

parability with actual 1995 industries could be accomplished only at a 117-industry level. Data were analyzed just for wage and salary workers, both be-

cause of the change in the sic system and because it would be difficult to establish comparability between the data for these workers, derived from the

Current Employment Statistics program, and data on self-employed and unpaid family workers, derived from the Current Population Survey.

Evaluating the 1995 occupational employment projections

Although too conservative, the BLS employment projections to 1995 correctly foresaw most general occupational trends

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The Bureau's occupational employment projections captured the majority of the general occupational trends over the 1984-95 period. Some of the most glaring inaccuracies in the projections for detailed occupations reflect the conservative nature of projected growth rates that was identified in previous evaluations. Although the impact of inaccurate industry employment projections on the occupational employment projections was significant, the projections of the changes in the utilization of occupations by industry resulted in the biggest source of projection error, as in past evaluations.

Major occupation groups

The direction of employment change was projected correctly for all nine of the major occupation groups. The absolute projection error was less than 10 percent for eight out of the nine groups and 11.3 percent for professional specialty occupations, the major occupation group with the largest absolute error. (See table 1.)

Projected employment was lower than actual in six major groups: execu-

tive, administrative, and managerial occupations; professional specialty occupations; marketing and sales occupations; administrative support occupations, including clerical; services occupations; and operators, fabricators, and laborers. Employment was overestimated for precision production, craft, and repair occupations, and technicians and related support occupations. The latter group's employment was projected the most accurately, at less than 1 percent more than actual employment. The decline in employment was slightly overestimated for agriculture, forestry, fishing, and related occupations.

Not only was the direction of employment change anticipated correctly for all the major groups, but the projected distribution of employment growth among the groups was reasonably accurate.¹ For example, the professional specialty occupation group had the largest absolute numerical error, nearly 2 million, but its share of total employment growth was underprojected by only 3.4 percent. Thus, the projection for total employment—low by about 7.3 million—had an impact on the overall accuracy of the projections.

The largest error in the projected share of employment growth was for precision production, craft, and repair occupations. This group's share of total employment growth was overprojected by about 7 percent, in line with its employment being overprojected by 886,000. For each major group, however, the same pattern of projection of employment growth and rprojection of the group's share of employment growth does not necessarily apply. In the case of operators, fabricators, and laborers, for example, employment was slightly underprojected, and the share of employment growth was overprojected. For marketing and sales workers, the projected share of total employment growth was almost identical to the actual share, although the level of employment was underprojected. (See table 1.)

The fastest growing occupation groups had the largest absolute projection errors. Technicians and related support occupations was projected to be the fastest growing group, but was outpaced by four other groups. The two actual leaders, professional specialty occupations and executive, administrative, and managerial occupations, which were both projected to grow faster than average, but not as fast as they really did grow.

Administrative support workers, including clerical workers, made up the largest group of workers in 1984 and also was projected to be, and was in actuality, the largest in 1995, even though it did not grow more slowly than average, as projected. The projection error for this group was 8.3 percent. The group's projected slow growth was based on the anticipated effect of the rapid spread of computerized office equipment. As a result, many clerical occupations were correctly projected to grow slowly or decline. However,

employment increased more rapidly than projected in several large clerical occupations, such as bill and account collectors, adjustment clerks, and teachers' aides and educational assistants.

Projection errors were also relatively large for both service occupations and marketing and sales occupations. Each of these groups grew faster than projected, and together they accounted for a combined employment growth of about 8.1 million jobs, rather than the expected 5.6 million. More than 60 percent of the projection error of 1.1 million for the marketing and sales occupations can be attributed to an underprojection of two occupations: cashiers and retail salespersons. These occupations accounted for an underestimate of almost 700,000 workers.

Projection errors for agriculture, forestry, fishing, and related occupations, and for operators, fabricators, and laborers, were relatively small. Part of this accuracy can be attributed to growth among occupations less affected by technological change, such as transportation and material-moving occupations; nursery workers; and animal caretakers, except farmworkers. Conversely,

precision production, craft, and repair occupations were overprojected by almost a million workers. Because these workers are concentrated in the construction and manufacturing industries, the projected increase in their employment was tied primarily to the projections for those industries.

Professional specialty occupations grew by about 4.7 million over the 1984–95 period, almost 2 million more than projected. Significant errors in the projections for detailed occupations with sizable employment had a substantial impact on the overall projection error for this group. For example, underprojections for five professional specialty occupations—computer systems analysts, engineers, and scientists; college and university faculty; adult and vocational education teachers; registered nurses; and social workers—contributed significantly to the underprojection of professional workers. Underprojection of the five occupations accounted for about 38 percent of underestimated employment for this major group. That the projection error for professional specialty occupations was only 11.3 percent can be attributed to some offsetting of this underprojection

caused by an overprojection of other types of engineers.²

Detailed occupations

The evaluation of the 1995 projections covered 348 detailed occupations. Table 2 presents data on the 207 occupations for which 1984 employment was greater than 50,000, ranked by absolute percent error.³ The absolute percent errors for all 348 averaged about 24 percent. More than three-fifths of the occupations, however, had below-average errors.

The Bureau can evaluate only the projections for occupations that had comparable definitions in surveys used to compile employment data in the base year and the target year of the projections. Consequently, in past evaluations, relatively few occupations could be evaluated, because the classification system changed rather frequently. However, many more occupations maintained comparability between 1984 and 1995 than in past evaluation periods, because the OES survey occupational classification remained very stable over that period. As a result, the number of occupations included in this evaluation is much larger than in past evaluations.⁴

Table 1. Employment, by major occupation group, 1984 actual and 1995 projected and actual

[Numbers in thousands]

Occupation	1984	Employment				Percent change, 1984–95		Numerical error, 1995 (projected minus actual)	Percent error, 1995	Share of total job growth, 1984–95	
		Projected 1995		Actual 1995		Projected	Actual			Projected	Actual
		Level	Share (percent)	Level	Share (percent)						
Total, all occupations	106,729	122,758	100.0	130,009	100.0	15.0	21.8	-7,250	-5.6	100.0	100.0
Executive, administrative, and managerial occupations	9,951	11,933	9.7	13,244	10.2	19.9	33.1	-1,311	-9.9	12.4	14.1
Professional specialty occupations	13,020	15,701	12.8	17,696	13.6	20.6	35.9	-1,995	-11.3	16.7	20.1
Technicians and related support occupations	3,535	4,564	3.7	4,541	3.5	29.1	28.5	23	.5	6.4	4.3
Marketing and sales workers	10,978	13,322	10.9	14,389	11.1	21.3	31.1	-1,068	-7.4	14.6	14.7
Administrative support occupations, including clerical ..	19,670	21,731	17.7	23,710	18.2	10.5	20.5	-1,979	-8.3	12.9	17.4
Service occupations	16,244	19,510	15.9	20,889	16.1	20.1	28.6	-1,379	-6.6	20.4	20.0
Agriculture, forestry, fishing, and related occupations	3,798	3,641	3.0	3,779	2.9	-4.1	-5	-138	-3.6	-1.0	-1
Precision production, craft, and repair occupations	13,469	15,110	12.3	14,224	10.9	12.2	5.6	886	6.2	10.2	3.2
Operators, fabricators, and laborers	16,064	17,246	14.0	17,536	13.5	7.4	9.2	-290	-1.7	7.4	6.3

Projection error is inversely related to employment size, as past projection evaluations have indicated. In 1984, fewer than 100,000 workers were employed in each of 211 of the 348 occupations included in the evaluation. These 211 occupations had an average projection error of about 29 percent, whereas 32 occupations with more than 500,000 workers in 1984 had an average error of about 12.2 percent.

The direction of employment change was projected correctly for more than 70 percent of the occupations included in the evaluation. Employment growth was projected for the majority of all the occupations. Of the 231 occupations for which employment actually grew from 1984 to 1995, an increase was projected for all but 16. However, of the 117 occupations for which employment declined, only 37 were projected to decline over the period.

The errors among the occupations included in the evaluation ranged widely. (See table 2.) For example, the difference between projected and actual employment was underestimated by about 42 percent for physicians' assistants and overestimated by about 190 percent for roustabouts. Since roustabouts are primarily concentrated in the oil and gas industry, this projection reveals how the effects of incorrect industry projections can affect the projections for individual occupations.

The last two columns in table 2 present the projected and actual share of the overall employment increase for each of the 207 occupations for which 1984 employment was greater than 50,000. Although there are some notable exceptions, the projected shares for the detailed occupations, like those for the major groups, are relatively accurate.

