Shortages of machinists: an evaluation of the information

Shortages of machinists appear to exist but the statistics that quantify the shortages are unreliable; some employers can cope by offering higher wages, others may use technological improvements or increase training

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Is there a shortage of machinists? Will machinists be in short supply in the future? Various studies offer conflicting answers that cannot be resolved with available data. However, an examination of Current Population Survey, Area Wage Survey, and other data can shed light on *why* the conflict exists. This article undertakes such an examination.

During the past few years many articles dealing with current and expected future shortages of machinists were published in national periodicals. Their basic conclusions are generally consistent: Employers currently are not able to hire as many skilled machinists as they would like; current training is not sufficient to alleviate shortages; and similar conditions have existed for some time. Concern about the future supply is also based on the expected decline in the number of 18- to 24-year-old workers in the 1980's. However, different conclusions result from studies concerning technological change. They generally state that the need for manual labor in factories, especially highly skilled machinists, will be reduced significantly in the future.

Because of the different viewpoints of these studies, future supply-demand conditions for machinists are unclear. Furthermore, very little of the statistical information used to present both sides is based on "hard data." Most data are obtained from employers in surveys that have questionable reliability. Existing Federal programs do not collect data on shortages of workers in specific occupations; such data would be very expensive to collect and because of their complexity their reliability would be questionable. Also, information about future occupational shortages is very limited. Nevertheless, by summarizing and analyzing a wide variety of data, insights can be gained into the problems and issues.

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Definition of terms

Shortages. Data are often misused or misinterpreted because definitions of terms are not clearly specified. Shortage, as used here, means that sufficient workers are not available and willing to work at the existing wage level. Traditional economic theory, which states that if wages are raised, supply will increase because more workers will seek jobs, is consistent with this definition. However, it usually takes time to acquire the required skills, so demand may not be met in the short run. Under these conditions, wages can be expected to rise as employers hire trained workers from each other, overtime will be used to meet production schedules, and less skilled workers will be employed. These factors are apt to raise prices and reduce productivity.

In addition, it is likely that employers would raise wages for trainees in an attempt to attract qualified

workers to machinist training programs and thereby reduce future shortages. However, wages alone do not affect one's career choice; working conditions, social status, and personal abilities and preferences are also considerations.

Hence, the job market for an occupation is very complex. Workers employed in a specific occupation may shift to another occupation; die; retire; change jobs by switching employers but remaining in the same occupation; or lose their jobs and become unemployed. Most occupations also have several skill levels, and employees can change jobs within the same occupation by moving up the skill ladder. At the same time that individuals leave an occupation or change jobs within it, others enter the occupation. They come from outside the labor force, as do new young workers and persons who are returning to work after raising a family, pursuing some additional education, or a short period of retirement. Entrants also may come from another occupation or from the ranks of the unemployed. Unfortunately, available data do not quantify these various situations accurately.

Machining occupational classification. Many discussions about shortages of machinists are confusing because it is unclear which jobs are included in the job classification. For example, the occupational titles of machinist, machining occupations, and metalworking occupations are often used to mean different groups of workers but sometimes they are used interchangeably. Furthermore, because consistency in occupational definitions does not exist among all Federal statistical programs, data on machinists from various sources may reflect different groupings of workers. For example, the occupational classification used by the Bureau to collect data on wages of machinists from the Area Wage Survey Program is not identical to the classification in the Current Population Survey (CPS). Similarly, the definition of machinists for which data are compiled on job openings registered by employers with the U.S. Employment Service does not match the CPS definition. Data on vocational programs also are classified differently.[1] The coverage of machinists in the various surveys conducted by employer associations to identify shortages also differs from that used in most Federal statistical programs. Inclusion of specific jobs within the broad term machinists also changes from one employer survey to another and probably among employers responding to the same survey. Therefore, results from one survey should not be compared with data based on other surveys unless consistency of job content has been ensured. Unfortunately, such comparisons have been made in the past even though the data were not comparable. This practice has contributed to much of the perplexity concerning shortages of machinists.

