Technological Change and Manpower Trends in Six Industries

Bulletin 1817

U.S. DEPARTMENT OF LABOR
Bureau of Labor Statistics

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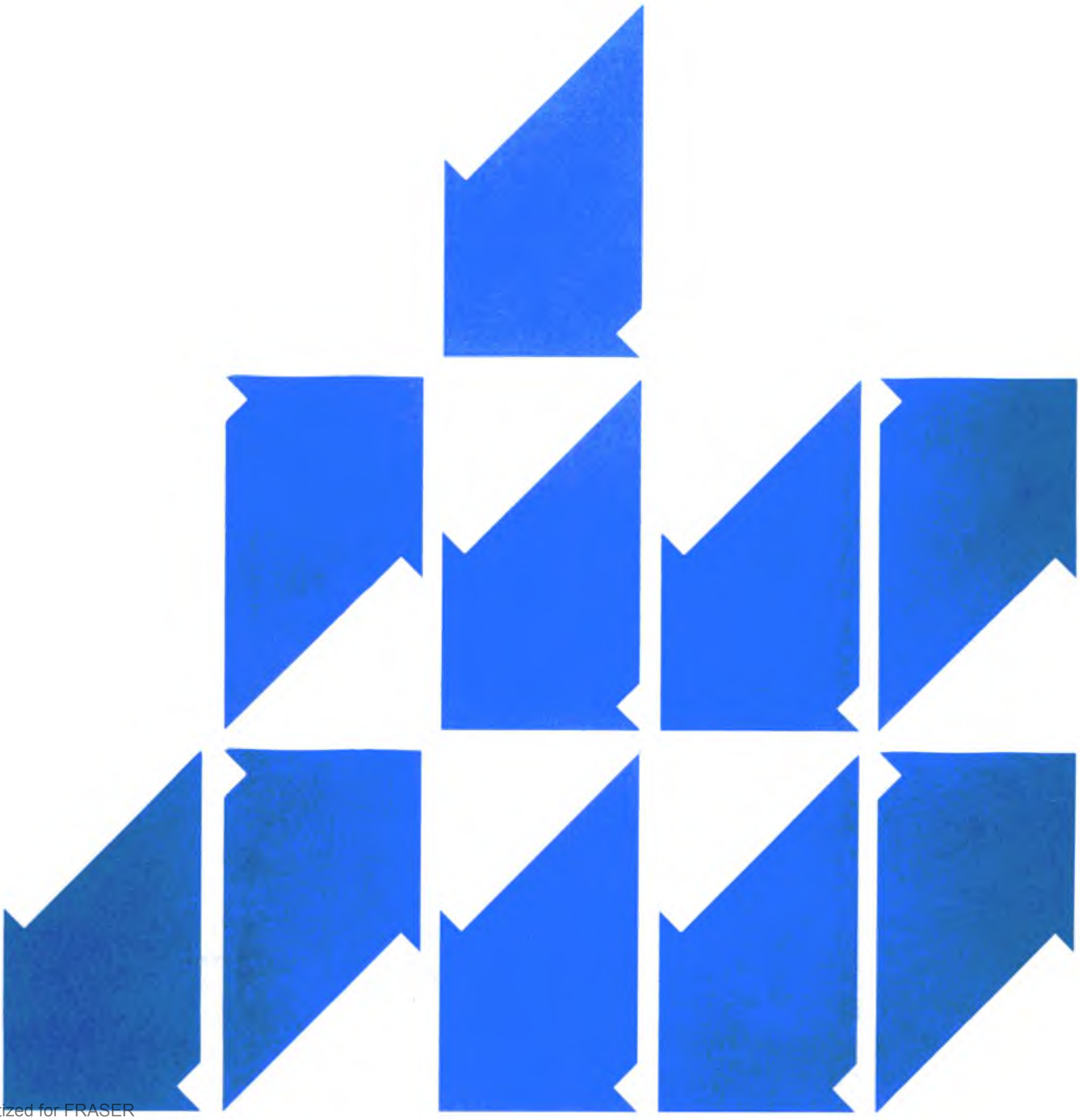

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Textile Mill Products
Lumber and Wood Products
Tires and Tubes
Aluminum
Banking
Health Services

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U.S. DEPARTMENT OF LABOR
Peter J. Brennan, Secretary
BUREAU OF LABOR STATISTICS
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Preface

This bulletin appraises some of the major technological changes emerging among selected American industries and discusses the impact of these changes on productivity and occupations over the next 5 to 10 years. It contains separate reports on the following six industries: textile mill products (SIC 22), lumber and wood products (SIC 24), tires and tubes (SIC 301), aluminum (SIC 3334 and SIC 3352), banking (SIC 60), and health services (SIC 80).

This publication is the first of a series which will update and expand BLS Bulletin 1474, *Technological Trends in Major American Industries,* published in 1966, as part of the Bureau's continuing research program on productivity and technological developments.

The bulletin was prepared in the Office of Productivity and Technology, under the direction of John J. Macut, Chief, Division of Technological Studies. Individual industry reports were written by staff members of the division under the supervision of Morton Levine and Richard W. Riche. The authors were: Textile mill products, Rose N. Zeisel; lumber and wood products, James D. York; tires and tubes, Rose N. Zeisel; aluminum, Morton Levine; banking, David H. Miller; and health services, Richard W. Riche. The Bureau staff received helpful suggestions and assistance from many experts in industry, government agencies, trade associations, trade journals, unions, and universities who answered queries and reviewed preliminary drafts. The Bureau of Labor Statistics is deeply grateful for their cooperation and aid.

The Bureau also wishes to thank the following companies and organizations for providing the photographs used in this study: Aluminum Co. of America, American Textile Manufacturers Institute, Inc., The Firestone Tire & Rubber Co., Forest Industries, The Goodyear Tire & Rubber Co., LeFebure Corp., and Siemens Corp.

Introductory Note

The appraisals of the effects of technological change in the six industries discussed in the following pages are accompanied by projections of levels of employment and output for 1980 and 1985. These projections were developed by the Bureau of Labor Statistics as part of a comprehensive set of projections for the economy as a whole and for major industry sectors and occupational groups. The projections are not forecasts but estimates of what the economy might be like under certain conditions. The projections rest on five major assumptions:

1. The overall rate of growth of private nonfarm productivity will be 2.7 percent a year;
2. hours worked in the private nonfarm economy will decline by 0.3 percent a year;
3. the overall unemployment rate will be 4 percent from the mid-1970's through 1985;
4. the Armed Forces, assuming an all-volunteer army, will be reduced to 2 million by 1980 and remain at that level through 1985;
5. prices, as represented by the GNP deflator, will increase at a rate of 3 percent a year during the projection period.

An imbalance in energy demand and supply was not considered in these projections. The effects of environmental protection regulations on technology, manpower, productivity, and investment are still uncertain and are only briefly touched upon in this bulletin. For further information about the assumptions and projections, see *Monthly Labor Review,* December 1973, pp. 3-42.

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Textile Mill Products

SUMMARY

Technological changes in the textile industry (SIC 22) are reducing unit labor requirements for semiskilled and unskilled workers and changing the job content of some occupations. Modifications to conventional machinery are being widely adopted; more advanced technologies are being installed in relatively few mills.

Although definitive measurements of productivity in the textile industry are not available, productivity improvement from 1960 to 1972 is suggested by an average annual rise in output of from 4½ to 6 percent and in man-hours of less than 1 percent.

Investment in plant and equipment is expected to move up sharply in the latter part of the 1970's, as it did in the mid-1960's. However, the anticipated outlays may be insufficient to reduce the proportion of plant and equipment considered by the industry to be technologically outmoded.

Textile mills employed more than a million workers in 1973, about 11 percent more than in 1960. Women workers accounted for almost half the total, only slightly higher than the proportion a decade earlier. According to a Bureau of Labor Statistics projection for 1980 consistent with a 4-percent national unemployment rate and other assumptions, textile employment growth from 1973 to 1980 should be very small—about 0.2 percent annually. (See introductory note.)

TECHNOLOGY IN THE 1970'S

Technological advances which may significantly affect productivity growth range from modifications of conventional machinery to radical changes in machine concepts. Modifications to conventional machines affect speed, capacity, automaticity, cleaning, materials transfer, and packaging, and account for most of the improvement in basic textile manufacture in the 1960's. These technological changes reduce unit manpower requirements, particularly for semiskilled and unskilled workers, and change job content. Newer technologies have similar manpower implications but, as yet, have been adopted by relatively few of the more modernized mills. These include direct-feed carding, shuttleless weaving, and the more revolutionary process of open-end spinning. One of the reasons for the limited installation of some new technologies—often of foreign manufacture—is the long delay in deliveries, sometimes as long as 2 to 3 years. Some of the major technology changes of the last few years, their manpower impact, and rate of diffusion are presented in table 1.

Fiber technology advances

The textile industry has shown great flexibility in its adaptation to synthetic fibers. In 1960, natural fibers accounted for over 70 percent of all fibers used; today manmade fibers are almost this proportion of the total. Although no definitive data exist, the shift from natural to manmade fiber has been an important factor in the industry's productivity growth. In general, manmade fibers require less labor per unit of output because they do not need the cleaning and other preparatory work necessary for natural fibers. Moreover, continuous filament synthetic yarns actually bypass the conventional spinning process in the preparation of both knit and woven fabrics.

Yarn manufacturing innovations

In general, yarn is still manufactured on a series of discrete machines, roughly similar to the process used half a century ago, although more automated yarn systems have been adopted by a small number of mills. Nevertheless, numerous machine improvements and auxiliary attachments (greater speed and capacity, automatic sensors, integration of processes, and improved materials handling) have continued to reduce labor requirements for operators and laborers. For example, one yarn mill built in 1970 reported operating 175 spindles per employee, compared with a roughly similar mill opened by the same company in 1964 with 110 spindles per employee.

Probably the major breakthrough in spinning since the introduction of the current system of ring spinning is the implementation of the process known as open-end spinning, mentioned earlier. It combines into one process the three separate operations of roving, spinning, and winding. Output per machine hour may be two or more times that of the conventional machine, greatly reducing unit labor requirements for machine operators. However, investment in the open-end system in this country has been delayed by some advances which have been made in the conventional process, some application limitations inherent in this newer system, the high cost of replacement, and the lack of availability of machines.