Sources of error

Errors in the projections for the detailed occupations included in the evaluation can ultimately be traced back to errors in assumptions or judgment, resulting in incorrectly projected changes in staffing patterns, industry projections, or a

combination of both. In order to identify the sources of error, two simulated matrices were created. The first of these was generated by multiplying the projected 1995 staffing patterns of industries by actual 1995 industry employment. The second was produced by multiplying the actual 1995 staffing patterns by projected employment by industry. The first simulation reveals the outcome if the Bureau had projected perfect industry employment totals and the second the outcome if it had projected perfect occupational staffing patterns. Table 2 presents projection errors from the two simulated matrices created to analyze these effects.

In viewing the projection levels and errors for the detailed occupations, it is possible to identify the effects analytical judgments had on the individual projections. Analyses of underlying trends or impacts of technological change were used in developing both the industry projections and the projected staffing patterns of industries. As mentioned in Arthur Andreassen's contribution to this article, industry employment projections were affected by unanticipated economic changes.⁵ Employment in manufacturing, for example, did not increase as projected, but declined because of a number of factors, including a reduction in defense spending, rapid growth of imports, and a trend toward outsourcing all types of services. In contrast, employment in services grew at a much faster rate than projected.

The effect of industry errors on occupational employment may be clearly seen in an example taken from table 2. Earlier, it was mentioned that one of the largest projection errors occurred for roustabouts, around 190 percent. Examining the projection errors from both simulations, one can see clearly that the error is attributable more to incorrect industry projections for the related oil and gas industries than to the projected staffing pattern: the error in the simulation using actual staffing patterns and projected industry totals is 115 percent, while it is only 38 percent with actual industry totals and projected staffing patterns.

Job clusters. In investigating sources of projection error, it is helpful to examine groups of related occupations, or job clusters. A number of such clusters have been selected for closer examination in this section because they show large projection errors or highlight specific sources of error. For example, the underprojection of the education industry affected the projections for education-related occupations. This conclusion is supported by a review of the two simulated matrices for the projection errors for college and university faculty and teachers' aides and educational assistants. Between 1984 and 1995, the employment of college and university faculty was projected to decline about 14 percent, whereas it actually increased approximately 12 percent. The projected decline was based primarily on the U.S. Department of Education's National Center for Education Statistics' projected drop in college enrollments, reflecting the shrinking population of 18- to 24-year-olds. Enrollment rates, however, increased during the 1980s, as colleges accepted greater numbers of older individuals and enrollment rates of students of traditional college age rose more rapidly than expected.

Due to similar misconceptions about enrollments in higher education, the employment of adult and vocational education teachers also was significantly under-projected. However, the absolute percent error for adult and vocational education teachers is actually larger in the simulation using the projected staffing patterns and actual 1995 industry totals than in the simulation using actual staffing patterns and projected industry employment. (See table 3.) This indicates that the error in the projections for adult and vocational education teachers was in fact more the result of the underlying assumptions or judgments that went into determining the utilization of the workers in the education industry, rather than a result of the projection for the education industry. Although moderately rising demand for adult education was anticipated, the declining population of 18- to 22-year-olds

Table 2. Employment, by occupation, 1984 actual and 1995 projected and actual

[Numbers in thousands]

Occupation	Total employment					Percent change, 1984-95	
	1984	Projected 1995		Actual 1995		Projected	Actual
		Level	Share (percent)	Level	Share (percent)		
Total, all occupations	106,729	122,758	100.00	130,009	100.00	15.0	21.8
Cooks, institution or cafeteria	361	426	.35	426	.33	18.0	18.1
Aircraft mechanics	82	98	.08	98	.08	19.7	19.8
Mail clerks, except mail machine operators and postal service	126	132	.11	132	.10	5.3	5.2
Supervisors of blue-collar workers	1,794	1,931	1.57	1,925	1.48	7.6	7.3
Butchers and meatcutters	229	220	.18	219	.17	-4.1	-4.5
Crushing and mixing machine operators and tenders	133	137	.11	138	.11	3.5	4.0
Highway maintenance workers	159	167	.14	168	.13	5.0	5.7
Cannery workers	74	72	.06	72	.06	-3.4	-2.8
Farmers	1,312	1,240	1.01	1,231	.95	-5.5	-6.2
Stock clerks	1,707	1,800	1.47	1,815	1.40	5.5	6.3
Industrial machinery mechanics	438	465	.38	470	.36	6.3	7.3
Secretaries	3,050	3,369	2.74	3,403	2.62	10.5	11.6
Pharmacists	157	174	.14	172	.13	10.7	9.6
Loan and credit clerks	146	172	.14	174	.13	17.5	19.2
Bus drivers, except school	138	156	.13	158	.12	13.3	14.9
Tire repairers and changers	80	90	.07	91	.07	12.8	14.5
Guards	680	903	.74	917	.71	32.8	34.9
Brokers, real estate	58	68	.06	69	.05	16.2	18.1
Supervisors of police and detectives	80	89	.07	88	.07	11.3	9.3
Purchasing agents, except wholesale, retail, and farm products	183	216	.18	220	.17	18.2	20.6
Bookkeeping, accounting, and auditing clerks	2,019	2,158	1.76	2,217	1.71	6.9	9.8
Order clerks for materials, merchandise, and service	263	315	.26	324	.25	19.9	23.3
Public relations specialists and publicity writers	83	108	.09	112	.09	30.9	34.6
Cabinetmakers and bench carpenters	104	124	.10	127	.10	18.7	22.1
Welders and cutters	291	330	.27	340	.26	13.5	16.9
Dental assistants	149	191	.16	197	.15	28.0	31.9
Dispatchers, except police, fire, and ambulance	118	142	.12	146	.11	19.7	23.5
Waiters and waitresses	1,570	1,978	1.61	1,916	1.47	25.9	22.0
Drywall installers and finishers	117	129	.11	125	.10	10.2	6.8
Pressing machine operators and tenders, textile, garment, and related	89	80	.07	78	.06	-10.3	-13.1
Stenographers	172	101	.08	105	.08	-41.2	39.2
Numerical control machine tool operators and tenders, metal/plastic	58	74	.06	77	.06	28.7	33.1
Pipelayers and pipelaying fitters	53	59	.05	57	.04	12.9	9.0
Food counter, fountain, and related workers	1,377	1,627	1.33	1,692	1.30	18.2	22.9
Paralegals	54	105	.09	110	.08	96.2	104.2
Licensed practical nurses	593	695	.57	724	.56	17.3	22.1
Machine-forming operators and tenders, metal and plastic	174	170	.14	177	.14	-2.2	1.9
Bank tellers	497	522	.43	545	.42	5.1	9.7
Machine builders and other precision machine assemblers	53	63	.05	61	.05	20.5	15.6
Medical assistants	126	204	.17	214	.16	62.5	70.6
Electricians	511	592	.48	565	.43	15.9	10.5
Truck drivers, light and heavy	2,123	2,511	2.05	2,648	2.04	18.3	24.7
Photographers	92	121	.10	115	.09	31.6	25.1
Production, planning, and expediting clerks	210	230	.19	243	.19	9.6	15.9
Packaging and filling machine operators and tenders	298	314	.26	333	.26	5.4	11.9
Textile drawout and winding machine operators and tenders	237	199	.16	188	.14	-15.9	-20.6
Sewing machine operators, nongarment	137	137	.11	130	.10	.4	-5.2

Table 2. Continued—Employment, by occupation, 1984 actual and 1995 projected and actual

[Numbers in thousands]