To avoid confusion in this article, the CPS definition of machinists was used because that survey provides more data than any other single source about employment and unemployment trends for workers in machining occupations. Furthermore, many other statistical series are reasonably compatible with the CPS or can be related through crosswalks.

Machining workers are classified in two skill-level groups in the CPS—skilled workers and operatives. Three skilled machining occupations identified separately in the CPS are discussed here—machinists, tool-and-die makers, and job and die setters. Data for five operative occupations—drill-press operatives; grinding-machine operatives; lathe and milling-machine operatives; punch-press-machine operatives; and other precision machine operatives—are also analyzed.

Each of these occupations includes workers found in a variety of jobs as classified by employers. For example, the occupation of tool-and-die maker in the CPS's conducted during 1972–80, includes 35 separate job titles, including diemaker, diesinker, jig-bore-tool maker, tool adjuster, and jig-and-fixture builder. Similarly, skilled machinists comprise about 25 specific job titles such as fitter-machine, precision machinist, toolroom machinist, lathe machinist, and aircraft machinist. Lathe and milling-machine operatives include more than 60 different job titles, such as lathe operator, lathe turner, tool-lathe operator, milling-machine operator, and gear cutter.

It should be pointed out that CPS statistics are compiled as if there were a clear break in skills between occupations rather than a continuum within each category. For example, all workers in the machinist or the lathe operators category do not perform at the same skill level. Also, the skills of workers who are counted in the skilled machining occupations in the CPS overlap with those of some operatives.

Machinists in the 1970's

Employment. Combined employment in the three skilled machining occupations covered separately in the CPS—job and die setters, metal; machinists; and tool-and-die makers—increased from 655,000 to 834,000, or 27 percent, between 1972 and 1980.[2] Job growth averaged 22,400 a year. (See table 1.) In comparison, employment in manufacturing industries, where most machinists are employed, grew by only 6 percent over the same period. Machinist employment grew from 377,000 to 567,000, or 50 percent, but the other skilled machining occupations—job and die setters and tool-and-die makers—declined slightly. During the 1975 recession, employment did not decrease significantly for any of the skilled machining occupations.

Employment in each of the operative machining occupations fell between 1972 and 1980 or remained at

Table 1. Employment in machining occupations, annual averages, 1972–80

[Numbers in thousands]

Occupation	1972	1973	1974	1975	1976	1977	1978	1979	1980
Skilled machining occupations, total	655	682	735	731	758	768	773	824	834
Job and die setters, metal	94	93	97	96	92	97	98	90	91
Machinists	377	402	461	461	478	478	493	552	567
Tool-and-die makers	184	187	177	174	188	193	182	182	176
Operative machining occupations, total	625	595	601	489	508	524	542	562	502
Drill press	75	77	69	61	65	62	64	67	61
Grinding machine	130	140	152	132	133	126	129	143	134
Lathe milling machine	123	136	137	118	106	121	125	123	114
Punch stamping press	157	175	170	130	155	152	156	158	127
Other precision machines	140	67	73	48	49	63	68	71	66

roughly the same level. For operative machining occupations as a group, employment dropped by an average of 15,400 annually. However, during the 1975 recession, employment decreased significantly in each of these occupations.

Unemployment. Unemployment rates for machinists and tool-and-die makers were lower than those for craftworkers as a whole in each year from 1972 to 1980. (See table 2.) The unemployment rates for tool-and-die makers were very low—less than 3 percent—for most of the period. However, even for this occupation the rate jumped significantly to 7.1 percent during the 1975 recession, although it declined to 3.3 percent in 1976. The unemployment rate for machinists was lower than that for tool-and-die makers prior to the 1975 recession, but was higher after 1975. The unemployment rate for job and die setters was also relatively low in the 1970's. During the 1970's, the unemployment rate for the skilled machining occupations was lower than that for durable goods manufacturing as a whole, in which more than 80 percent of all skilled machining workers are employed. Unemployment rates for operative machining occupations were generally higher than average.

Earnings. Earnings data for machinists, tool-and-die makers, and machine-tool operators are collected through the Bureau's Area Wage Surveys. The definitions for both machinists and tool-and-die makers used in these surveys are not identical to those in the CPS, but they are very comparable. However, the skill level of the machine-tool operators for which wage data are collected is much higher than that which the average worker reported in operative machining occupations in the CPS.

