for 1995-2002. These groups include **chief executives; computer and information systems managers; computer hardware engineers; computer software engineers; computer support specialists; database administrators; engineering managers; network and computer systems administrators; network and data communications analysts;** and **market and survey researchers**. The creation of these new occupational categories has had marked effects on data for other professions where people in the newly formed groups used to be counted, such as **biological technicians; computer scientists and systems analysts; economists; electrical and electronics engineers;** and **operations research analysts**.

The revised SOC is not perfect. In particular, more work needs to be done to improve the ability to track social scientists and science and engineering technician occupations. The white paper on federal sources of STEM statistics will include recommendations on these matters for U.S. statistical agencies. It will also include tips for lay people on locating and using these resources.

About the STEM Workforce Data Project

The purpose of the STEM Workforce Data Project is to identify and distribute reliable statistics on scientific, technological, engineering and mathematical workers in the United States. Like the similar IT Workforce Data Project (see <http://www.cpst.org> for those reports), the STEM project uses the full range of statistical resources offered by U.S. federal agencies as well as other private sources of information. Our reports have drawn upon previously unused data, maintained by the Bureau of Labor Statistics, from Current Population Surveys, but other sources of information are also being examined and applied.

This is a project of the Commission on Professionals in Science and Technology (CPST) in Washington, D.C., supported by grants from the Alfred P. Sloan Foundation. Queries about the project are welcome. The principal investigators are Eleanor Babco, who recently retired as CPST's executive director (202-326-7080; babco@cpst.org), and Richard Ellis of Ellis Research Services in Carlisle, PA (717-218-9818; raellis@earthlink.net). Nathan Bell, CPST's associate director, is the project's manager (nbell@cpst.org). Dr. B. Lindsay Lowell of the Center for the Study of International Migration at Georgetown University is contributing expertise on foreign content in the U.S. STEM workforce. Dr. Ronil Hira of the Rochester Institute of Technology will comment on the policy implications of STEM workforce trends. Robert K. Weatherall, the retired past director of the Office of Career Services at MIT, is participating in the project as a reviewer of draft reports, as is CPST's new executive director, Dr. Lisa Frehill (lfrehill@cpst.org).

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