Occupation	Total employment					Percent change, 1984-95	
	1984	Projected 1995		Actual 1995		Projected	Actual
		Level	Share (percent)	Level	Share (percent)		
Carpet installers	64	75	.06	70	.05	15.8	9.3
Salespersons, retail	3,284	3,729	3.04	3,970	3.05	13.6	20.9
Heating, air-conditioning, and refrigeration mechanics and installers	209	247	.20	233	.18	18.0	11.1
Police patrol officers	334	378	.31	403	.31	13.1	20.7
Janitors and cleaners, including maids/housekeeping cleaners	2,449	2,890	2.35	3,086	2.37	18.0	26.0
Extruding and forming machine setters, operators, and tenders	104	110	.09	103	.08	5.6	-.8
Carpenters	940	1,029	.84	965	.74	9.5	2.7
Travel agents	94	138	.11	129	.10	46.5	37.3
Sheet metal workers and duct installers	215	246	.20	230	.18	14.3	7.0
Employment interviewers, private or public employment service	63	89	.07	83	.06	39.5	30.1
Cost estimators	143	171	.14	184	.14	19.2	28.5
Central office and PBX installers and repairers	77	86	.07	80	.06	11.4	3.8
Insulation workers	53	60	.05	65	.05	12.9	21.9
Chemists	84	89	.07	96	.07	5.6	14.0
Personnel clerks, except payroll and timekeeping	115	135	.11	125	.10	16.5	8.2
Helpers, construction trades	466	484	.39	525	.40	3.8	12.5
Librarians, professional	128	139	.11	152	.12	8.5	18.2
Chemical equipment controllers, operators, and tenders	77	79	.06	73	.06	3.1	-5.1
Police detectives and investigators	55	60	.05	66	.05	10.1	20.8
Plastic molding machine operators and tenders, setters, and setup operators	142	185	.15	169	.13	29.6	18.9
Registered nurses	1,326	1,758	1.43	1,937	1.49	32.6	46.1
Maintenance repairers, general utility	999	1,173	.96	1,294	1.00	17.4	29.5
Physicians	487	600	.49	548	.42	23.2	12.6
Painters and paperhangers, construction and maintenance	368	384	.31	424	.33	4.3	15.2
Refuse collectors	106	125	.10	114	.09	17.9	7.0
Welfare eligibility workers and interviewers	82	94	.08	105	.08	15.0	28.1
Concrete and terrazzo finishers	100	117	.10	130	.10	17.0	30.4
Mobile heavy equipment mechanics	102	119	.10	107	.08	16.6	5.6
New-accounts clerks, banking	87	99	.08	111	.09	14.4	27.7
Data entry keyers, except composing	369	370	.30	414	.32	.4	12.3
Institutional cleaning supervisors	108	141	.12	128	.10	30.9	18.2
Taxi drivers and chauffeurs	84	95	.08	107	.08	12.9	26.7
Sewing machine operators, garment	673	568	.46	511	.39	-15.7	-24.1
Payroll and timekeeping clerks	192	182	.15	163	.13	-5.6	-15.2
Artists and commercial artists	184	240	.20	272	.21	30.2	47.3
Combination machine tool setters, setup operators, operators, and tenders	95	122	.10	109	.08	28.1	14.8
Cooks, restaurant	485	630	.51	714	.55	29.9	47.0
Respiratory therapists	53	64	.05	73	.06	20.6	36.6
Machine feeders and offbearers	278	296	.24	265	.20	6.6	-4.7
Lawyers	527	722	.59	645	.50	37.1	22.6
Firefighters	214	247	.20	220	.17	15.3	2.9
Machinists	386	424	.35	378	.29	9.7	-2.1
Clinical lab technologists and technicians	231	245	.20	279	.21	6.0	20.6
Aircraft pilots and flight engineers	66	82	.07	93	.07	24.0	41.2
Hairdressers, hairstylists, and cosmetologists	525	687	.56	611	.47	30.8	16.4
Food preparation workers	879	1,078	.88	1,230	.95	22.6	39.9
Home appliance and power tool repairers	75	86	.07	77	.06	15.2	2.3
Child care workers, private household	401	347	.28	308	.24	-13.5	-23.2
Cutting and slicing machine setters, operators, and tenders	82	81	.07	94	.07	-.7	14.4

Table 2. Continued—Employment, by occupation, 1984 actual and 1995 projected and actual

[Numbers in thousands]

Occupation	Total employment					Percent change, 1984-95	
	1984	Projected 1995		Actual 1995		Projected	Actual
		Level	Share (percent)	Level	Share (percent)		
Bus drivers, school	311	364	.30	420	.32	17.2	35.0
Writers and editors, including technical writers	194	246	.20	284	.22	26.9	46.5
Library assistants and bookmobile drivers	97	107	.09	123	.09	9.7	26.6
Insurance sales workers	425	474	.39	415	.32	11.4	-2.5
Wholesale and retail buyers, except farm products	189	214	.17	187	.14	13.2	-1.2
Cashiers	2,016	2,627	2.14	3,080	2.37	30.3	52.8
Insurance adjusters, examiners, and investigators	109	138	.11	162	.12	26.7	48.9
Science and mathematics technicians	233	268	.22	233	.18	15.3	.1
Automotive body and related repairers	202	243	.20	210	.16	19.9	3.9
Bricklayers and stonemasons	154	170	.14	148	.11	10.6	-4.2
Cleaners and servants, private household	532	409	.33	484	.37	-23.1	-9.1
Personnel, training, and labor relations specialists	221	262	.21	310	.24	18.5	40.2
Underwriters	90	112	.09	97	.07	24.1	7.4
Woodworking machine operators and tenders, setters, and setup operators	72	77	.06	67	.05	6.7	-7.8
Inspectors and compliance officers, except construction	120	133	.11	158	.12	10.9	32.2
Machine assemblers	51	61	.05	53	.04	19.8	2.9
Hotel desk clerks	97	115	.09	137	.11	18.3	41.6
Drafters	326	367	.30	315	.24	12.7	-3.5
Plumbers, pipefitters, and steamfitters	384	442	.36	378	.29	14.9	-1.7
Farm managers	164	180	.15	154	.12	9.8	-6.1
Gardeners and groundskeepers, except farm	597	639	.52	545	.42	7.0	-8.8
Physical therapists	59	86	.07	104	.08	45.3	76.6
Designers	198	252	.21	307	.24	27.7	55.5
Brokerage clerks	51	60	.05	73	.06	18.0	43.7
Automotive mechanics	706	859	.70	728	.56	21.6	3.1
Dental hygienists	83	107	.09	130	.10	28.7	56.9
Bus and truck mechanics and diesel engine specialists	256	309	.25	262	.20	20.4	2.0
Water and liquid waste treatment plant and systems operators	71	79	.06	97	.07	11.6	36.8
Inspectors, testers, and graders, precision	701	791	.64	668	.51	13.0	-4.6
Drivers/salesworkers	253	276	.23	339	.26	9.2	33.9
Cooks, short order and fast food	543	637	.52	785	.60	17.3	44.6
Order fillers, wholesale and retail sales	188	182	.15	225	.17	-3.1	19.6
Roofers	137	156	.13	131	.10	13.5	-4.6
Counselors	116	135	.11	168	.13	16.0	44.8
Office machine and cash register servicers	53	70	.06	58	.04	31.8	9.9
Laundry and drycleaning machine operators and tenders, except pressing	130	145	.12	182	.14	11.5	39.2
Millwrights	87	94	.08	78	.06	7.0	-10.9
Customer service representatives, utilities	104	122	.10	152	.12	16.7	45.9
Industrial truck and tractor operators	426	381	.31	477	.37	-10.6	11.8
Upholsterers	68	77	.06	64	.05	11.9	-6.8
Hosts and hostesses, restaurant/lounge/ coffee shop	158	203	.17	255	.20	28.5	61.4
Reservation and transportation ticket agents and travel clerks	106	115	.09	145	.11	9.0	37.0
File clerks	223	231	.19	292	.22	3.4	30.6
Recreation workers	154	180	.15	228	.18	16.8	47.7
Psychologists	92	110	.09	139	.11	19.8	51.5
Electronics repairers, commercial and industrial equipment	77	91	.07	76	.06	18.4	-2.3
Bartenders	366	466	.38	385	.30	27.4	5.1
Statistical clerks	69	60	.05	77	.06	-12.6	11.4

Table 2. Continued—Employment, by occupation, 1984 actual and 1995 projected and actual

[Numbers in thousands]