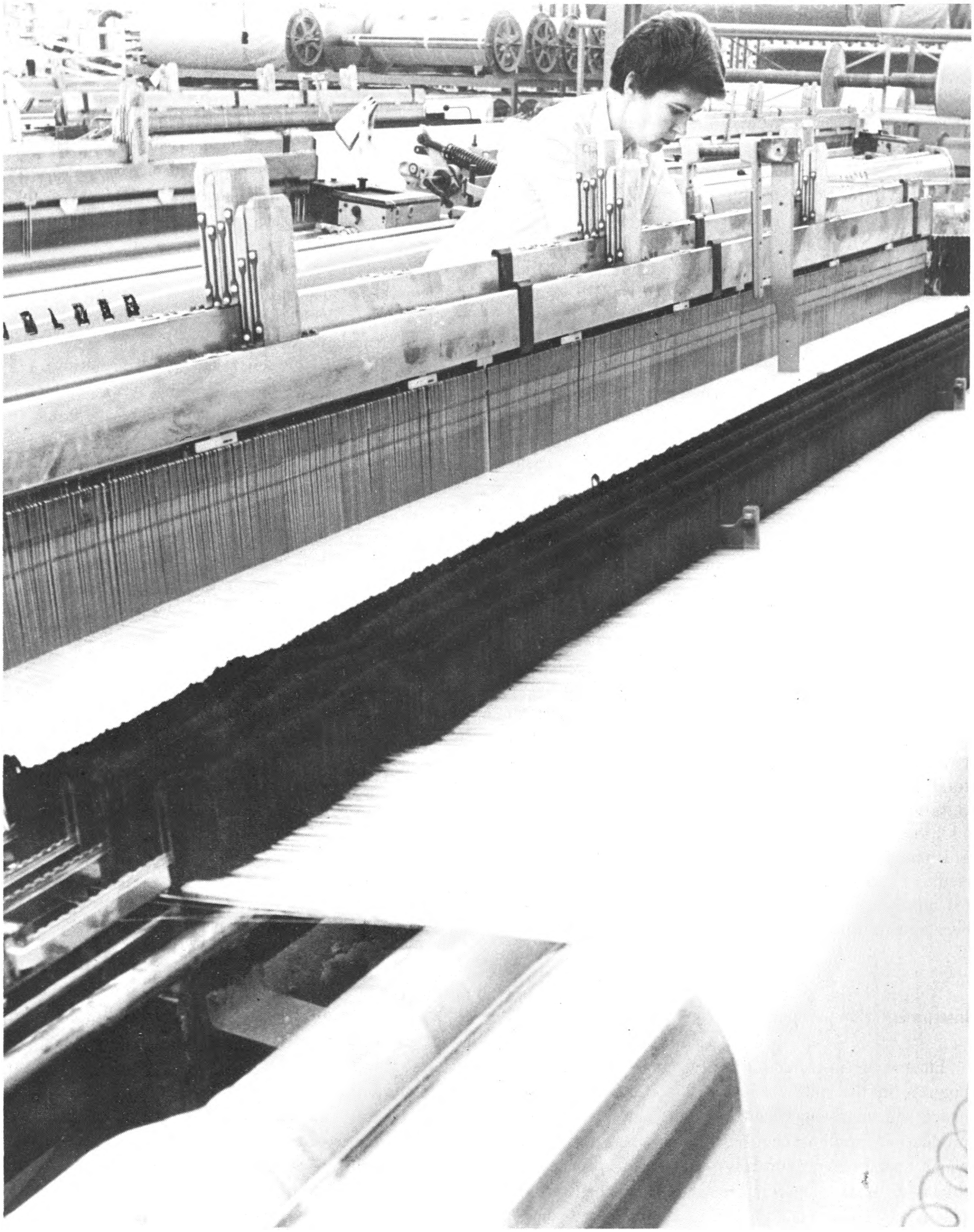
Weaving and finishing improvements

American mills continue overwhelmingly to use the conventional weaving method of shuttle looms, but those used are faster, wider, and more automated than 5 years ago, reducing labor requirements for weavers. Improvements such as laborsaving warp-tying methods and winding attachments are also greatly reducing unit labor requirements for associated jobs.

The advances in traditional looms have tended to limit adoption of several types of shuttleless looms to less than 10 percent of the total, although it is generally acknowledged that these looms permit increased speed, reduce maintenance costs and noise, and require fewer preparatory processes. Because of their increased productivity relative to conventional looms, shuttleless looms may account for close to 20 percent of total output, according to an industry specialist. According to one company's report, production was maintained at the same level with 40 percent fewer shuttleless looms than with conventional looms. The use of the new looms required less floor space and 30 percent less labor, affecting weavers and associated jobs. Other reliable industry reports generally confirm this potential increase in productivity with the shift to looms which do not

Table 1. Major technology changes in the textile industry

Technology	Description and impact	Diffusion
Texturizing	Heat sets a crimp in synthetic fiber to provide bulk, an additional process on specialized machines. Stimulated growth of knitting sector.	Started commercially in mid-1960's; very rapid growth since then.
Direct-feed carding	Eliminates picking process and associated manpower.	Installed in relatively few mills.
Open-end spinning	Integrates roving, spinning, and winding. Can produce 2 or more times the output of the conventional spindle.	Installed for evaluation in several mills.
Spinning attachments	Automatic doffing (unloading) machines reduce unit requirements for doffer operators.	Automatic doffers installed in a few mills experimentally in mid-1960's; still limited to less than 5 percent of spindles.
	Automatic devices for piecing (tying) broken yarn reduce unit requirements for spinners.	Automatic piecing devices not available commercially.
Winding attachments and integration	Automatic creeling (loading) of machines; automatic tying-in of yarn ends. Reduces unit requirements for operators.	Automatic creeling and tying-in machinery installed in only a few of the newest mills.
	Integration of filling winding with weaving. Eliminates separate process and associated handling.	Winding on the loom installed only in largest mills in mid-1960's. Now installed on 30 percent of looms.
Shuttleless looms	Operate at faster speeds and require fewer auxiliary operations than shuttle looms. Can produce about 50 percent more cloth than the average shuttle loom per hour.	Installed in only a few mills in mid-1960's. Now account for 7-10 percent of all looms.
New knitting machines	New machines operate at faster speeds and are more automated. Electronic patternmaking devices reduce preknit time. Reduce unit labor requirements and permit greater flexibility in design change.	Very substantial growth of new machines in last 5 years. Electronic patternmaking being rapidly adopted.
Continuous computerized finishing	Integrates dyeing and finishing techniques and incorporates computerized instrumentation. Reduces unit labor costs and improves quality.	Very substantial growth.



Shuttleless looms can produce about 50 percent more cloth than the average shuttle loom, with less labor.

have shuttles. Shuttleless weaving is expected to increase substantially—as it already has overseas—because of the potential increase in productivity.

The competitive position of weaving mills is being tested by the advance in knitting technology. Technological changes in knitting and knitting yarn have stimulated output growth, reduced unit labor requirements, and gained broad acceptance in traditional woven-goods markets. Now the warp-knit machine can produce about twice as much cloth per hour as the double-knit machine does, affecting requirements for knitting operators and job content. Electronic knitting, in which construction of goods is controlled by electronic impulses, has been relatively well accepted, and now electronic pattern scanners can reduce knitting preparation time and permit more rapid adoption of fashion changes. However, a new technology—stretch wovens—may offset some of these developments.

Fabric finishing has made significant strides in recent years, largely stimulated by the use of new fibers and the growth of the knitting industry. In batch dyeing, the cycles have been drastically cut and greater efficiency attained through computer process control. Continuous processing is replacing older discrete finishing operations, particularly in the pile and tufted industries, and dramatically reducing man-hour requirements.

In carpeting manufacture, new technologies include the use of new fibers for face and backing and more sophisticated machinery and accessories, which generally increase output per man-hour. Tufting machines, which produce about 90 percent of all carpeting, are more than twice as productive as those of 10 years ago and now a totally new system of tufting, lower in cost and more versatile, is being installed in some carpet mills. In addition, new techniques of continuous dyeing and finishing are reducing unit manpower requirements. As a result of these changes, requirements per unit of output for almost all occupations in carpet manufacture have been and continue to be reduced.

Instrumentation increases

Electronic instrumentation is making significant progress in the mills, reducing downtime and maintenance and improving quality. For almost every stage of production, some type of device is being introduced which measures or controls yarn speed, evenness or thickness, breaks, temperature, and other specifications. Electronic counters, monitoring devices, and digital computers are now generally used in most modernized mills.

Solid state electronics, including printed circuits, is a major step forward in mill instrumentation. In twisting machines, for example, plug-in printed circuits contain electronic memory devices which control the spindles. On looms, these printed circuits sense breaks in loom filling. With the use of such instrumentation, unit labor requirements for semiskilled machine operators and for maintenance personnel are considerably lower than with more conventional mechanical devices. Since solid state electronic equipment is less costly and more reliable than older forms of electronic instrumentation, it is expected to become increasingly important.

Computers have not been widely adopted by the textile industry. According to one estimate, about 328 textile establishments, or less than 5 percent of the total, had one computer or more in mid-1972. These are, however, the largest companies, which account for a substantial proportion of the industry's production. Growing interest in minicomputers, more adaptable to smaller textile operations, may increase the use of computers.

Computerized instrumentation probably lends itself best to wet-processing finishing operations. In some plants, programmed systems are being used for batch blending of dyestuffs in which the dyer may control 50 machines. He selects the required program and pushes the button to start the operation. In the conventional batch system, several workers would be required.

PRODUCTION AND PRODUCTIVITY OUTLOOK

Output

Textile mill output increased at an average annual rate of from 4½ to 6 percent from 1960 to 1972, considerably above the rate in the 1950's, and continued to rise sharply in 1973. Knitting, carpet manufacture, and manmade woven fabric production were the strongest growth sectors, while cotton broadwoven production did not change appreciably over this period. In the last half of the 1960's, the growth of the knit goods sector, associated with technological advances and fashion changes, made sharp inroads into traditional woven goods markets.

As part of its general set of economic projections the Bureau of Labor Statistics has developed projections of output growth for 1980 and 1985. These output figures are not forecasts, but projections of what the economy might be like under certain conditions. The projection for output of textile mill products in 1980, consistent with a 4-percent national unemployment rate and other assumptions, suggests a rate of increase from 1972 to

1980 which is considerably lower than the rate of the past 12 years. (See introductory note.) From 1980 to 1985, according to these projections, the rate of increase would continue to decline sharply.

Imports have seriously affected some sectors of the textile industry, although international agreements have been a moderating influence. Imports of all textile products constituted about 10 percent of domestic consumption in 1972, compared with 4 percent a decade earlier. The cotton import-consumption ratio, at about 12 percent in 1972, was more than double the ratio of a decade earlier. Manmade fiber textile imports increased more than fourfold in the last 5 years, to about 7 percent of domestic consumption. The wool ratio stood at 24 percent, and for many individual textile products the ratio was even higher.