The hourly earnings of machinists, tool-and-die makers, and machine-tool operators from the Area Wage Surveys varied only slightly within the same city for each year in which data were available during 1972–80. In general, tool-and-die makers earned a little more than machinists who in turn earned slightly more than machine-tool operators, although the pattern varied among cities. (See table 3.) For each occupation, there were some significant earnings differentials among cities.

Workers in the machining occupations covered in the BLS Area Wage Surveys had higher average hourly earnings than all production workers in manufacturing industries in the same city as reported in the Bureau's Current Employment Statistics program. Between 1972 and 1980, the wages of workers in the machining occupations relative to all production workers remained the same or declined slightly in five cities for which data are readily available.

Training. Data on registered apprenticeships indicate that completions declined significantly between 1970 and 1980 for machinists and tool-and-die makers. The number of machinist apprenticeship completions fell from 3,822 to 1,905 between 1970 and 1975, increased to nearly 3,000 in 1977, and then decreased to 2,450 in 1979. Tool-and-die makers followed a similar pattern but their decline from 1970 was even greater. The following tabulation shows the number of completions and additions to registered apprenticeship programs in 1972–79 for machinists and tool-and-die makers:

	Machinists		*Tool-and-die makers*	
	Completions	*Additions*	*Completions*	*Additions*
1972	3,695	—	3,825	—
1973	2,357	—	2,716	—
1974	2,047	6,526	2,051	4,934
1975	1,905	4,858	1,849	2,900
1976	2,526	5,567	1,901	3,888
1977	2,967	5,488	2,387	5,150
1978	2,859	6,385	2,311	5,501
1979	2,450	6,397	1,807	5,379

However, workers who complete apprenticeship programs are not new entrants to an occupation in an accounting sense, because apprentices are counted in the employment totals for the occupation. Adding them as new workers, when they complete training, would result in double counting. Data on the additions to apprenticeship programs each year provide a better measure of new entrants to an occupation. These data show that the number of new additions to apprenticeship programs averaged between 5,000 and 6,500 for machinists and 3,000 to 5,500 for tool-and-die makers from the mid- to late 1970's. They do not display the declining pattern shown by completions.

Training programs for tool-and-die makers, machine-tool operators, and machine-shop occupations also are offered in public vocational educational programs. Data on completions are very sparse and their meaning is vague because both secondary and post-secondary completions are added together in reports. Thus, the completions may reflect a 1- or 2-year program or just one course. Furthermore, the skills of the individuals com-

pleting these programs are minimal compared to those of persons finishing apprenticeship programs, and completion of vocational courses does not qualify individuals for journeyman positions. Generally, those completing these programs subsequently enter apprenticeship programs in order to pursue careers in machining occupations. In 1978, 2,400 students completed tool-and-die making training in public vocational schools, 3,400 completed training in machine-tool operation, and 32,000 completed training in other machine-shop occupations.

Implications of the data

The data presented above do not prove or disprove that shortages of machinists exist. Nevertheless, they are compatible with the existence of such shortages. The data indicate that skilled machinists are important in production activities: During the 1970's, they increased as a proportion of total employment, and even during the 1975 recession, their employment did not decrease. The very low unemployment rates for skilled machining workers during the 1970's also is very compatible with a shortage of workers. However, it is doubtful that general shortages of machine operatives occurred during this period because of their relatively high unemployment rates. However, during some years, these rates were very low for certain operative occupations and indicate possible shortages.

Unlike the data on unemployment, those on earnings of machining workers do not show a pattern that would, in theory, be expected with the existence of shortages. When there are shortages in an occupation over time, its wages should increase relative to those of other workers who are not in limited supply. This was not the case for machinists, as the differential wage between machinists and all production workers did not change significantly. However, the constant wage differential is not definitive proof that a shortage did not exist. Wage structures are interconnected in complex ways, and there could be conditions that would not allow the differential to change significantly despite a shortage. For example, the industries employing many machinists and tool-and-die makers have numerous small firms that compete for work through bids in response to service requests. If one firm raises its wages, it must also raise its bids, and risk losing work. Thus, raising wages to attract workers may be counter-productive, if the new workers are subsequently not needed because work is not available.