Occupation	Total employment					Percent change, 1984-95	
	1984	Projected 1995		Actual 1995		Projected	Actual
		Level	Share (percent)	Level	Share (percent)		
Dentists	160	200	.16	165	.13	25.1	2.9
Tool and die makers	165	178	.15	146	.11	8.3	-11.2
Radiologic technologists and technicians ..	109	134	.11	172	.13	23.2	58.0
Musicians	184	208	.17	267	.21	13.0	45.2
Accountants and auditors	902	1,213	.99	991	.76	34.5	9.8
Producers, directors, actors, and entertainers	61	76	.06	98	.08	23.6	59.7
Amusement and recreation attendants	179	218	.18	282	.22	21.6	57.2
Head sawyers and saw machine operators and tenders, setters, and setup operators	75	80	.07	65	.05	6.6	-13.1
College and university faculty	758	654	.53	848	.65	-13.8	11.8
Paper goods machine setters and setup operators	60	63	.05	51	.04	4.4	-15.1
Sales agents, real estate	290	332	.27	270	.21	14.2	-7.2
Dispatchers, police, fire, and ambulance ...	58	64	.05	84	.06	10.5	43.6
Duplicating, mail, and other office machine operators	152	175	.14	230	.18	15.5	51.4
Punch machine setters and setup operators, metal and plastic	63	61	.05	49	.04	-2.7	-21.4
Flight attendants	68	83	.07	109	.08	21.0	59.7
Chemical engineers	52	64	.05	51	.04	21.8	-2.3
Farm workers	1,002	863	.70	692	.53	-13.8	-30.9
Postal mail carriers	240	248	.20	330	.25	3.3	37.9
Radio and television announcers and newscasters	58	64	.05	50	.04	9.9	-12.6
Social workers	342	419	.34	570	.44	22.5	66.6
Barbers	75	83	.07	65	.05	9.8	-13.4
Station installers and repairers, telephone	58	47	.04	37	.03	-18.1	-35.6
Insurance claims clerks	78	87	.07	120	.09	12.4	54.9
Teachers' aides and educational assistants	594	700	.57	966	.74	17.9	62.8
Sheriffs and deputy sheriffs	61	62	.05	86	.07	2.9	42.3
Messengers	90	100	.08	139	.11	11.2	54.6
Correction officers	167	225	.18	314	.24	34.5	87.7
Civil engineers, including traffic engineers	188	243	.20	188	.14	29.4	.1
Telephone and cable television line installers and repairers	123	140	.11	198	.15	14.1	61.8
Textile machine setters and setup operators	58	49	.04	38	.03	-15.4	-34.7
Industrial engineers, except safety engineers	117	152	.12	116	.09	30.0	-.3
Vehicle washers and equipment cleaners	165	177	.14	254	.20	7.4	54.5
Computer operators, except peripheral equipment	241	350	.29	267	.21	45.5	11.1
Machine tool cutting operators and tenders, metal and plastic	172	164	.13	125	.10	-4.6	-27.4
Child care workers	511	563	.46	821	.63	10.1	60.5
Nursery workers	54	58	.05	85	.07	6.9	55.8
Mechanical engineers	231	309	.25	233	.18	33.6	1.0
Meat, poultry, and fish cutters and trimmers, hand	98	93	.08	138	.11	-4.3	41.5
Lathe machine tool setters and setup operators, metal and plastic	99	98	.08	74	.06	-.5	-25.0
Grinding machine setters and setup operators, metal and plastic	89	87	.07	64	.05	-2.2	-28.1
Drill machine tool setters and setup operators, metal and plastic	65	64	.05	47	.04	-.7	-27.4
Electrical and electronic assemblers	256	300	.24	218	.17	17.0	-15.0
Data-processing equipment repairers	61	106	.09	77	.06	72.8	24.8
Switchboard operators	256	330	.27	238	.18	29.1	-7.0
Electrical and electronic equipment assemblers, precision	175	205	.17	148	.11	17.5	-15.4

Table 2. Continued—Employment, by occupation, 1984 actual and 1995 projected and actual

[Numbers in thousands]

Occupation	Total employment					Percent change, 1984-95	
	1984	Projected 1995		Actual 1995		Projected	Actual
		Level	Share (percent)	Level	Share (percent)		
Animal caretakers, except farm	71	75	.06	124	.10	6.2	75.0
Computer programmers	440	782	.64	559	.43	77.6	26.9
Adult and vocational education teachers ...	303	352	.29	587	.45	15.9	93.6
Computer systems analysts, engineers, and scientists	306	503	.41	860	.66	64.4	180.8
Structural and reinforcing metal workers ...	77	91	.07	63	.05	17.8	-17.8
Typists and word processors	922	954	.78	662	.51	3.5	-28.1
Bill and account collectors	112	144	.12	259	.20	28.4	131.1
Electrical and electronic technicians/ technologists	310	460	.37	316	.24	48.4	2.0
Welding machine setters, operators, and tenders	131	157	.13	107	.08	19.9	-18.1
Reporters and correspondents	69	83	.07	57	.04	19.9	-18.2
Custom tailors and sewers	112	123	.10	83	.06	10.5	-26.1
Emergency medical technicians	62	66	.05	140	.11	5.3	124.5
Electromechanical equipment assemblers, precision	61	75	.06	48	.04	24.0	-20.0
Adjustment clerks	130	158	.13	384	.30	21.9	196.0
Precision instrument repairers	57	65	.05	39	.03	13.4	-31.3
Service station attendants	289	287	.23	167	.13	-.8	-42.1
Electrical and electronics engineers	399	607	.49	353	.27	52.2	-11.4
Roustabouts	78	79	.06	27	.02	1.1	-65.2
				Absolute percent error, 1995		Share of total job growth, 1984-95	
	Numerical error, 1995 (projected minus actual)	Absolute percent error, 1995	Actual industry totals to projected staffing pattern		Projected	Actual	
			Actual industry totals to projected staffing pattern	Actual staffing pattern to projected industry totals			
Total, all occupations	-7,250	5.6	0.0	5.6	100.00	100.00	
Cooks, institution or cafeteria	0	.1	22.4	17.8	.41	.28	
Aircraft mechanics	0	.1	14.6	13.4	.10	.07	
Mail clerks, except mail machine operators and postal service	0	.1	6.5	6.6	.04	.03	
Supervisors of blue-collar workers	6	.3	1.3	1.7	.85	.56	
Butchers and meatcutters	1	.4	13.5	10.9	-.06	-.04	
Crushing and mixing machine operators and tenders	-1	.5	1.0	2.0	.03	.02	
Highway maintenance workers	-1	.6	13.0	12.0	.05	.04	
Cannery workers	0	.6	11.1	10.8	-.02	-.01	
Farmers	9	.7	8.8	3.8	-.45	-.35	
Stock clerks	-15	.8	2.0	3.2	.58	.46	
Industrial machinery mechanics	-5	1.0	5.9	6.8	.17	.14	
Secretaries	-34	1.0	4.5	6.0	2.00	1.52	
Pharmacists	2	1.0	2.7	5.5	.10	.06	
Loan and credit clerks	-2	1.4	7.7	7.9	.16	.12	
Bus drivers, except school	-2	1.4	30.2	24.7	.11	.09	
Tire repairers and changers	-1	1.5	4.2	5.8	.06	.05	
Guards	-14	1.5	11.1	11.5	1.39	1.02	
Brokers, real estate	-1	1.6	47.3	10.5	.06	.05	
Supervisors of police and detectives	2	1.8	14.9	10.7	.06	.03	
Purchasing agents, except wholesale, retail, and farm products	-4	2.0	8.6	9.0	.21	.16	
Bookkeeping, accounting, and auditing clerks	-59	2.7	1.0	3.8	.87	.85	
Order clerks for materials, merchandise, and service	-9	2.8	4.2	.6	.33	.26	
Public relations specialists and publicity writers	-3	2.8	10.1	11.5	.16	.12	
Cabinetmakers and bench carpenters	-4	2.8	2.5	2.7	.12	.10	
Welders and cutters	-10	2.8	12.4	10.8	.25	.21	
Dental assistants	-6	3.0	9.8	12.1	.26	.20	
Dispatchers, except police, fire, and ambulance	-5	3.1	4.4	8.6	.15	.12	

Table 2. Continued—Employment, by occupation, 1984 actual and 1995 projected and actual

[Numbers in thousands]

Occupation	Numerical error, 1995 (projected minus actual)	Absolute percent error, 1995	Absolute percent error, 1995		Share of total job growth, 1984-95	
			Actual industry totals to projected staffing pattern	Actual staffing pattern to projected industry totals	Projected	Actual
Waiters and waitresses	61	3.2	15.2	10.1	2.54	1.49
Drywall installers and finishers	4	3.2	8.6	3.9	.07	.03
Pressing machine operators and tenders, textile, garment, and related	3	3.2	15.7	15.2	-.06	-.05
Stenographers	-3	3.3	3.4	7.8	-.44	-.29
Numerical control machine tool operators and tenders, metal/plastic	-3	3.3	20.9	19.9	.10	.08
Pipelayers and pipelaying fitters	2	3.6	1.6	5.2	.04	.02
Food counter, fountain, and related workers	-65	3.8	6.5	9.9	1.56	1.35
Paralegals	-4	3.9	20.7	10.9	.32	.24
Licensed practical nurses	-29	4.0	10.0	12.6	.64	.56
Machine-forming operators and tenders, metal and plastic	-7	4.0	13.4	7.2	-.02	.01
Bank tellers	-23	4.2	12.2	8.7	.16	.21
Machine builders and other precision machine assemblers	3	4.3	14.3	20.8	.07	.04
Medical assistants	-10	4.7	8.2	12.4	.49	.38
Electricians	27	4.8	11.6	5.5	.51	.23
Truck drivers, light and heavy	-137	5.2	4.1	8.4	2.42	2.26
Photographers	6	5.2	10.1	3.1	.18	.10
Production, planning, and expediting clerks	-13	5.5	17.9	13.0	.13	.14
Packaging and filling machine operators and tenders	-19	5.8	5.0	2.6	.10	.15
Textile drawout and winding machine operators and tenders	11	5.9	11.0	4.7	-.24	-.21
Sewing machine operators, nongarment ...	8	5.9	11.2	2.4	.00	-.03
Carpet installers	4	5.9	20.2	9.2	.06	.03
Salespersons, retail	-241	6.1	1.6	4.6	2.78	2.95
Heating, air-conditioning, and refrigeration mechanics and installers	14	6.2	12.1	5.6	.23	.10
Police patrol officers	-25	6.3	7.0	12.0	.27	.30
Janitors and cleaners, including maids/ housekeeping cleaners	-196	6.3	6.7	12.6	2.75	2.74
Extruding and forming machine setters, operators, and tenders	7	6.4	8.7	3.0	.04	.00
Carpenters	64	6.6	12.2	3.8	.56	.11
Travel agents	9	6.7	14.1	9.5	.27	.15
Sheet metal workers and duct installers ...	16	6.8	2.6	4.5	.19	.06
Employment interviewers, private or public employment service	6	7.2	23.0	13.3	.16	.08
Cost estimators	-13	7.3	7.3	.3	.17	.18
Central office and PBX installers and repairers	6	7.3	9.1	17.8	.05	.01
Insulation workers	-5	7.4	4.7	3.4	.04	.05
Chemists	-7	7.4	2.6	11.3	.03	.05
Personnel clerks, except payroll and timekeeping	10	7.7	7.9	.7	.12	.04
Helpers, construction trades	-41	7.8	6.1	.4	.11	.25
Librarians, professional	-13	8.2	9.6	16.0	.07	.10
Chemical equipment controllers, operators, and tenders	6	8.6	1.4	9.6	.01	-.02
Police detectives and investigators	-6	8.9	.1	7.5	.03	.05
Plastic molding machine operators and tenders, setters, and setup operators ...	15	9.0	6.7	2.7	.26	.12
Registered nurses	-179	9.2	3.7	12.3	2.70	2.63
Maintenance repairers, general utility	-121	9.4	5.5	7.4	1.08	1.27
Physicians	52	9.4	22.3	9.5	.70	.26
Painters and paperhangers, construction and maintenance	-40	9.5	2.3	5.8	.10	.24
Refuse collectors	12	10.2	46.4	22.8	.12	.03
Welfare eligibility workers and interviewers	-11	10.2	2.2	8.3	.08	.10
Concrete and terrazzo finishers	-13	10.3	2.0	8.3	.11	.13