However, in 1973, the volume of imports fell substantially, reflecting an increase in worldwide demand, currency changes, and fiber shortages. At the same time, a new international trade agreement has been negotiated which will set import limits on textiles of most fibers for the next 4 years, replacing the cotton agreements which have been in effect since 1962. As a result, the downward trend in imports is expected to continue.

Productivity growth

Because of limitations of available data, the Bureau of Labor Statistics does not publish measures of productivity for the textile industry. However, a rough indication of productivity changes can be derived by examining output data developed by the Bureau of Labor Statistics and the Federal Reserve Board and man-hours data of the Bureau of the Census and the Bureau of Labor Statistics. On the basis of these data, increases in output per man-hour in the 12 years ending in 1972 are suggested by the substantial average annual rise in output, 4½ to 6 percent, compared with the moderate rise in man-hours of less than 1 percent annually. In part, the improvement in output per man-hour during the last decade reflects a shift of production to more capital-intensive sectors, particularly knitting and carpet production, and a shift to greater use of the manmade fibers which have lower unit labor requirements than the natural fibers.

For individual sectors of the industry, an examination of various measures of output and man-hour data suggests considerable variation in productivity growth. The most rapid growth in that 12-year period appears to have occurred in the knitting and carpet mills. In the hosiery sector, for which an official Bureau of Labor Statistics index is available, output per man-hour rose at an average annual rate of 6.4 percent from 1960 to 1972, compared with 4.1 percent in the previous 10-year period. This high rate of productivity growth, which is not expected to continue in the 1970's, accompanied a sharp increase in output and rapid technological changes associated with the shift to pantyhose.

Best plant practice

Although no general conclusions can be drawn from one year's data, some indication of the potential productivity levels for several industry sectors is suggested by the difference between the productivity level of the most efficient plants and the industry sector average. Comparative data are presented in table 2 for 1967 (latest data available) on average value added per production worker man-hour for the "most efficient" and "least efficient" plants in eight sectors of the industry. (Although it has limitations, value added per man-hour is used here as an approximate indicator of productivity.) For purposes of this report, the "most efficient" mills are defined as those which fall into the highest quartile of the ranking of plants by value added per production worker man-hour; the "least efficient" are those in the lowest quartile.

In the industry sectors for which 1967 data are available, average value added per production worker man-hour in the "most efficient" mills ranged from almost two and a half to more than five times greater than the average of the "least efficient" mills. The differences were smallest in the yarn (except wool) mills and in the cotton weaving mills; the largest variance was in the tufted carpet sector.

Although the wide range in productivity within an industry sector may reflect differences in management, labor, and other factors, one of the important keys, judging by Census data, appears to be capital outlays. Average expenditures for plant and equipment per employee by the "most efficient" mill in 1967 were larger than outlays by the "least efficient" mill or the average mill in almost every sector shown in table 2. Available 1958 data, although not fully comparable, showed the same pattern.

INVESTMENT

Capital expenditures

Expenditures for plant and equipment rose from $370 million in 1960 to $790 million in 1973, averaging

Table 2. Value added and capital expenditures in the textile industry: Ratios of "most efficient" to "least efficient" plants and to average plant, 1967

Industry sector	Value added per production worker man-hour		Capital expenditures per employee	
	"Most efficient" to "least efficient" plants	"Most efficient" to average plant	"Most efficient" to "least efficient" plants	"Most efficient" to average plant
	(Ratios)			
Weaving, cotton	2.4	1.5	.9	1.2
Weaving, narrow fabric	3.5	1.8	3.3	2.3
Hosiery, women's, except socks	2.8	1.6	1.7	.8
Knit outerwear	4.0	2.1	1.7	1.4
Knit fabric	4.9	2.2	2.7	1.9
Carpets, tufted	5.2	1.9	1.3	1.3
Yarn mills, except wool	2.4	1.4	1.3	1.3
Throwing and winding	4.4	1.9	5.1	1.3

NOTE: Establishments in each sector were ranked by the ratio of value added per production worker man-hour. The "most efficient" mills are defined as those which fall into the highest quartile; the "least efficient" are those in the lowest quartile.

SOURCE: Based on unpublished Census Bureau data prepared for the National Commission on Productivity.

about $574 million annually. The average annual increase was particularly rapid in the first half of the period, when a strong economy and technological innovations encouraged modernization and expansion. Per production worker, expenditures rose at an average annual rate of 15 percent from 1960 to 1966 compared with less than 1 percent from 1966 to 1973. In general, larger multiunit companies, with greater availability of capital, account for the bulk of the industry's outlays. (See table 3.)

Over this period, however, investments have been insufficient to substantially reduce outmoded facilities. A recent private survey of large plants revealed that 20 percent of plant and equipment was still considered outmoded in 1972 compared with 29 percent in 1962. Only the transportation equipment industry (excluding autos and airlines) had a larger proportion of outdated equipment in 1972.

Anticipating a more favorable economic climate, and spurred on by the shortage of labor, the industry plans to spend about $840 million in 1975, slightly above the peak expenditures of 1966. However, considering the increase in machinery prices since 1966, these planned outlays represent a substantial drop from the peak level. (Although this drop is probably offset to some extent by the greater efficiency of capital, definitive data are not available on this point.) Moreover, about 3 percent of the total outlay in 1972 was spent for pollution control and the proportion is expected to at least double by 1976.

Funds for research and development

Outlays for research and development (R&D) of new products and processes totaled $59 million in 1972, more than double the outlay 10 years earlier, but considerably below the peak level of $70 million in 1969. (Data include a small proportion of R&D outlay by the apparel industry.) These investments are a very small percentage of sales of companies performing R&D, which are for the most part the largest companies in the

Table 3. Indicators of technological change in the textile industry, 1960-72

Indicator	Average annual rate of change[1]		
	1960-72	1960-66	1966-72
Payroll per unit of value added	−0.6	−1.5	−0.1
Capital expenditures per production worker	4.9	15.2	−1.8
Research and development funds as percent of net sales[2]	−0.6	−1.1	−2.6

[1] Linear least squares trend method.

[2] Of textile and apparel companies which have research and development programs. The latest data available are for 1971.

SOURCES: Bureau of Labor Statistics; Bureau of the Census; Bureau of Economic Analysis; National Science Foundation.

industry. Moreover, R&D per dollar of net sales has been declining. (See table 3.) The industry plans to increase outlays to $68 million in 1976, only slightly below the 1969 peak. In real terms, however, the dip from 1969 would be considerably greater in view of the increase in costs. The low level of R&D outlays is associated with the fact that the industry relies heavily on research carried out by synthetic fiber producers, machine manufacturers, the Federal Government, and foreign manufacturers.

EMPLOYMENT AND MANPOWER

Employment trends

Textile mills employed 1,024,000 workers in 1973, compared with 924,000 in 1960, an average increase of 1.0 percent annually. (See chart 1.) This rate contrasted sharply with the 1950-60 period when employment was reduced at an annual rate of 3.3 percent. The BLS projection for 1980, assuming a 4-percent unemployment rate, suggests that textile employment growth from 1973 to 1980, should be very small—about 0.2 percent annually. (See introductory note for other assumptions.) From 1980 to 1985, the projected level of employment declines—at an average annual rate of 0.2 percent—back to the 1973 employment level.

With the exception of weaving, in which employment fell 12 percent, every major sector of textiles experienced an employment increase from 1960 to 1973. As a proportion of the total, weaving still dominated with 36 percent of textile employment, but knitting rose to 27 percent. Yarn and thread mills were the third largest group, with 15 percent of the total. The rest of textile employment—about 22 percent—was about equally divided among finishing, floor covering, and miscellaneous industries.

Currently, labor is in short supply in southern mill towns, particularly skilled and semiskilled labor. In late 1973, for example, the unemployment rate in one of the cities with a large concentration of textile employment was less than 2 percent. In recent years, the South has attracted more and better paying industries, which has reduced the supply of labor available to the mills.

Women have historically constituted a large proportion of the textile labor force and in recent years their relative position has been strengthened by technological changes which reduce physical difficulty or danger. In 1973, almost 460,000 workers or 46 percent of all textile employees were women, the ratio having increased slowly since 1940. The ratio of women in all manufacturing is about 28 percent. Of textile operatives, women accounted for 55 percent in 1970. In general, job opportunities for women in the textile industry increase sharply in times of male labor shortage. Such a shortage occurred during World War II and also in the mid-1960's, when new industries successfully competed for the available male labor force.

Considerable gains have been made in recent years by black workers. According to the Census of Population, about 115,000 black workers were employed in 1970 in textile mills compared with 43,000 in 1960, or more than 2½ times as many. Most of the change has occurred, however, since the mid-1960's. According to data available for South Carolina, one of the leading textile States, black workers constituted 25 percent of nonsalaried textile workers in 1971-72 compared with 6 percent in 1964-65. In addition, many black workers have been upgraded from unskilled to semiskilled and skilled jobs.