Table 2. Unemployment rates for machining occupations, annual averages, 1972–80

[In percent]

Occupation	1972	1973	1974	1975	1976	1977	1978	1979	1980
Total, all workers	5.6	4.9	5.6	8.5	7.7	7.0	6.0	5.8	7.1
Craftworkers	4.3	3.7	4.4	8.3	6.9	5.6	4.6	4.5	6.6
Job and die setters, metal	3.1	1.2	2.2	7.8	4.0	3.2	2.8	3.5	4.8
Machinists	3.2	1.9	2.2	7.0	5.9	3.8	3.1	2.7	4.8
Tool-and-die makers	4.0	1.6	2.5	7.1	3.3	2.0	2.6	.9	2.8
Nontransport operatives	7.6	6.1	13.2	14.7	10.8	9.5	8.1	8.4	12.2
Drill press	9.5	6.3	9.9	20.0	15.8	9.5	4.9	5.8	13.4
Grinding machine	5.6	2.2	4.5	11.8	7.1	4.7	4.9	3.1	8.8
Lathe milling machine	5.1	1.8	3.4	13.1	8.6	5.3	4.6	2.9	9.1
Punch stamping press	8.2	4.7	9.5	23.2	12.1	9.4	8.0	12.9	24.1
Other precision machines	5.8	3.4	4.9	14.5	10.3	5.6	7.0	6.7	12.8
Total, durable goods manufacturing	5.4	7.9	5.4	11.3	7.7	6.2	4.9	5.0	8.9

Table 3. Earnings of workers in selected machining occupations relative to those of all production workers, selected cities, 1972 and 1980

City and occupation	1972	1980
Boston:		
Machinists	1.47	1.22
Machine-tool operators	1.43	1.12
Chicago:		
Machinists	1.31	1.32
Tool-and-die makers	1.41	1.39
Machine-tool operators	1.28	1.30
Houston:		
Machinists	1.29	1.23
Tool-and-die makers	1.17	1.15
Baltimore:		
Tool-and-die makers	1.32	1.31
Machine-tool operators	1.15	1.14
Cincinnati:		
Tool-and-die makers	1.30	1.26
Machine-tool operators	1.24	1.17

Trends in training through apprenticeship programs shed some light on the job market situation for machining workers because apprenticeship training is provided by employers. During periods of shortages or expected shortages, employers should be willing to increase training. However, during the 1970's, apprenticeships decreased, implying that shortages did not exist or that they were not severe enough to warrant increased training opportunities. However, the employer surveys conducted by associations discussed earlier in this article not only indicate the existence of shortages, but expanded apprenticeship training programs. But many employers prefer not to have registered apprenticeship programs because these must strictly conform to Department of Labor regulations, and last for 4 years. Many employers evidently feel they can train workers to acceptable standards in less time through nonregistered programs. Reducing the length of training is very consistent with the existence of shortages. Data on enrollment and completions of nonregistered programs do not show up in Federal statistics.

As indicated previously, specific data designed to measure occupational shortages are not compiled by the Federal Government. Although data are available on job orders placed with U.S. Employment Service offices throughout the country, they are not comprehensive, covering only an estimated 10 to 15 percent of all job

openings, and they are not statistically valid for analyzing year-to-year changes.

However, a 1980 pilot survey of job vacancies in Massachusetts, conducted to test the collectibility of such data, point to the existence of a shortage of machinists—at least in that State. The job vacancy rate (vacant jobs divided by total employment) for machinists was 13.3 percent in 1979 and 12.5 percent in 1980,[3] significantly higher than for any other occupation in the State. High vacancy rates (over 4 percent in each year) also were found for mechanical engineers, computer scientists, registered nurses, licensed practical nurses, and computer programmers. These occupations are traditionally placed in the "shortage" category, and it is significant that the vacancy rate for machinists was much higher.