Table 2. Continued—Employment, by occupation, 1984 actual and 1995 projected and actual

[Numbers in thousands]						
Occupation	Numerical error, 1995 (projected minus actual)	Absolute percent error, 1995	Absolute percent error, 1995		Share of total job growth, 1984-95	
			Actual industry totals to projected staffing pattern	Actual staffing pattern to projected industry totals	Projected	Actual
Mobile heavy equipment mechanics	11	10.4	8.1	3.6	.11	.02
New accounts clerks, banking	-12	10.4	17.7	9.0	.08	.10
Data entry keyers, except composing	-44	10.7	4.6	7.9	.01	.20
Institutional cleaning supervisors	14	10.8	28.8	12.8	.21	.08
Taxi drivers and chauffeurs	-12	10.8	6.0	18.0	.07	.10
Sewing machine operators, garment	57	11.1	2.7	9.2	-.66	-.70
Payroll and timekeeping clerks	19	11.4	16.7	3.7	-.07	-.13
Artists and commercial artists	-31	11.6	2.7	5.7	.35	.37
Combination machine tool setters, setup operators, operators, and tenders	13	11.6	3.8	13.7	.17	.06
Cooks, restaurant	-83	11.7	4.2	9.4	.90	.98
Respiratory therapists	-9	11.7	.8	12.2	.07	.08
Machine feeders and offbearers	31	11.8	11.7	.8	.11	-.06
Lawyers	76	11.8	9.5	3.8	1.22	.51
Firefighters	27	12.1	27.7	12.1	.20	.03
Machinists	46	12.1	.4	11.9	.23	-.04
Clinical lab technologists and technicians	-34	12.1	2.3	12.7	.09	.21
Aircraft pilots and flight engineers	-11	12.2	15.5	24.6	.10	.12
Hairdressers, hairstylists, and cosmetologists	75	12.3	13.5	.2	1.01	.37
Food preparation workers	-152	12.4	.0	11.5	1.24	1.51
Home appliance and power tool repairers	10	12.6	16.2	.0	.07	.01
Child care workers, private household	39	12.7	6.4	5.9	-.34	-.40
Cutting and slicing machine setters, operators, and tenders	-12	13.2	10.9	1.9	.00	.05
Bus drivers, school	-55	13.2	14.6	23.8	.33	.47
Writers and editors, including technical writers	-38	13.4	6.9	1.0	.33	.39
Library assistants and bookmobile drivers	-16	13.4	2.8	15.4	.06	.11
Insurance sales workers	59	14.2	23.5	6.1	.30	-.05
Wholesale and retail buyers, except farm products	27	14.6	18.2	1.6	.16	-.01
Cashiers	-453	14.7	8.8	7.1	3.81	4.57
Insurance adjusters, examiners, and investigators	-24	14.9	12.1	3.7	.18	.23
Science and mathematics technicians	35	15.2	25.3	9.3	.22	.00
Automotive body and related repairers	32	15.4	24.4	5.9	.25	.03
Bricklayers and stonemasons	23	15.4	20.7	3.3	.10	-.03
Cleaners and servants, private household	-75	15.4	20.1	5.9	-.77	-.21
Personnel, training, and labor relations specialists	-48	15.5	15.5	.7	.26	.38
Underwriters	15	15.6	19.4	1.3	.14	.03
Woodworking machine operators and tenders, setters, and setup operators	10	15.7	15.9	.8	.03	-.02
Inspectors and compliance officers, except construction	-26	16.1	11.3	5.1	.08	.17
Machine assemblers	9	16.4	2.4	21.7	.06	.01
Hotel desk clerks	-23	16.5	8.6	8.6	.11	.17
Drafters	53	16.8	3.4	10.9	.26	-.05
Plumbers, pipefitters, and steamfitters	64	16.9	21.7	3.6	.36	-.03
Farm managers	26	17.0	17.9	.8	.10	-.04
Gardeners and groundskeepers, except farm	94	17.2	36.2	14.1	.26	-.22
Physical therapists	-19	17.8	6.6	12.2	.17	.19
Designers	-55	17.9	4.9	4.3	.34	.47
Brokerage clerks	-13	17.9	11.2	6.4	.06	.10
Automotive mechanics	131	17.9	28.9	7.9	.95	.09
Dental hygienists	-23	18.0	6.5	12.2	.15	.20
Bus and truck mechanics and diesel engine specialists	47	18.1	28.0	7.4	.33	.02
Water and liquid waste treatment plant and systems operators	-18	18.4	5.2	13.8	.05	.11

Table 2. Continued—Employment, by occupation, 1984 actual and 1995 projected and actual

[Numbers in thousands]

Occupation	Numerical error, 1995 (projected minus actual)	Absolute percent error, 1995	Absolute percent error, 1995		Share of total job growth, 1984-95	
			Actual industry totals to projected staffing pattern	Actual staffing pattern to projected industry totals	Projected	Actual
Inspectors, testers, and graders, precision	123	18.4	5.2	9.0	.57	-.14
Driver/salesworkers	-63	18.5	15.6	6.9	.15	.37
Cooks, short order and fast food	-148	18.9	9.3	9.4	.58	1.04
Order fillers, wholesale and retail sales	-43	19.0	18.1	.8	-.04	.16
Roofers	25	19.0	24.7	3.4	.12	-.03
Counselors	-34	19.9	1.9	17.3	.12	.22
Office machine and cash register servicers	12	19.9	18.8	4.5	.11	.02
Laundry and drycleaning machine operators and tenders, except pressing	-36	19.9	5.0	14.9	.09	.22
Millwrights	16	20.0	15.1	3.6	.04	-.04
Customer service representatives, utilities	-31	20.0	31.5	16.5	.11	.21
Industrial truck and tractor operators	-96	20.1	18.4	2.7	-.28	.22
Upholsterers	13	20.1	16.8	5.6	.05	-.02
Hosts and hostesses, restaurant/lounge/ coffee shop	-52	20.3	12.3	10.7	.28	.42
Reservation and transportation ticket agents and travel clerks	-30	20.5	4.8	22.2	.06	.17
File clerks	-61	20.8	16.0	6.8	.05	.29
Recreation workers	-48	20.9	4.1	15.2	.16	.32
Psychologists	-29	21.0	6.5	11.6	.11	.20
Electronics repairers, commercial and industrial equipment	16	21.1	15.3	4.4	.09	-.01
Bartenders	82	21.2	35.7	10.9	.62	.08
Statistical clerks	-17	21.5	16.0	9.2	-.05	.03
Dentists	35	21.5	34.9	8.5	.25	.02
Tool and die makers	32	21.9	7.8	12.2	.08	-.08
Radiologic technologists and technicians ..	-38	22.0	11.4	11.9	.16	.27
Musicians	-59	22.2	2.4	22.1	.15	.36
Accountants and auditors	223	22.5	23.0	.0	1.94	.38
Producers, directors, actors, and entertainers	-22	22.6	2.2	12.6	.09	.16
Amusement and recreation attendants	-64	22.7	1.0	21.4	.24	.44
Head sawyers and saw machine operators and tenders, setters, and setup operators	15	22.7	22.6	1.2	.03	-.04
College and university faculty	-194	22.8	4.9	18.8	-.65	.38
Paper goods machine setters and setup operators	12	23.0	27.7	3.7	.02	-.04
Sales agents, real estate	62	23.1	34.1	5.6	.26	-.09
Dispatchers, police, fire, and ambulance ...	-19	23.1	10.8	13.9	.04	.11
Duplicating, mail, and other office machine operators	-55	23.7	21.0	9.1	.15	.34
Punch machine setters and setup operators, metal and plastic	12	23.9	7.6	12.9	-.01	-.06
Flight attendants	-26	24.2	3.9	27.1	.09	.18
Chemical engineers	13	24.6	15.3	9.2	.07	-.01
Farm workers	171	24.7	11.7	6.7	-.87	-1.33
Postal mail carriers	-83	25.1	6.6	19.7	.05	.39
Radio and television announcers and newscasters	13	25.8	10.2	17.4	.04	-.03
Social workers	-151	26.5	10.5	15.9	.48	.98
Barbers	17	26.8	30.2	2.1	.05	-.04
Station installers and repairers, telephone	10	27.1	7.6	18.1	-.07	-.09
Insurance claims clerks	-33	27.5	22.1	8.7	.06	.18
Teachers' aides and educational assistants	-266	27.6	7.6	20.8	.66	1.60
Sheriffs and deputy sheriffs	-24	27.7	17.0	12.9	.01	.11
Messengers	-39	28.1	23.8	5.6	.06	.21
Correction officers	-89	28.3	20.0	10.3	.36	.63
Civil engineers, including traffic engineers	55	29.3	22.9	4.9	.34	.00