Occupational trends

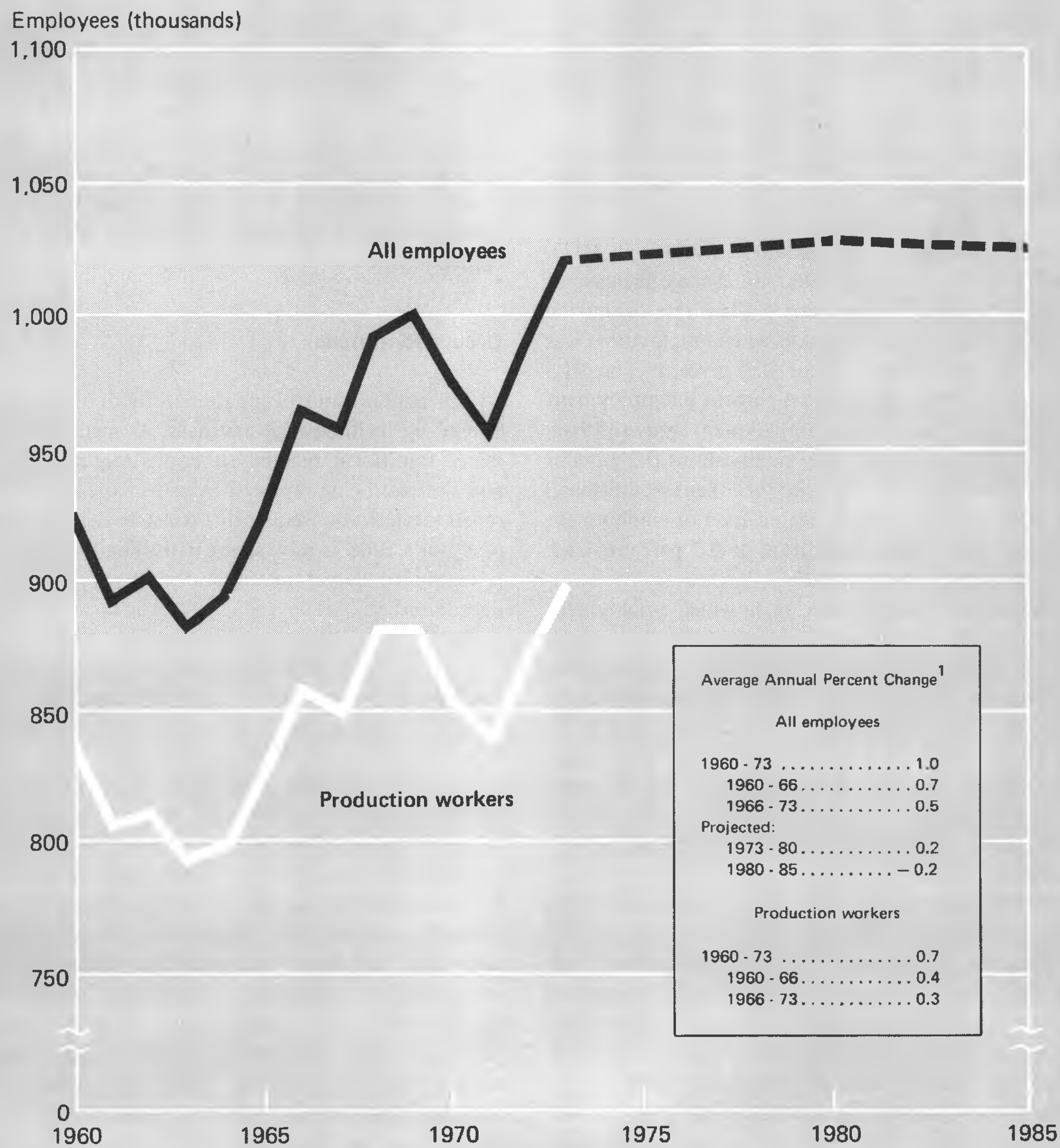
Job content and occupational distribution are being altered by technological advances. As mentioned earlier, many traditional manual functions requiring dexterity and skill are being replaced by automatic detection and repair devices. Consequently, considerably more of the operator's time is now spent patrolling more machines, primarily to detect malfunctions, than was the case a decade earlier.

At the same time, requirements for various occupations are changing. Blue-collar workers still constitute four out of five workers though long-term trends show a decline in their proportion, with the possible exception of skilled workers. As machine speed, capacity, and automaticity increase, for example, fewer semiskilled operatives such as spinners and weavers are required for the same production. Similarly, unit requirements for laborers are being reduced in all modernized mills as materials handling is further mechanized or two operations are combined. In contrast, skilled workers such as mechanics and fixers are becoming more essential as textile machines increase in complexity and continuity of operation. New technologies, such as computer processing, electronic instrumentation, and pollution control may also require more technically trained personnel than the textile industry has generally required in the past. Among white-collar workers, every major group—professional and technical, managers and officials, clerical, and sales—has been increasing as a proportion of total employment.

Changes in occupational distribution in the industry reflect shifts in the importance of subindustries, changes in management organization, and the availability of

Chart 1

Employment in the Textile Industry, 1960-73 and Projected for 1980 and 1985

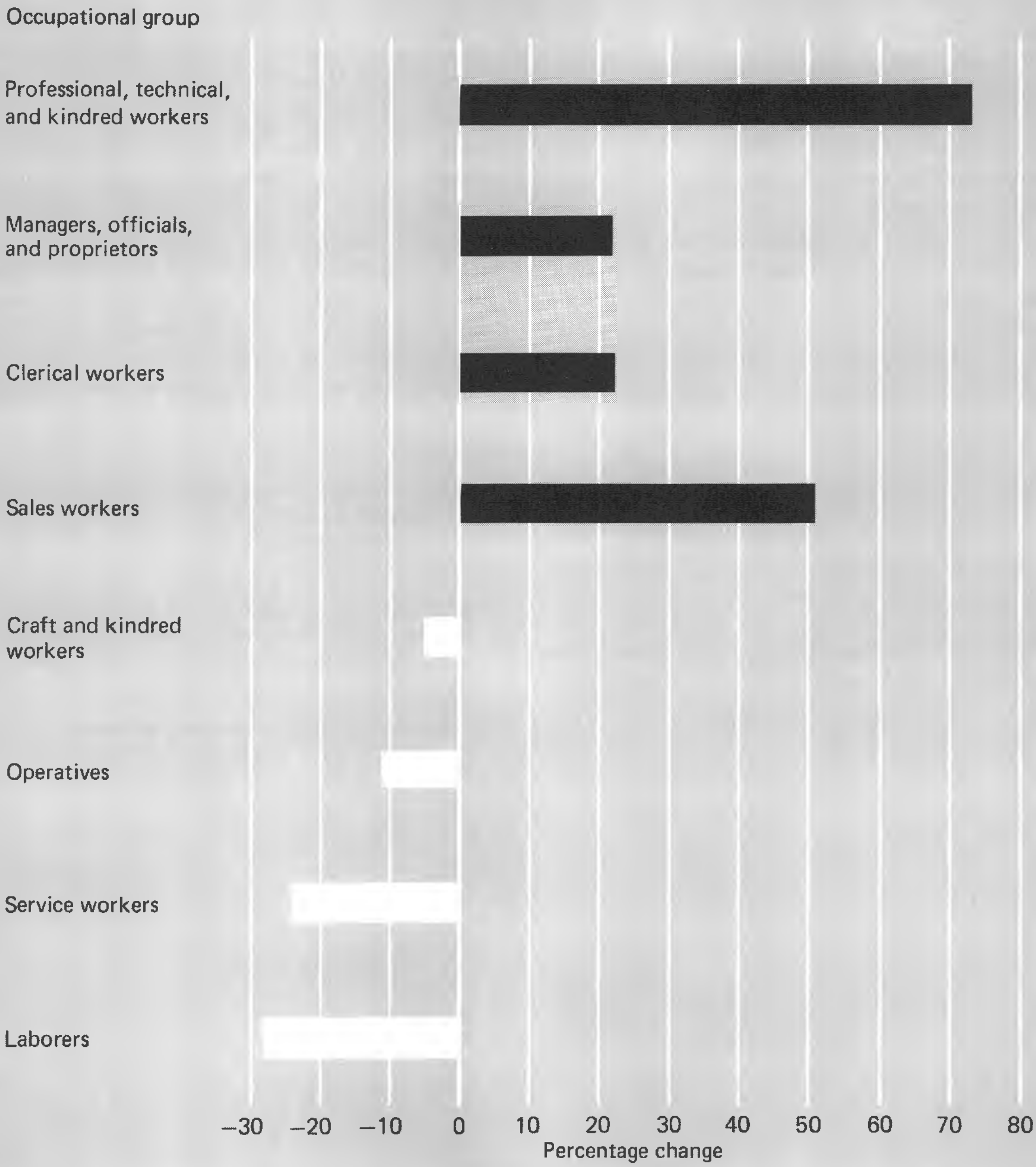


[1] Least squares trend method for historical data; compound interest method for projections.

Source: Bureau of Labor Statistics.

Chart 2

Projected Changes in Employment in the Textile Industry by Occupational Group, 1970 to 1980



Source: Bureau of Labor Statistics.

labor, as well as adoption of technological advances. Table 4 summarizes the likely effects of these factors on the occupational distribution by 1980.

Chart 2 provides information about the changes in employment levels that can be expected in each occupational group between 1970 and 1980.

Table 4. Employment in the textile industry by occupational group, 1970 and 1980

(Percent distribution)

Occupational group	1970	1980
All occupations	100.0	100.0
White-collar	16.1	19.2
Blue-collar	83.9	80.8
Craft and kindred workers	12.9	14.0
Operatives	64.1	60.6
Service workers	2.3	1.9
Laborers	4.6	4.3

SOURCE: Bureau of Labor Statistics.

Adjustment of workers to technological change

Relatively few labor-management agreements exist in the textile industry and provisions for easing the workers' adjustments to technological changes are therefore largely at management's discretion. Only about a fourth of all textile workers are in mills covered by collective bargaining (these are largely in the North) compared with 60 percent in all manufacturing industries. The major unions are the Textile Workers Union of America (TWUA), the United Textile Workers of America (UTWA), and the International Ladies' Garment Workers' Union (ILGWU), which covers knitting establishments.

Several labor-management agreements have some formal provisions regarding technological changes which affect layoff, work assignments, and job content. Of twelve major collective bargaining agreements in 1972 covering 1,000 workers or more, four, accounting for almost half of the workers covered, required advance notice of technological change. Only two contracts required advance notice for layoff, plant shutdown, or relocation. These twelve contracts do not make provision for severance pay. In general, some degree of protection from layoff and changes in work schedules is afforded the worker by provisions governing seniority.

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Lumber and Wood Products (except Furniture)

SUMMARY

The gradual introduction of new machinery and the growing use of existing modern equipment in the lumber and wood products industry (SIC 24) may reduce labor requirements and, at the same time, increase output. In logging operations, this trend has already resulted in the reduction of work-crew size. In sawmills, the introduction of new equipment and its increasing diffusion have acted to change the nature of jobs involved with the production of lumber from logs. Moreover, the increasing use of modern machinery has raised skill requirements.

Outlays for new plant and equipment have grown rapidly since 1960. Rising from a level of $334.0 million in 1960, investment expenditures reached $716.3 million in 1971. The real increase in investment is lower because of price increases. Should the strong demand for the output of lumber and wood products continue, expenditures for new plant and equipment are likely to continue to rise.

Because of limitations in available data, definitive measurements of productivity in the lumber and wood products industry are not available. However, output rose during the 1960-73 period at an average annual rate of 4 percent while man-hours rose at only 0.2 percent. These trends in output and man-hours suggest that productivity, which has been improving, may continue to grow during the 1970's.

Overall employment showed no change (on an average annual basis) during the 1960-73 period, and BLS projections indicate that employment may change very little from 1973 to 1980. This projection is based on a 4-percent national unemployment rate and other assumptions discussed in the introductory note.