Journal articles analyzing employment and shortages of machinists often discuss the age distribution of these workers. Much is written that the average age of machinists is increasing. Such reports generally imply that the age distribution of machinists is becoming skewed toward the older age groups; but data on the age distribution of machinists and job and die setters collected in the CPS dispute this conclusion. For example, between 1972 and 1980, the proportion of these workers who were 55 to 64 years old declined, and significant increases were recorded in the 20 to 24 and 25 to 34 age groups. The rise in the younger group followed the trend of the total population and of craftworkers as a whole. Some of the employer surveys we have mentioned, which indicate shortages and the need for more training, also imply that the increasing average age of these workers is not a problem.

A look at the 1980's

Because machining workers are key to many types of industrial production, economic and industrial planners are very concerned about the future job market for these workers. The issue is particularly significant to those concerned with the capability of U.S. industry to cope with a major defense buildup. Some insights about this topic can be gained from BLS projections of employment in machining occupations.[4]

Until 1980, the Bureau's occupational projections were developed using historical employment data derived from the CPS. However, in 1980, the Bureau shifted the base for current occupational employment from the CPS to employment data generated by the Occupational Employment Statistics (OES) Survey. OES data are obtained by mail questionnaire from a sample of establishments that is designed to produce estimates of industry staffing patterns. Specific occupational definitions are listed on the questionnaire for each major occupation in an industry, and up to 16 different machining occupations can be found on an industry questionnaire. For these reasons, as well as others related to survey methods and procedures, OES survey-based employment data are believed to be more accurate than those derived from the CPS for measuring employment data by detailed industry. However, because national OES survey data were not available prior to 1978, analysis of historical data is CPS-based.

Employment data on machining occupations in the CPS and the OES survey are not strictly comparable because of differences in definitions, as well as in survey procedures and methods. For example, the 1980 CPS total for skilled machining occupations—job and die setters, machinists, and tool-and-die makers—was 834,000, about 266,000 higher than the 568,000 in 12 separate OES occupations that are in theory comparable to the three CPS groups combined. Actually, the numbers of job and die setters were reasonably close, 91,000 (CPS) and 93,300 (OES), as were the totals for tool-and-die makers, 176,000 (CPS) and 170,000 (OES). However, figures for machinists varied considerably, 304,000 (OES) and 567,000 (CPS).

Data in the CPS are collected directly from individuals who respond to questions about their work activities. It is very likely that operators of numerically controlled machine tools, and the highly skilled "machine tool operators, combo" who operate several machines are included in the CPS machinist category rather than in the operative category, "other precision machine operatives." These workers probably consider themselves to be machinists rather than machine operators, and they are apt to report to a CPS interviewer in a manner that would result in their being classified as the former. Their salaries also are very close to, if not higher than, machinists' and tool-and-die makers', and far exceed those of other workers in the machine operator class. If one assumes that these workers are counted in the CPS machinist category, and adds their OES employment (52,700 numerically controlled machine tool operators and 170,700 machine tool operators, combo) to the OES employment of skilled machining workers, the OES total would be 791,300, compared with 773,000 in the CPS.

The above discussion was designed to establish reasonable comparability of data on employment of skilled machining workers based on CPS and OES survey data. If the data are reasonably comparable, comparisons can be made between historical and projected data. As noted earlier, employment in skilled machining occupations grew an average of 22,400 a year between 1972 and 1980. In the Bureau's three alternative projections of employment to 1990, the average annual growth of employment for skilled machining workers (including numerically controlled machine tool operators and machine tool operators, combo) ranged from 11,900 to 23,200 from 1980 to 1990. In each projection, the rate of growth of employment is expected to be slower than

in the 1970's, and only in the high-trend model is the 1980-to-1990 numerical average annual growth similar to that of the 1970's. (See table 4.)

Conclusions

Information about the job market for skilled machining workers during the 1970's is consistent with the existence of shortages. However, statistics generated by ongoing government data collection programs do not provide the information necessary to quantify the shortage. Quantitative data from surveys conducted by employer associations are statistically unreliable and probably overstate the numerical shortage. Some employers do not experience a shortage of skilled machining workers because they offer higher than average wages, benefits, or both. Also, the severity of the shortages varies among geographic areas.