Table 2. Continued—Employment, by occupation, 1984 actual and 1995 projected and actual

[Numbers in thousands]						
Occupation	Numerical error, 1995 (projected minus actual)	Absolute percent error, 1995	Absolute percent error, 1995		Share of total job growth, 1984–95	
			Actual industry totals to projected staffing pattern	Actual staffing pattern to projected industry totals	Projected	Actual
Telephone and cable television line installers and repairers	-59	29.5	38.1	13.7	.11	.33
Textile machine setters and setup operators	11	29.6	39.1	4.9	-.06	-.09
Industrial engineers, except safety engineers	35	30.5	4.9	21.0	.22	.00
Vehicle washers and equipment cleaners ..	-78	30.5	2.6	29.0	.08	.39
Computer operators, except peripheral equipment	83	31.0	35.3	1.6	.68	.11
Machine tool cutting operators and tenders, metal and plastic	39	31.4	17.8	10.4	-.05	-.20
Child care workers	-258	31.4	19.1	15.5	.32	1.33
Nursery workers	-27	31.4	16.3	16.1	.02	.13
Mechanical engineers	75	32.3	14.5	14.8	.48	.01
Meat, poultry, and fish cutters and trimmers, hand	-45	32.4	6.0	27.9	-.03	.17
Lathe machine tool setters and setup operators, metal and plastic	24	32.6	13.0	15.4	.00	-.11
Grinding machine setters and setup operators, metal and plastic	23	36.1	21.0	13.3	-.01	-.11
Drill machine tool setters and setup operators, metal and plastic	17	36.8	16.6	17.2	.00	-.08
Electrical and electronic assemblers	82	37.6	4.6	43.0	.27	-.16
Data-processing equipment repairers	29	38.5	33.2	3.1	.28	.07
Switchboard operators	92	38.9	48.9	7.4	.46	-.08
Electrical and electronic equipment assemblers, precision	57	38.9	6.8	48.7	.19	-.12
Animal caretakers, except farm	-49	39.3	13.2	22.4	.03	.23
Computer programmers	223	40.0	46.2	3.3	2.13	.51
Adult and vocational education teachers ...	-235	40.1	26.4	15.1	.30	1.22
Computer systems analysts, engineers, and scientists	-356	41.5	39.8	3.6	1.23	2.38
Structural and reinforcing metal workers ...	27	43.3	47.6	2.8	.09	-.06
Typists and word processors	292	44.0	55.5	8.2	.20	-1.11
Bill and account collectors	-115	44.5	42.5	3.1	.20	.63
Electrical and electronic technicians/technologists	144	45.5	25.7	17.7	.94	.03
Welding machine setters, operators, and tenders	50	46.3	29.6	13.8	.16	-.10
Reporters and correspondents	26	46.6	16.6	10.9	.09	-.05
Custom tailors and sewers	41	49.4	47.9	3.2	.07	-.12
Emergency medical technicians	-74	53.1	39.0	23.1	.02	.33
Electromechanical equipment assemblers, precision	27	55.1	.7	42.3	.09	-.05
Adjustment clerks	-226	58.8	59.5	.4	.18	1.09
Precision instrument repairers	26	65.0	21.4	22.4	.05	-.08
Service station attendants	120	71.4	85.6	16.3	-.01	-.52
Electrical and electronics engineers	253	71.8	41.4	20.2	1.30	-.20
Roustabouts	52	190.1	37.6	114.6	.01	-.22

was expected to lead to declining demand for vocational education and training. However, the growing number of both entry-level and experienced workers in need of vocational training or retraining in order to update job skills and keep up with rapidly changing technology had more of an impact on demand for these teachers than was anticipated.

Likewise, errors in projections for computer-related occupations were a significant factor contributing to the underestimate of employment for professional specialty occupations.⁶ A closer examination of the simulated matrices for certain others reveals the cause of the errors to be largely a result of incorrect assumptions behind the projections of

the utilization of these workers by industry. (See table 4.) In the case of computer programmers, highly significant increases were projected across all industries as improvements in computer hardware and software made the technology more versatile, cheaper, and easier to use. But it was precisely these improvements that led to more moder-

ate growth, as computer users, other computer professionals, and automation were able to take over many of the tasks previously performed only by programmers. Similarly, moderate increases were expected for computer operators and operators of peripheral electronic data-processing equipment across all industries as computer usage rose throughout the economy. However, expanding technologies not only reduced both the size and cost of computer equipment, but also automated the tasks previously performed by numerous operators.

In contrast to the increases in employment projected for programmers, significant *decreases* were projected across all industries for data entry keyers, except composing, as a result of anticipated technological change. Although the trend was correctly anticipated, technology appears to have had an even greater impact on these workers than was projected. Virtually the entire error in the projections for data entry keyers, composing, can be attributed to incorrect staffing patterns.

Overall industry employment for health services was significantly underestimated for hospitals, as well as doctors, nursing homes, and miscellaneous health services. Absolute errors for health-related occupations ranged from 53 percent for emergency medical technicians to 1 percent for pharmacists. Although the industry projections had a profound impact on estimated employment for these occupations, much of the error in the individual health-related occupations also can be attributed to errors in staffing patterns. (See table 5.) For example, the 1984 projection of a growing demand for physicians' assistants was realized as the health care industry began to focus more and more on cost containment. The Bureau projected the employment of physicians' assistants to increase moderately in hospitals and significantly in outpatient care facilities. However, the projection was too conservative. Similarly, the im-

pact of a growing demand for rehabilitation and long-term care services was underestimated, as the employment of occupational therapists, projected to grow much faster than average at 36 percent, grew by a phenomenal 159 percent. In the case of licensed practical nurses, the projection was relatively accurate, off by only 4 percent, a result of both underprojected industry totals for health services and incorrect staffing patterns, which offset each other. Along with changes in patient care requirements, the trend toward a reliance on nursing personnel with higher levels of clinical skill was expected to slow growth among licensed practical nurses. However, rapid industry growth in

health services and an aging population spurred more demand than was originally expected in nursing homes and residential care facilities.

The BLS evaluation of industry projections also revealed that employment in manufacturing was projected to increase over the 1984–95 period, rather than decline. As a result, the majority of the occupations with declining employment that were projected to increase are in manufacturing and include engineers, precision production workers, machine operators and tenders, and handworkers and fabricators. For example, the employment of workers concentrated in industries that manufacture computer and office equipment, electrical industrial

Table 3. Sources of projection error for education-related occupations, 1995, and projected and actual share of total job growth, 1984–95

Occupation	Absolute percent error	Absolute percent error (actual industry totals to projected staffing pattern)	Absolute percent error (actual staffing pattern to projected industry totals)	Share of total job growth	
				Projected	Actual
College and university faculty	22.8	4.9	18.8	-0.65	0.38
Adult and vocational education teachers	40.1	26.4	15.1	.30	1.22
Teachers' aides and educational assistants	27.6	7.6	20.8	.66	1.60

Table 4. Sources of projection error for computer-related occupations, 1995, and projected and actual share of total job growth, 1984–95

Occupation	Absolute percent error	Absolute percent error (actual industry totals to projected staffing pattern)	Absolute percent error (actual staffing pattern to projected industry totals)	Share of total job growth	
				Projected	Actual
Computer programmers	40.0	46.2	3.3	2.13	0.51
Computer operators, except of peripheral equipment	31.0	35.3	1.6	.68	.11
Operators of peripheral electronic data-processing equipment	100.7	108.4	4.2	.12	-.05
Data entry keyers, except composing	10.7	4.6	7.9	.01	.20
Data entry keyers, composing	79.8	79.9	5.3	.06	-.03

apparatus, electronic components and accessories, and aerospace components, such as those workers in occupations listed in table 6, was projected to grow slightly when, in fact, it fell from 1984 to 1995. As indicated in the table, the projected industry totals were the major factor contributing to the error for these occupations.