TECHNOLOGY IN THE 1970'S

New technology which helps improve manpower utilization is being gradually introduced into the various segments of the lumber and wood products industry. This industry includes all stages of the production process from the harvesting of the logs to the finished products. Many of these technologies, already in limited use in the industry, are expected to be increasingly utilized. They include the use of the portable steel spar, the tree shear, and the chipping headrig, as well as automatic sorting and stacking machinery.

Logging innovations

New equipment and techniques are increasing efficiency in logging operations. (See table 5 for a brief description of innovative changes in this and other segments of the industry.) The extent of displacement of the natural spar tree by a portable steel spar has been steadily increasing. (A spar tree is used for attaching lines for drawing logs to a central location.) The advantages of the portable spar will continue to force producers to make the conversion. Portable steel spars combine strength with mobility, can be rigged in 2 to 3 hours compared to the 2 to 3 days required for natural spar tree rigging, handle more logs per hour, and reduce labor requirements for riggers.

Where log assembly is not done by using a natural or portable spar, improved tractors and skidders assemble logs more quickly at central loading areas. New front-end and knuckle boom loaders and lifting equipment shorten time required to put these logs on trailers, and improved techniques, such as preloading of trailers, further increase the number of logs handled per hour.

The increasing use of shears in felling operations has also had an effect in reducing the number of fellers required. It was estimated by an equipment manufacturer that tree shears can do in 2 hours what it would take one man using a chainsaw 8 hours to do. The shear is like a pair of scissors and slices trees instead of sawing them. It has a wedge-shaped blade which makes it possible to fell the trees in a uniform direction. This directional felling facilitates the skidding operation (the movement of logs to a central point) and thus saves on labor in this operation as well. One limitation of the shears, however, is that they are not good for use on steep terrain. Another is the log splitting they cause, which may reduce the yield or grade of lumber cut.

Portable steel spar is used to assemble logs at a central loading point for shipment to the mills.

Chainsaws continue to be important, however, and new types are being introduced. A mobile chainsaw has been developed which can be mounted on either a crawler tractor or rubber-tired skidder. Like the shear, it is designed for directional felling of trees. The speed of the saw is not quite as great as that of the shear, however. Also, a low-cost hydraulic chainsaw has been introduced which reduces manpower requirements in the bucking (cutting trees into logs) and loading operation. It enables one man to buck and load virtually as fast as two men using conventional equipment.

The use of balloons and helicopters for logging thus far has proven to be of limited significance. The feasibility of balloons appears to be restricted to particular applications such as use over difficult terrain where conventional high-lead logging can not be used. However, recent experimentation with balloon logging has been going on and the findings may open up some new possibilities. The limited lift capacity and high cost of operation of the helicopter are factors which impose sharp restrictions on its usefulness in harvesting. However, renewed interest in helicopter logging, as in balloon logging, has come about and further experimentation to determine its feasibility is going on.

Another important piece of laborsaving equipment is the rubber-tired skidder. This piece of equipment is increasingly replacing tractors for logging operations, although tractors are still used for log retrieval. This machine can cover much more ground and thus is able to retrieve many more logs in a given time period. It has greatly increased the productivity of equipment operators and is in widespread use. A rubber-tired skidder can haul a larger volume of logs over longer distances and helps reduce road building.

Tree harvesters have been introduced which incorporate several logging operations into a single machine. They can fell, delimb, and top trees. Also, their felling shears can be used to buck trees into shorter lengths during the delimbing operation. According to one report, the use of the shears on the tree harvester can replace as many as three fellers and their power saws.

New developments in sawmills

A number of innovations have been important in improving productivity in sawmills. One which greatly reduces manpower requirements is a sawing device known as the chipping headrig, which processes small softwood logs at a high rate of speed. It produces

Table 5. Major technology changes in the lumber and wood products industry

Technology	Description and impact	Diffusion
Portable steel spar	Provides a mobile substitute for the natural spar tree in assembling logs for shipment and obviates such things as the high climbing and rig-up functions.	Producers have steadily converted to the portable spar from the natural spar.
Tree shear	Fells trees by slicing rather than sawing and greatly reduces time required for felling.	The shear has been rapidly supplanting the chain saw except where terrain doesn't permit.
Balloon logging	The use of balloons in logging operations permits the logging of areas which would be inaccessible to conventional logging methods. It could be used to supplement conventional methods on certain types of terrain.	It is economical only on relatively inaccessible terrain and so its use is limited.
Helicopter logging	Helicopters also enable logging operations to be carried out where conventional logging equipment could not be used.	Penetration has been limited by restricted lift capacity and high operating cost.
Rubber-tired skidder	Retrieves logs and is able to cover more ground than caterpillars.	It has achieved extensive industry penetration.
Chipping headrig	A sawing device which processes small softwood logs at a high rate of speed. Eliminates the need for a skilled sawyer.	It is achieving greater industry penetration as more mills try to utilize the small softwood logs.
Automatic sorting and stacking machinery	Greatly reduces the manpower required for the sorting and stacking operation by performing each operation automatically.	It has been installed by many of the larger mills.
Electromechanical stress grader	Provides greater precision in the measurement of the stress value of lumber. May have some impact on the skilled visual grader.	Diffusion of this innovation still appears to be limited.

saleable chips instead of sawdust. At one southern sawmill the chipping headrig eliminated five men from the board production process. According to yet another source, the chipping headrig requires one less man per shift than multiple band systems.

Other important laborsaving equipment includes automatic devices which can sort boards according to size and stack them. Since both operations can be performed automatically, manpower requirements can be greatly reduced. One hardwood mill, for example, reported a reduction in manpower from 15 to 3 men in the sorting and stacking operation; a nearby southern pine mill reported a saving of four men in the sorting and four men in the stacking operation as a result of using this equipment.

Automatic electronic log scaling and measuring devices are now being used by some mills. They provide greater accuracy and eliminate the need for log scalers, but increase maintenance requirements.

Use of carbide saws and knives is becoming very common. They have the advantage of lengthening tool life and reducing the need for filing labor. They also reduce the skill requirements for the filing operation.

The fully automated grader system can also provide substantial manpower savings. Using this system, a single man can perform the grading operation where six men might be needed without it. An electromechanical stress grader has been developed which increases efficiency in the grading of softwood lumber. This machine is more effective than visual grading because it measures the stress value of lumber more exactly. These graders, which have not yet been widely introduced, may have some impact on employment of the skilled visual grader.

Automated kiln controls also have reduced labor requirements. Formerly, a man had to be with the kiln 24 hours a day. With the automatic kiln controls, the labor requirements can be reduced by 2 to 3 men. One experiment, using commercially available controls, indicated that automated kiln control will reduce damage to lumber by closely controlling drying conditions in the kiln.

An innovation which should soon be in commercial use is equipment for automatic trimming and clipping. It uses the same computer logic as automatic grading. It provides improved decisions and accuracy and reduces the number of clippermen and trim sawyers required.

The basic technology for board and cant scanners is now available but is in limited use. These scanners should provide more accurate cutting and may reduce skill requirements and the need for sawyers.

Changes in millwork, veneer, and plywood operations

Automatic lathe chargers, operated by one man, automatically lift and center blocks (logs bucked to uniform block lengths) between the chucks. The operator need only make minor adjustments to the alignment when the contour of the blocks is unusual. The automatic lathe charger is much faster than the old electric hoist it replaces and it eliminates one job, that of the lathe spotter helper.

A process for curing and drying panels by bombarding them with high speed electrons has been developed. The electrons can be used to dry and cure the coatings on plywood and particleboard without heat. The electron bombardment takes place inside a leadlined concrete vault. Panels move through the vault at speeds up to 100 linear feet per minute. The process is faster and more efficient than existing curing methods and the adhesion on wood is superior. This curing process also causes surfaces to be more resistant to checking, peeling, cracking, and blistering.

Another major development in the plywood industry has been the increasing switch by plywood producers to jet veneer drying. This process, which requires few moving parts, involves directing hot air vertically onto the veneer and reduces the need for maintenance workers. Users of these driers have claimed they more than doubled processing volume, reduced space allocation, achieved more rapid drying, and improved drying quality.

This increase in the volume of production spurred the development of better methods of feeding the green veneer into the machine. The conventional feeder system had a crew of two to four drier feeders who had to transfer each sheet to the feed belt from the veneer stacks. With the improved feed system, the worker simply has to push the lead end of the veneer onto the feed system. After the full width of the feed deck has been loaded, the veneer is automatically drawn into the drier by the feed system. The worker feeds the other decks in sequence as the veneer is being drawn into the machine. Only one or two men are involved in the feeding operation. Two to three times as much veneer can now be produced using the same number or fewer men.

PRODUCTION AND PRODUCTIVITY OUTLOOK

Output

Output in the lumber and wood products industry increased at an average annual rate of 4.0 percent (Federal Reserve Board Index of Industrial Production) during the 1960-73 period. This rate was more than twice the 1950-60 average.

As part of its general set of economic projections, the BLS has developed projections of output growth for 1980. These are projections of what the economy might be like under certain conditions. The projections of output show that, at a 4-percent unemployment level for the economy as a whole, the output of the lumber and wood products industry will increase at roughly 4.4 percent per year from 1973 to 1980, about the same rate as in the previous decade. (See introductory note for other assumptions.)

Productivity growth

Because of limitations in available data, definitive BLS measurements of productivity in the lumber and wood products industry are not published. However, improvement is indicated by the data for output and man-hours. (See chart 3.) Output, as noted above, rose at an average annual rate of 4.0 percent from 1960 to 1973, while man-hours increased at an average annual rate of only 0.2 percent between 1960 and 1973. These rates resulted mainly from the introduction of better equipment. In the sawmill industry, for example, many of the smaller mills have been squeezed out by larger mills which are using the latest equipment and are thus able to achieve greater productivity and cost savings. Also, the reduction in man-hours may, in part, be due to a shift from the use of clear to common lumber.

Best plant practice

Some idea of the potential productivity level for each subindustry can be gained by finding the difference between the productivity level of the most efficient plants and the average for the subindustry group. Data on value added per production worker man-hour in 1967 (latest data available) for the "most efficient" and "least efficient" plants in several selected sectors of the industry are presented in table 6. The productivity indicator used here is value added per man-hour, despite certain limitations such as those resulting from product mix differentials. "Most efficient" plants are defined here as those which fall into the highest quartile of plants ranked in order on the basis of value added per production worker man-hour; the "least efficient" are the ones which fall into the lowest quartile.