Employers can deal with shortages in many ways. Some can offer wages that are higher than other employers in their locality and therefore are able to hire the workers they need, while others implement technological gains or increase training.

Those using technological development to cope with shortages may expand their use of numerically controlled machine tools, machining centers, adaptive control, digital readout, manual data input control, improved cutting-tool materials, and group technology.[5] However, because technological improvements often require substantial capital investment, smaller employers may have great difficulty in obtaining the required funds and therefore cannot make the desired innovations.

Many employers have increased training in an effort to reduce shortages of skilled machining workers. Skilled machining workers must be trained on the job; therefore, unless employers cooperate, additional workers will not become available. However, training is expensive and many employers are not able to significantly expand their training efforts.

General shortages of skilled machinists should not worsen during the 1980's, but they may be marked in some localities. For example, if defense purchases were to rise rapidly during a short time frame and affect industries in a specific area, the shortage could become so acute that the planned increases in production could not occur.

In general, however, unless programs are designed to foster action on the part of employers, current shortages are not likely to be reduced significantly. Some specific program may be necessary to provide employers with an incentive to expand the rate at which new technology is introduced or to increase the number of workers trained each year.

Because skilled machining workers must be trained on the job in 3- to 4-year programs, increases in such programs providing machining skills offered in vocational education and Comprehensive Employment and Training Act (CETA) programs will not reduce shortages. However, individuals who complete these programs do qualify for entry into employer training programs and many employers prefer to enroll individuals who have completed an appropriate vocational education or CETA program. Because machinists are expected to have excellent job prospects through the 1980's, earnings are above average, and unemployment rates are low, expansion of these programs is appropriate. However, the major impact of this action will be to improve the quality of the individual entering employer training programs, rather than increasing their number. □

Table 4. Employment in skilled machining occupations, 1980 and projected 1990

[Numbers in thousands]

Occupation	1980 employment	Projected 1990 employment		
		Low trend	High trend I	High trend II
Total, all skilled machining occupations	791.4	910.4	1,023.2	958.2
Job and die setters, metal	93.3	112.5	124.2	114.5
Diesetters	4.3	5.2	5.8	5.4
Machine toolsetters, metal	55.5	65.9	73.7	67.2
Setters, molding and coremaking machines	1.3	1.9	1.9	1.9
Punch press setters, metal	19.2	23.3	25.9	23.9
Shear and slitter setters	5.5	6.6	7.2	6.7
Setters, plastic molding machine	7.4	9.6	9.8	9.4
Machinists	304.3	352.2	390.8	386.3
Layout markers, metal	21.3	24.3	27.2	24.8
Machinists	281.9	326.7	362.3	335.4
Moldmakers, pottery	1.1	1.2	1.4	1.3
Tool and die makers	170.3	184.3	212.2	188.7
Tool-and-die makers	162.8	175.7	202.5	180.7
Diesinkers	3.1	3.4	3.9	3.5
Instrument makers	4.3	5.1	5.7	5.1
Machine-tool operators, combo	170.7	199.9	226.2	205.9
Machine-tool operators, numerical control	52.7	61.2	69.9	62.8

FOOTNOTES

[1] The value of consistency in data collection programs is recognized by the Federal Government. In 1980, the Office of Management and Budget issued the Standard Occupational Classification (SOC) which is to be used by all Federal agencies in collecting occupational data. Federal statistical data therefore will become more compatible throughout the 1980's, as agencies convert to the SOC.

[2] Data from the Current Population Survey are not presented for the years prior to 1972 because the data are not comparable.

[3] See Massachusetts Division of Employment Security, *Job Openings in Massachusetts, 1980,* and *An Analysis of Selected High Net Demand Occupations: Findings From a State-Wide Survey* (Massachusetts, The Executive Office of Economic Affairs, 1981).

[4] Projections are developed of the labor force, the gross national product, industry output, industry employment, and occupational employment. The latter are available by 3-digit Standard Industrial Classification industry detail in the form of an industry-occupational matrix.

[5] See *Technology and Labor in Four Industries,* Bulletin 2104 (Bureau of Labor Statistics, January 1982), ch. 3.