Implications for future analyses

The most recent occupational projections to be evaluated were those ending in the year 1990. Looking at the major occupational groups, we can readily see that the projections for 1995 appear more accurate overall than do the 1990 projections. No major group was off by more than in the past, and the largest absolute error for a major group was only 11.3 percent, compared with 22 percent in 1990 for the group, marketing and sales occupations. It is important to remember, however, that projections on such an aggregate scale are, by their nature, uncertain. Because individual occupations, and not major groups, are analyzed, errors are compounded as these occupations are combined. The detailed occupations that make up each group can be large enough that any error in their individual projection can affect the outcome for the overall major group.

In developing the detailed 1984–95 occupational projections, analysts reviewed all available data from both the OES survey and the Current Population Survey (CPS) and projected changes in the occupation-industry cells accordingly, bringing knowledge gained through experience and through studies undertaken in preparing the *Occupational Outlook Handbook*. As a result, numerous changes were made to the occupational coefficients—changes affecting the proportion of an occupation within each industry—as analytical judgments were translated into numerical estimates. A BLS bulletin indicates that, in order to maintain consistency among judgments of the analysts,

Table 5. Sources of projection error for health-related occupations, 1995, and projected and actual share of total job growth, 1984–95

Occupation	Absolute percent error	Absolute percent error (actual industry totals to projected staffing pattern)	Absolute percent error (actual staffing pattern to projected industry totals)	Share of total job growth	
				Projected	Actual
Physicians' assistants	42.4	34.7	11.4	0.07	0.16
Occupational therapists	47.4	39.9	13.0	.05	.15
Occupational therapy assistants and aides	41.9	33.8	13.6	.01	.03
Emergency medical technicians	53.1	39.0	23.1	.02	.33
Licensed practical nurses	4.0	10.0	12.6	.64	.56

Table 6. Sources of projection error for production workers, 1995, and projected and actual share of total job growth, 1984–95

Occupation	Absolute percent error	Absolute percent error (actual industry totals to projected staffing pattern)	Absolute percent error (actual staffing pattern to projected industry totals)	Share of total job growth	
				Projected	Actual
Aircraft assemblers, precision	27.1	16.0	52.1	0.02	-0.01
Electrical and electronic equipment assemblers, precision	38.9	6.8	48.7	.19	-.12
Electromechanical equipment assemblers, precision	55.1	.7	42.3	.09	-.05
Electrical and electronic assemblers	37.6	4.6	43.0	.27	-.16

the following guidelines for increasing or decreasing coefficients were implemented to develop the initial projected coefficients for all occupations across all industries:⁷ small change—1 to 4 percent; moderate change—5 to 9 percent; significant change—10 to 20 percent; and very significant change—20 or more percent. The evaluation of the 1984–95 projections has provided analysts the first chance to look back at their work.

Prior to the current evaluation, every BLS evaluation of its occupational projections revealed the projections to be conservative. As the analysis of both individual projections for detailed occu-

pations and percent-change ranges in the *Occupational Outlook Handbook* indicate, the 1984–95 projections are also on the conservative side. The majority of the projections were clustered around average growth, when, in actuality, more occupations appear to have grown much faster than the average or to have declined. The inherent conservatism contributed to overall errors in staffing patterns as well, and part of the reason appears to have been that analysts were too conservative in projecting the matrix coefficients. This trend toward conservatism is recognized by the Bureau, and since 1984, guidelines for projecting the changes in the occupational co-

efficients have been revised. For example, in developing the most recent round of projections from 1994 to 2005, the Bureau set forth the following guidelines for interpreting the projected range of changes in the coefficients: small change—10 percent; moderate change—20 percent; significant change—35 percent; and very significant change—50 percent or more. Expanding the range for identifying small, moderate, and large changes should clearly have an impact on the conservatism inherent in the methodology.

With the help of the simulated matrices prepared for the current evaluation, however, it has been possible to pinpoint the *major* source of error for each detailed occupation. Although the impact of good industry projections on developing good occupational projections cannot be underestimated, the chief weakness appears to be in projecting staffing patterns. In the simulated matrix for which the projected staffing patterns were applied to actual 1995 industry totals, the sum of the absolute errors, weighted by 1995 employment, was 7.7 percent. By contrast, in the matrix for which actual 1995 staffing patterns were applied to projected 1995 industry totals, the sum of the absolute errors, weighted by 1995 employment, dropped to 5.6 percent.

In addition to the influence of conservative coefficient change factors on the projections, the impacts of features such as technological change and trends that were not fully realized contributed significantly to errors in staffing patterns. Incorrect analytical judgments relating to the rate and impact of technological change and to trends such as outsourcing and the growth of temporary help agencies played a large role in this regard. The analysis behind the projection for typists is a case in point. As mentioned by Neal Rosenthal in the introduction to this article, the use of computers and word-processing equipment was expected to have a negative impact on the employment of typists and word

processors across all industries. But because it was assumed that a very large number of establishments were already using such equipment, and because future technological advances in computing technology were not fully realized at the time, the declining trend in the employment of typists and word processors was not expected to accelerate. The analysis wound up underestimating the impact of changing technology, as actual employment in 1995 fell short of projected employment by more than 290 thousand workers.

Similar to unforeseeable events such as the reduction in defense spending resulting from the breakup of the Soviet Union, changes brought about by technology are becoming harder to predict. For example, the impact of Internet technology is nowhere near being fully realized today, just as the expansion of computer technology into both the home and the workplace, as well as the impact of the personal computer, was recognized, but not fully accounted for, in past projection cycles. □

Footnotes

¹ In discussing the accuracy of the projected distribution of employment growth among major groups, it is worth addressing a claim made by John H. Bishop in a recent article evaluating the accuracy of BLS projections that “The BLS systematically under-projects the growth of skilled jobs and over-projects the growth of unskilled jobs” (John H. Bishop, “Is the Market for College Graduates Headed for a Bust? Demand and Supply Responses to Rising College Wage Premiums,” *New England Economic Review*, May–June 1996, pp. 115–34, quote from p. 123). In his comparison of projected and actual growth for the major occupational groups from 1984 to 1995, Bishop concluded that BLS projected shares of employment growth for professional, technical, and managerial jobs, and for operative, laborer, and service jobs were “far off the mark.” If we examine the projected and actual shares of employment growth presented in table 1, however, this does not appear to be the case. Using Current Population Survey–(CPS) based data as the “actual” data to compare with the projections, rather than data based on the Occupational Employment Statistics (OES) survey, which the Bureau uses in developing its projections, Bishop concluded that, from 1984 to 1995, professional, technical, and managerial jobs accounted for 58.3 percent of employment growth,

and operative, laborer, and service jobs accounted for 15.9 percent. However, OES-survey-based data paint a different picture. The problem is that the two data sources are not comparable when one estimates employment growth shares for the major occupational groups. BLS industry-occupation data (see table 1) indicate that professional, technical, and managerial jobs actually accounted for only 38.5 percent of employment growth from 1984 to 1995, which is much closer to the projected 35.5 percent. Likewise, operative, laborer, and service jobs accounted for 26.3 percent, only slightly lower than the projected 27.8 percent. (See John H. Bishop and Shani Carter, “How accurate are recent BLS occupational projections?” *Monthly Labor Review*, October 1991, pp. 37–43; and John H. Bishop and Shani Carter, “The Worsening Shortage of College-Graduate Workers,” *Educational Evaluation and Policy Analysis*, Fall 1991, pp. 221–46, as well as Bishop, “The Market for College Graduates.”)

² More details on assumptions leading to the overprojection of engineers are presented in *Occupational Outlook Quarterly* (Bureau of Labor Statistics, Fall 1997).

³ Details on all 348 occupations included in the evaluation are available from the Office of Employment Projections. Data comparing employment, percent changes, and employment growth categories for all 348 occupations included in the evaluation appear in the Fall 1997 *Occupational Outlook Quarterly*.