In the selected industry sectors for which 1967 data are available, value added per production worker man-hour in the "most efficient" plants varied from a little over 3 to nearly 6 times greater than the rate in the "least efficient" plants. The smallest difference was in the veneer and plywood subgroup; the largest difference was in the subgroup of logging camps and contractors.

Census data would seem to indicate that capital outlays are an important factor responsible for the existing differences in productivity levels within industry sectors. Table 6 shows that the "most efficient" plants spent more on plant and equipment per employee in 1967 than either the "least efficient" mills or the average mill in every sector shown.

INVESTMENT

Capital expenditures

Expenditures for plant and equipment rose from

Table 6. Value added and capital expenditures in the lumber and wood products industry: Ratios of "most efficient" to "least efficient" plants and to average plant, 1967

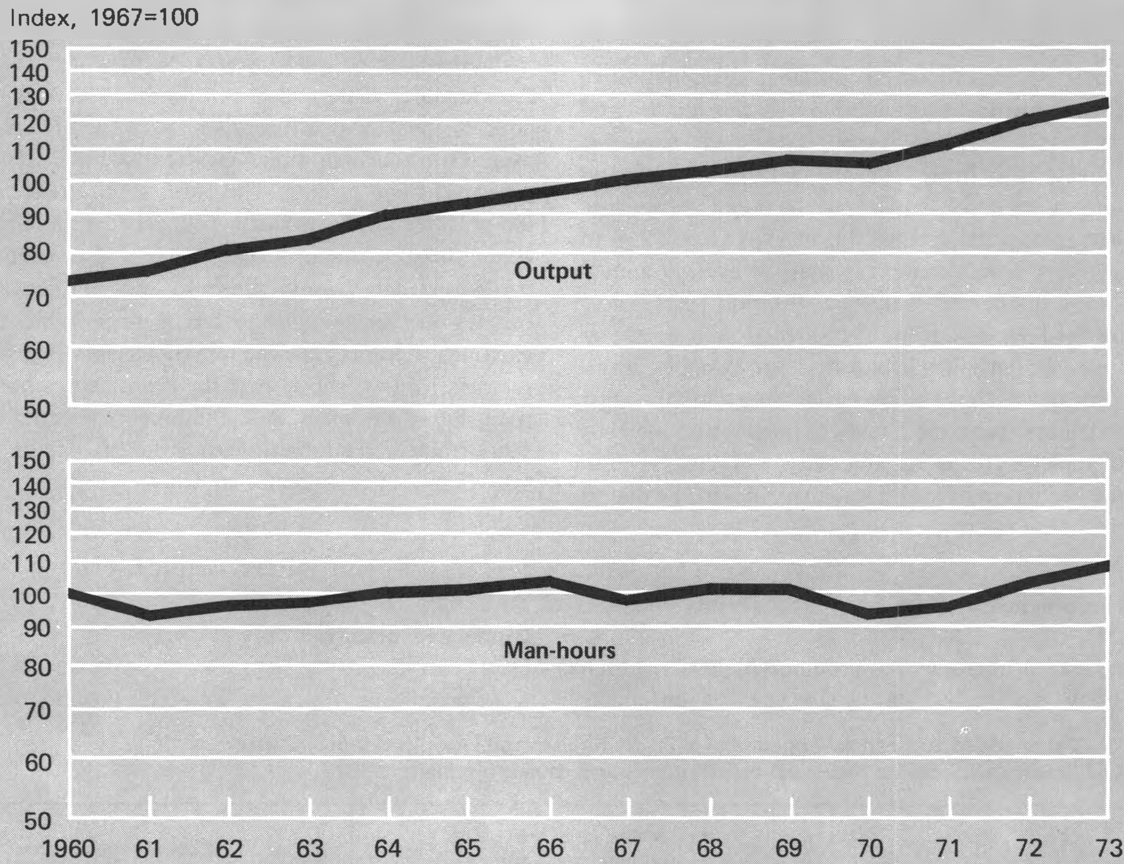
Industry sector	Value added per production worker man-hour		Capital expenditures per employee	
	"Most efficient" to "least efficient" plants	"Most efficient" to average plant	"Most efficient" to "least efficient" plants	"Most efficient" to average plant
	(Ratios)			
Logging camps and contractors	5.7	1.8	2.0	1.4
Sawmills and planing mills	4.1	1.7	1.6	1.2
Veneer and plywood	3.2	1.5	1.2	1.3

NOTE: Establishments in each sector were ranked by the ratio of value added per production worker man-hour. The "most efficient" establishments are defined as those which fall into the highest quartile; the "least efficient" are those in the lowest quartile.

SOURCE: Based on unpublished Census Bureau data prepared for the National Commission on Productivity.

Chart 3

Output and Man-Hours in the Lumber and Wood Products Industry, 1960-1973



Source: Bureau of Labor Statistics; Board of Governors of the Federal Reserve System.

$334.0 million in 1960 to $716.3 million in 1971, an average annual increase of 7.9 percent. However, the real increase in investment is somewhat lower because of price increases. Expenditures for plant and equipment per production worker rose at an average annual rate of 8.6 percent in the 1950 decade and at 8.5 percent annually between 1960 and 1971.

The increasing importance of capital relative to labor is reflected in the changing ratio of payroll to value added. (See table 7.) This ratio declined from .621 in 1960 to .512 in 1971, an average annual rate of decline of 1.6 percent. This reversed the trend of the preceding decade, 1950-60, when the ratio actually increased from .552 in 1950 to .621 in 1960.

Funds for research and development

Data on expenditures for research and development (R&D) for this industry are combined with those of the furniture industry. These outlays increased from $10 million in 1960 to $48 million in 1971, according to unpublished data provided by the National Science Foundation. As a percentage of sales, R&D outlays are very small relative to other manufacturing industries. R&D expenditures declined in the first part of the period but rose rapidly in the latter part, as shown in table 7. Comparable R&D data for the entire 1950-60 period are not available but the data for 1958 and 1959 are in line with later figures.

Table 7. Indicators of technological change in the lumber and wood products industry, 1960-71

Indicator	Average annual rate of change[1]		
	1960-71	1960-66	1966-71
Payroll per unit of value added	−1.6	−1.7	−1.5
Capital expenditures per production worker	8.5	10.4	10.1
R&D expenditures per sales dollar[2]	0.0	−5.8	15.3

[1] Linear least squares trend method.

[2] R&D expenditures per sales dollar for the lumber and wood products industry and the furniture industry combined. Separate figures for the lumber and wood products industry were not available.

SOURCES: Bureau of the Census; National Science Foundation.

EMPLOYMENT AND MANPOWER

Employment trends

Total industry employment hardly changed between 1960 and 1973, rising from 626,800 to 631,500, as shown in chart 4. However, 1973 employment was about 19,500 higher than in 1972. For the 1960-73 period, the number of production workers declined from 561,100 to 544,200, at an average annual rate of 0.3 percent. Assuming a 4 percent national unemployment rate, total employment for the industry may remain relatively unchanged between 1973 and 1980. (See introductory note.)

Employment in sawmills and planing mills declined from 287,500 in 1960 to 217,600 in 1973. Employment in the logging camp and logging contractor classification also declined, from 91,000 in 1960 to 72,000 in 1973. Wooden container manufacturing employment declined from 41,800 in 1960 to 27,800 in 1973.

Employment in millwork and miscellaneous wood products, on the other hand, has increased. Millwork employment increased from 146,500 in 1960 to 214,400 in 1973. Employment in miscellaneous wood products increased from 60,000 in 1960 to 99,800 in 1973.

Occupational trends

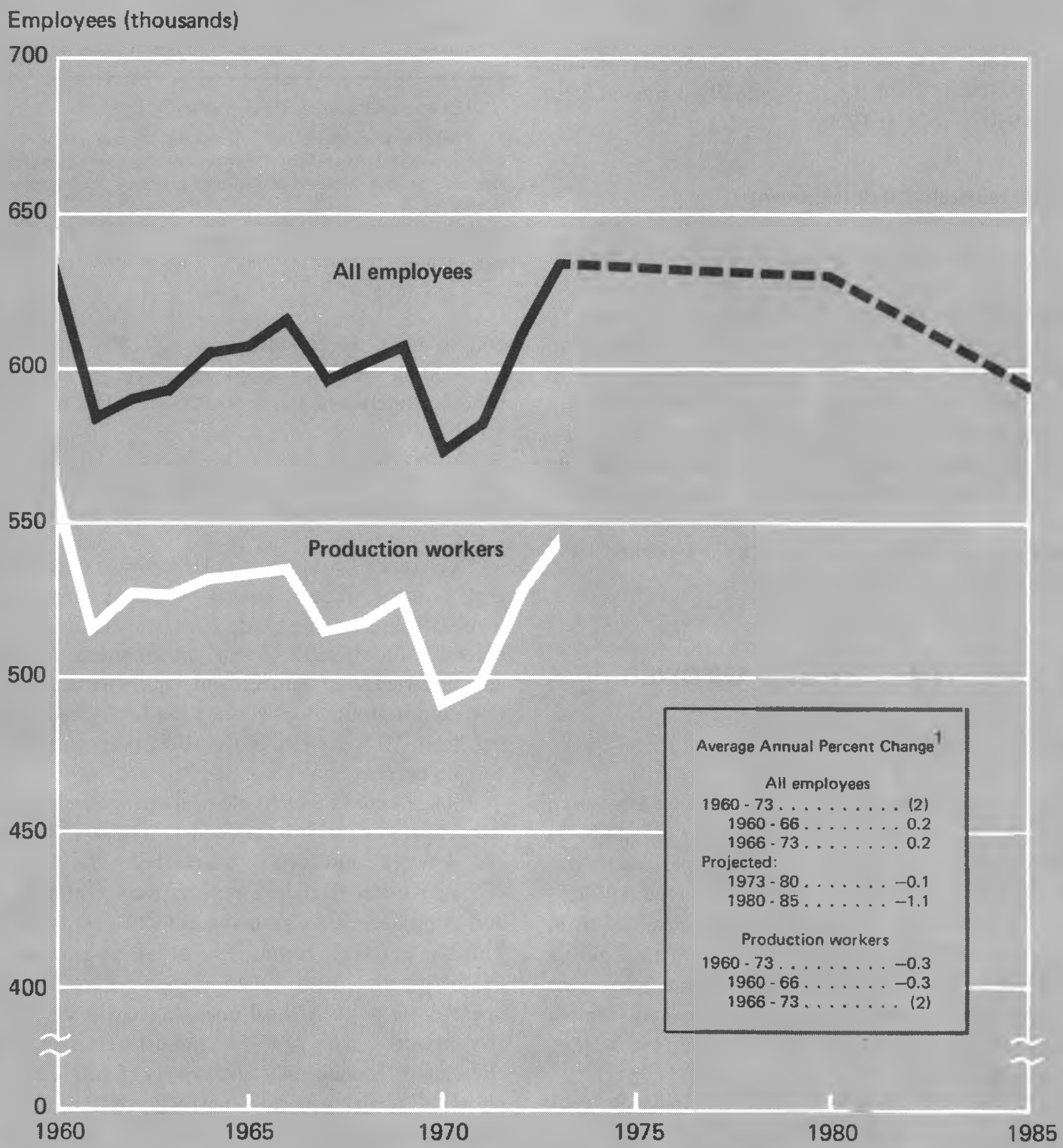
New types of equipment have eliminated many jobs and brought about changes in occupational requirements. These requirements have shifted away from an emphasis on strength toward an emphasis on dexterity and knowledge of lumber and equipment. The proportion of nonproduction workers has been steadily increasing, from 10.5 percent of the all-employee total in 1960 to 13.8 percent in 1973.