⁴ Only 132 occupations were covered in the evaluation of the 1990 projections. (See Neal H. Rosenthal, “Evaluating the 1990 projections of occupational employment,” *Monthly Labor Review*, August 1992, pp. 32–48.)

⁵ See pages 9–15, this issue.

⁶ The detailed professional occupation with the largest underestimate of employment was computer engineers, scientists, and systems analysts. So as not to lose a group with significant employment change in the evaluation, the three occupations were combined in order to accommodate the change in the occupational classification when computer engineers and the residual, all other computer scientists, were added to the OES survey in 1989. Though it is not classification pure—that is to say, a change occurred with the addition of computer engineers in 1989—the combined group is assumed to account for the same group of workers for which projections were developed in 1984. The OES survey definition of what computer engineers do is “Analyze data processing requirements to plan EDP system to provide system capabilities required for projected work loads. Plan layout and installation of new systems or modifications of existing system. May set up and control analog or hybrid computer systems to solve scientific or engineering problems” (*Occupational Employment Statistics Dictionary of Occupations: 1988–1996* (Bureau of Labor Statistics, September 1995)). Because the title “computer engineer” is often interpreted to denote engineers who design computer hardware, it is likely that some workers in the group were being collected as part of all other engineers or as electrical and electronics engineers. However,

the historical time series does not reveal any great shift in employment when the separate title was added, indicating that computer engineers were already distributed between electrical and electronics engineers and other computer professionals. CPS data show a similar trend, and there is no separate category for computer engineers.

Some shift in employment away from engineers

probably accounts for a portion of the growth in this occupation. Nonetheless, even with the addition of the title "computer engineer," the remarkable growth of computer-related occupations was underestimated, in large part due to the unanticipated rapid advancement of computing technology, particularly the expansion of personal computers. Over the 1984–95 period, the employment

of computer systems analysts and scientists was projected to increase 64 percent, making this occupation one of the 10 projected fastest growing ones. However, employment actually increased 181 percent over the period.

⁷ See *Employment Projections for 1995: Data and Methods*, Bulletin 2253 (Bureau of Labor Statistics, April 1986).

Technical note

Framework of the projections. The 1984–95 projections of occupational employment were developed within the framework of an industry-occupation matrix containing 378 industries and more than 500 occupations. Data used to develop the 1984 matrix and projected 1995 matrix came from a variety of sources. For industries covered by the Occupational Employment Statistics (OES) survey, the most current survey data were used to develop the occupational distribution or staffing patterns for estimating 1984 wage and salary employment. Employment by occupation in each industry was derived by multiplying the occupational distribution of employment by 1984 wage and salary worker employment for each industry, each of which was obtained from the BLS Current Employment Statistics (CES) survey. Both the CES and OES surveys are surveys of business establishments, covering only wage and salary workers. The 1984 CPS data were used to develop the occupational distribution patterns for workers in agriculture and private households, as well as to develop economywide estimates of self-employed and unpaid family workers by occupation. Occupational distribution patterns for the Federal Government were developed from data compiled by the Office of Personnel Management. Data from the National Center For Education Statistics (NCES) were used for teachers, and data from other independent sources were utilized for select occupations.¹

The most recent OES survey data available for developing the 1984 matrix came from 1991 for mining, construction, finance, insurance, real estate, and services, other than hospitals and education; from 1982 for trade, transportation, communications, public utilities, and State and local governments; and from 1983 for manufacturing industries and hospitals. The OES survey occupational classification system was revised significantly in 1983, to make it compatible with the newly released Standard Occupational Classification. As a result, only the 1983 survey of manufacturing and hospitals conformed to the 1983 classification, so BLS analysts "forced" the 1981 and 1982 data into

the new 1983 configuration.² However, some occupations were split into more than one occupation or had not been previously identified separately. One of the difficulties in evaluating the 1984–95 set of projections results from the 1984 matrix being constructed with OES survey data collected prior to 1983. The Bureau has developed a national industry-occupation matrix time series covering the 1983–95 period. The series is as consistent as possible with the occupational classification used in the 1994 matrix, which was the most current matrix available when the historical time series were developed.³ The actual 1995 employment data used for purposes of the current evaluation were taken from that time series. The 1986 matrix, the first matrix in which all of the OES survey data came from surveys conducted after 1983, was used to develop the 1984 data. For this reason, the original 1984–95 published matrix data were not comparable to the actual 1984 and 1995 data published in the historical time series.

In order to reconcile the projected matrix with the historical time series for the purpose of the evaluation, simulated 1984–95 projections were created. To develop these projections, each employment cell coefficient (percent of industry employment accounted for by the occupation) in the 1984 matrix in the historical time series was multiplied by the 1984–95 percent change in that coefficient (change factor) in the original 1984 and 1995 matrices, and the resulting distribution of occupational employment by industry was then benchmarked to the projected industry employment in the original 1995 industry projections. In the resulting simulated projections for most occupations, the projected 1984–95 percent changes remained the same or were very close to the original projections, but the data were defined consistently with the historical time series. The employment of self-employed and unpaid family workers was taken directly from the original published 1984–95 projections, because the CPS data in 1984 were comparable to the CPS data in 1995, with some minor exceptions. Occupations in the historical matrix that did not appear in the original 1984–95 projections matrix were

aggregated into the appropriate residuals; for example, loan interviewers were aggregated into the "all other clerical occupations" residual.

Once the data were prepared, the next task was to select the occupations for evaluation. Occupations were selected only if they met certain criteria. To begin with, all residual occupations were dropped from the evaluation, because occupations for which there were only aggregated data were not necessarily comparable, as indicated in the preceding paragraph. Of the remaining detailed occupations, only those for which the definition remained comparable over the projection period were included. Occupations also were dropped if examination of the historical time series indicated inconsistencies with logical expectations for the year-to-year total employment trend. Because occupations covered in the OES surveys changed over time as improvements in the quality of the survey were made, problems occurred in the development of comparable time series. In order to make the historical time series as consistent as possible with the 1994 matrix, a number of steps were taken to achieve uniformity over time.⁴ For example, occupations appearing in an earlier matrix that were collapsed in the 1994 matrix were also collapsed in the time series. Finally, seven occupations were eliminated because the base-year numbers from the original 1984 published matrix were so different from those in the historical 1984 matrix, that they did not appear comparable. Consequently, additional occupations were eliminated because the difference in employment between the original 1984 published matrix and the 1984 historical matrix was too large, based on certain criteria.⁵

Other data errors. The discussion in the text of the article, as well as in this technical note, has focused on errors in individual projections that can be traced back to incorrectly anticipated changes in staffing patterns or incorrect industry projections. Also, comparability problems stemming from inconsistencies in the classification system over time were highlighted. However, it is important to bear in mind that other data problems exist and that differences in actual and pro-

jected employment levels are not always due to projection errors. Consequently, real employment trends in an occupation may not

necessarily be measured by comparable surveys 10 years apart. And although survey data are generally considered reliable, sampling

and response errors certainly had an impact on the data in both the initial and the terminal years of the projection period evaluated. □

Footnote to the technical note

¹ Prior to 1990, NCES data were used for preschool teachers and kindergarten and elementary school teachers. However, in the 1990, 1992, and 1994 matrices, OES survey data were employed for these occupations, but the OES classification broke teachers up into elementary school teachers, on the one hand, and preschool and kindergarten teachers, on the other. Similar difficulties were encountered with higher education teachers. For these reasons, employment data for elementary school teachers and preschool and kindergarten teachers were rolled up in the historical time series, but dropped from the current evaluation.

² A comprehensive methodological statement outlining BLS data sources and procedures is published in *Employment Projections for 1995*.

³ For more information on the methodology used to develop the projections, see the appendix to the series of articles under "Employment Outlook: 1994–2005," *Monthly Labor Review*, November 1995, pp. 85–87; and *BLS Handbook of Methods*, Bulletin 2490 (Bureau of Labor Statistics, April 1997).

⁴ For a more comprehensive methodological statement, *The National Industry-Occupation Em-*

ployment Matrix: 1983–1995 Time Series, a technical note available from the Office of Employment Projections.

⁵ Specifically, occupations were dropped if the original 1984 level of employment differed by more than 40,000, but less than 100,000, from the actual 1984 level in the historical matrix, and the percent difference in 1984 employment was more than 50 percent; or if the original 1984 level of employment differed by more than 100,000 from the actual 1984 level in the historical matrix, and the percent difference in 1984 employment was more than 30 percent.

Errata

In the article, "Employment trends in textiles and apparel, 1973–2005," *Monthly Labor Review*, August 1997, table 6 (page 33) is mislabeled. The title should be (correction in italics):

Table 6. Employment in the *apparel* industry: 1983, 1994, 2005

Also, in the table, the total for all occupations in 1983 is 1,163 (in thousands).