Jobs affected by technological change include sawyer, lathe operator, and dryer feeder. Sawyers now operate the setwork and dogs (which hold the log on the carriage) using electronic pushbuttons. Optical scanners and computers are also being used to operate setworks. This is not yet common, but is a growing trend. Formerly, two men called doggers were required to operate the dogs. A third man, called a setter, operated the setworks. The need for these three men has been eliminated, leaving only the sawyer. Lathe operators in plywood plants can now perform all the work using pushbuttons, whereas they previously had two or three men working with them. Automatic dryer feeders now put the green veneer into the dryers, thus eliminating the need for the two to three men who previously performed the job.

The occupational distribution projected for 1980 by BLS takes into account the impact of technological and

Chart 4

Employment in the Lumber and Wood Products Industry, 1960-73 and Projected for 1980 and 1985



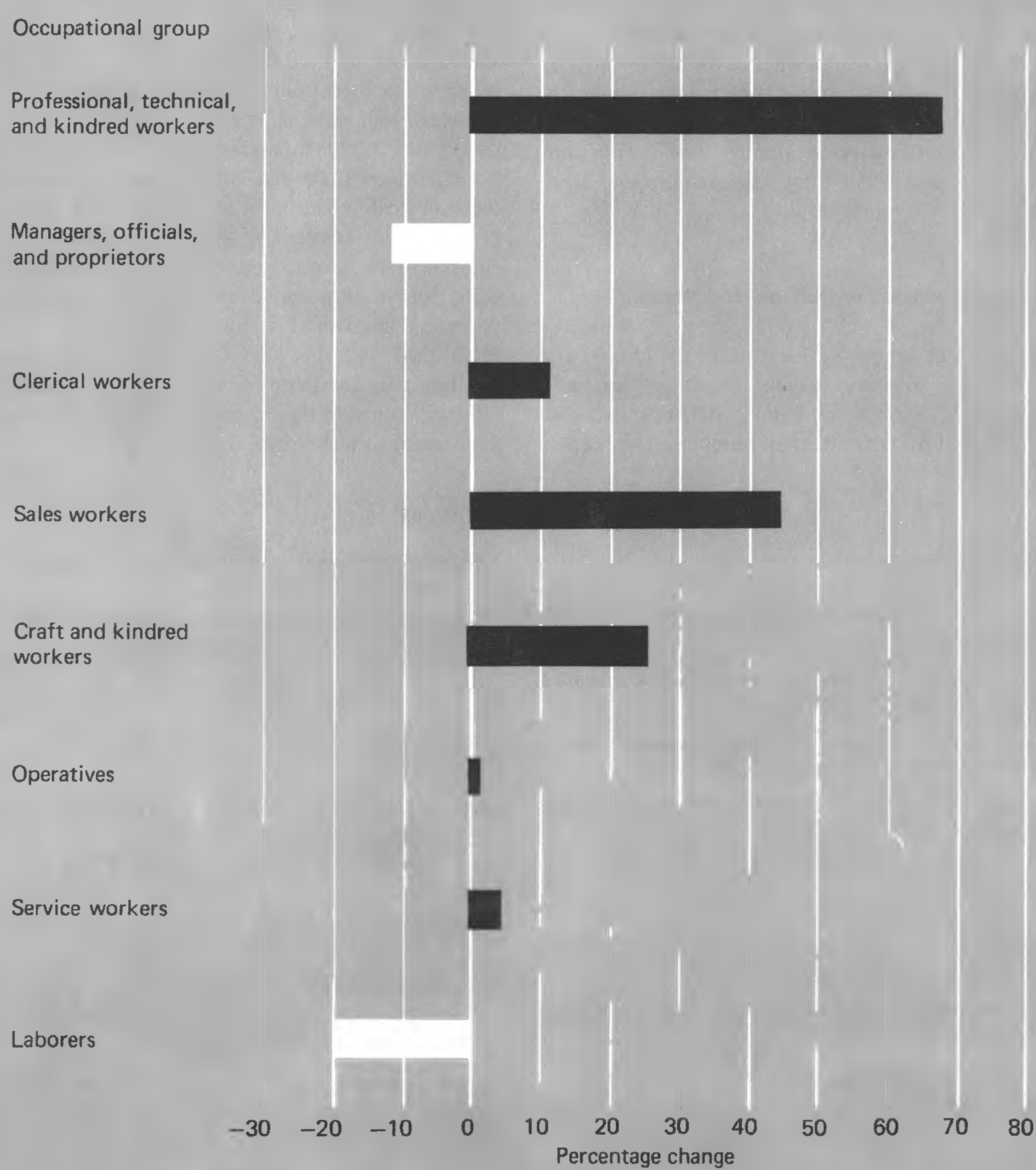
[1] Least squares trend method for historical data; compound interest method for projections.

[2] Less than 0.05 percent.

Source: Bureau of Labor Statistics.

Chart 5

Projected Changes in Employment in the Lumber and Wood Products Industry by Occupational Group, 1970-1980



Source: Bureau of Labor Statistics.

other changes underway in the industry, and their effect on occupations. Thus, it is likely that by 1980 white-collar workers will represent a greater proportion of over-all industry employment (from about 17 percent in 1970 to nearly 19 percent) with a corresponding decline in blue-collar employment, from roughly 81.5 percent of the total in 1970 to slightly less than 80 percent.

Among white-collar workers, the greatest increase in relative importance between 1970 and 1980 will be for professional and technical workers; among blue-collar workers, craft workers will grow proportionately faster. Laborers, on the other hand, will decline significantly as a proportion of total industry employment, from nearly 29 percent in 1970 to about 23 percent in 1980. Chart 5 shows the changes expected among these occupations between 1970 and 1980 under the assumptions mentioned in the introductory note.

Adjustment of workers to technological change

The degree of union organization in the lumber and wood products industry (except furniture) was estimated by the Bureau of Labor Statistics to range between 25 and 50 percent of all production workers in 1970. The comparable figure for all manufacturing was 44.3 percent. The principal unions organizing the industry are affiliated with the AFL–CIO. These are the United Brotherhood of Carpenters and Joiners of America, the International Woodworkers of America, and the Coopers' International Union of North America. Thirteen percent of the Carpenters' membership work in the industry whereas nearly all (95 percent) of the Woodworkers are thus employed. Similar information for the Coopers' union is not available, however.

The limited information available indicates that labor and management, through collective bargaining, are giving more attention to worker adjustments to technological change. For example, in one large company having over 5,000 employees, union and management set up a joint committee to study problems generated by technological change. Another contract contains a provision for employees who are displaced by new equipment to have the opportunity to operate the new equipment if they can demonstrate the necessary competence. They would be compensated at the rate of pay established for the job. General contract provisions covering such areas as retirement, layoff and recall, plant closings, transfer rights, and retraining also assist in adjustment to technological change.

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Tires and Tubes

SUMMARY

Major technological changes are evolving in tire manufacture (SIC 301). These include new radial tire machinery; faster, larger capacity equipment; more efficient materials handling techniques; and automated instrumentation. In general, these changes affect job content and reduce requirements per tire for semiskilled operators and unskilled workers. Radial tire manufacture, which currently requires more unit man-hours than conventional tires in almost every phase of production, will probably change significantly over the decade.

Output per all-employee man-hour rose at an average annual rate of 3.4 percent in the 12 years from 1960 to 1972, but most of the gain occurred in the first half of the period. Productivity growth is likely to be affected in the next several years by the conversion to radial tires.

Expenditures for plant and equipment rose sharply in the 1960's, averaging about 2½ times the outlay in the 1950's. From 1960 to 1972, the average annual rate of increase was 9.3 percent. Investments are expected to continue moving up in the 1970's as the industry retools for radial tires.

Employment rose at an average annual rate of 2.1 percent from 1960 to 1973. The growth rate from 1973 to 1980 is expected to be considerably more rapid, according to a BLS projection assuming a national 4-percent unemployment rate. (See introductory note for other assumptions.) From 1980 to 1985, however, the growth rate is likely to be very slow. Some dislocation may be associated with the phasing out of antiquated plants.

TECHNOLOGY IN THE 1970'S

In general, technological changes in tire manufacture[1] include faster, larger capacity machines, materials handling mechanization, and automated instrumentation. Many of these changes improve productivity and reduce requirements for semiskilled and unskilled workers. Radial tires, however—expected to take a major share of the market in a few years—currently utilize techniques which require more man-hours per unit of output for almost all phases of production. These techniques are likely to change significantly by the end of the decade. (See table 8 for a brief description of the major changes in technology in the industry and their impact.)

Improved, automated equipment

In general, equipment for manufacturing conventional and bias-belted tires has greatly improved in recent years, including faster, larger capacity machines and automatic loading and unloading devices. These reduce process time and lower unit labor requirements for machine operators and unskilled materials handlers. For example, in older mills, one man can handle 15-20 curing presses; in newer plants, 60-90 presses.

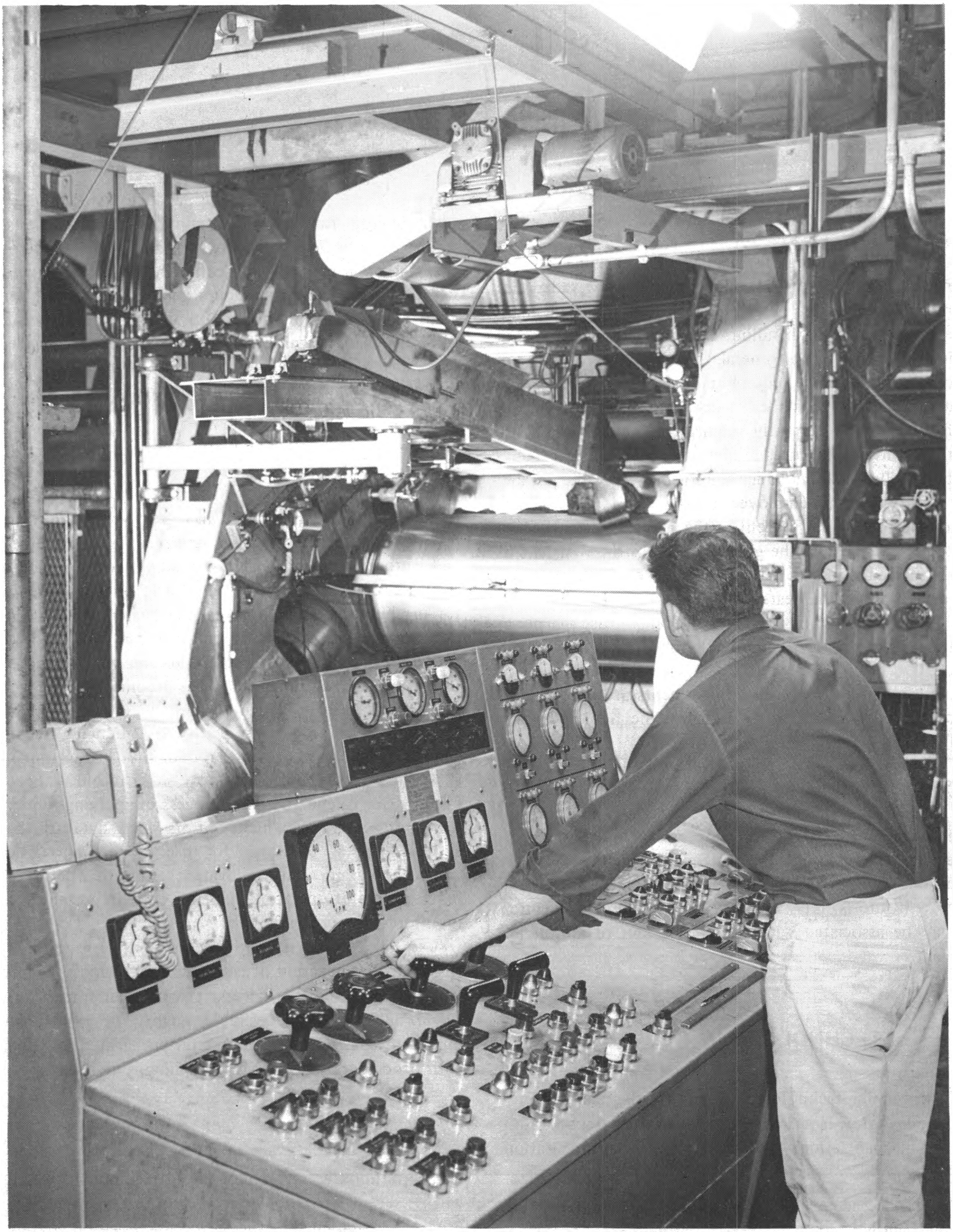
Automated instrumentation has become important in modernized mills to control weight, thickness, temperature, time, etc., improving quality and reducing downtime and thereby improving productivity. For example, a sophisticated control system has recently been installed for calendering—the process of applying rubber to fabric cords—in which sensors feed data to the system's digital processor for use in the automatic control program. This innovation tends to alter skill requirements of operators, increasing the importance of monitoring the process.

Use of computers for process control is limited largely to optimization of compounding formulas (composition of ingredients necessary for rubber formation) to attain the most desirable quality of rubber at minimum cost. Computers are still primarily associated with office data such as payroll, billing, and inventories.

Continuous processing

The outlook is for technological developments which will tie several operations into a continuous system. For example, at present, the average mixing or compounding

[1] This technology review is primarily concerned with passenger car tires.



Automatic gauges and controls assist employees in the fabric calendering operation where rubber stock is pressed onto both sides and between tire cords.

Table 8. Major technology changes in the tire industry

Technology	Description and impact	Diffusion
Steel wire fabric	Steel wire covered with rubber for use as belts; requires more skilled labor.	Standard equipment on luxury autos; common for trucks.
Bias-belted tire construction	Body plies placed at an angle to direction of travel with belts on top; requires more labor than conventional tire.	Manufacture started in 1969. In 1973, almost 50 percent of passenger car tires were bias-belted.
Radial-belted tire construction	Body plies placed perpendicular to the direction of travel with belts on top; conversion costly; now requires up to 50 percent more labor than bias-belted tire.	In 1973, about 13 percent of passenger car tires; estimates for 1980 range up to 70 percent.
Segmented molds	Segmented molds may be used for curing rigid steel-belted radials. Curing time can range up to 15 percent longer than for other tires.	Now being installed in new plants producing radials.
Computer control	Automatic control system for calendering (applying rubber to fabric cords); reduces unit labor requirements.	Recently installed in at least one plant.

operation (the first process in tire production) utilizes discontinuous internal mixers and batch machines such as roll mills for subsequent operations. Continuous processing is expected to convert the currently typical mixing methods so as to reduce associated manpower by 30 percent—according to one industry estimate—affecting both operators and unskilled workers.

Radial tire technology

The conversion to radial tires is expected to be more complex than the shift from conventional to bias-belted tires. For radial tire production, changes are required for almost every process in the plant: compounding, fabric preparation, building, and curing. In addition to the problems of labor and plant utilization associated with retooling, estimates of labor required per radial tire range from 20 to 50 percent greater than for the bias-belted tire. Although the techniques of radial production are not new to American companies, several of whom have been manufacturing radials in Europe for many years, the effort here is being directed toward new, simplified machinery which can more cheaply and readily accommodate the radials. Some authorities in the industry expect that radial tires may constitute as much as two-thirds of all passenger car tires by the end of the decade.

Tire building and operation of the bias cutter are primarily responsible for the higher labor costs in radial tires. In the conventional "building" process, a highly skilled operator assembles all components of the tire on a building drum and the tire is expanded to full diameter later. For the more rigid radials, building is generally a two-part operation which requires specially designed machinery. According to one industry spokesman, output on current machinery totals about 100 radial tires per man per shift compared with 150 bias-belted tires. New techniques for radial tire manufacture are being developed and it is expected that labor costs will be reduced substantially by the late 1970's. For example, a more sophisticated, one-stage building process for radials is now being evaluated by the industry.

For the "curing" process, some radials may use a more costly segmented mold to accommodate the inflexible tire material rather than the simpler conventional mold. In some cases, the time required to cure radials may range up to 15 percent longer than for other tires, requiring more man-hours per tire for machine operators. In some newer plants, however, existing equipment is being modified to cure radials in a relatively shorter time with less labor per tire.

New fiber technology

Nylon has steadily declined from 60 percent of all cord material in 1967 to less than half in 1972, yielding largely to polyester fiber. Polyester consumption has jumped to more than one-third of the total cord used in 1972 from about 11 percent in 1967. This shift occurred when bias-belted tires, for which polyester was favored, were accepted as standard equipment on 1969 model cars.

However, more radical changes are now expected with the conversion to radial tires, which require stronger, more rigid fibers. Assuming radial-belted production expands as expected, steel wire, which is in general use in Europe, will gain a sizable share of the U.S. market by 1980. Glass fiber, improved polyester, and the new Fiber B are also expected to compete strongly for the radial tire cord market. Nevertheless, nylon and polyester probably will continue as the prime fiber cords for bias-belted tires.

New machinery is being developed to process steel cord, particularly for the smaller companies. The European method of calendering steel wire cords, now being adopted by some large companies, is extremely costly and requires more skilled labor.

PRODUCTION AND PRODUCTIVITY OUTLOOK

Output

Output of tires and tubes (chart 6) rose at an average annual rate of 5.6 percent from 1960 to 1972. Following the pattern of motor vehicle production, the rise in tire output in the first half of the period (7.6 percent annually) was substantially greater than in the last half (4.3 percent). Sizable declines occurred in 1967 and 1970, largely associated with strikes in the rubber and auto industries, but in general the slower rate of output growth in the late 1960's reflected the weaker economy. As the economy strengthened in the early 1970's, output of both original tires and replacement tires moved up sharply. In 1973, however, tire production leveled off.

Although the restrictive effect of the fuel shortage on tire production may be considerable in the short run, the long-run outlook is expected to be strong. The industry anticipates peak demand for original tires in 1980 as car and truck sales increase. While replacement tire demand may be adversely affected by the growth of radials whose life expectancy is about twice that of other tires, their greater durability may be offset by a general rise in tire usage. Estimates of the share of radial tire production by 1980 range from 40 to 70 percent of passenger car tires, compared with 13 percent in 1973.

Tire imports have increased sharply since the mid-1960's, to over 8 percent of consumption by 1972. Although it was generally expected that imports would accelerate in the 1970's, the outlook in the short run is now unclear as a result of the fuel shortage.

Productivity growth

Output per all-employee man-hour increased at an average annual rate of 3.4 percent from 1960 to 1972 (chart 6), higher than the annual rate in the 1950's. Almost the entire productivity gain, however, occurred in the first half of the 1960's—an annual rate of 6.3 percent from 1960 to 1966 compared with 1.7 percent from 1966 to 1972. This sharp decline in the rate of productivity advance in the second half of the 1960's was accompanied by a serious cutback in output growth while man-hours rose more rapidly.

Productivity growth is likely to be affected by the planned conversion to radials in the next few years, but the extent of the problem is not clear at this time. According to industry estimates, 20-50 percent more labor is currently required for radial tires than for bias-belted tires. Moreover, the complex retooling may result in a loss of productive capacity in the next few years. However, new technologies, described earlier, are expected to substantially reduce unit labor requirements by the end of the decade.

Best plant practice

Although no general conclusions can be drawn from one year's data, some indication of the potential for productivity growth in the tire industry is suggested by the spread in productivity among the establishments (table 9). In 1967 (latest data available), average value added per production worker man-hour (an approximate indicator of productivity) was three times larger in the "most efficient" group than in the "least efficient" group and about a third higher than the average for the industry. In this study, the "most efficient" plants are those which fall into the highest quartile of the ranking of plants by value added per production worker man-hour; the "least efficient" are those in the lowest quartile.

The wide range in productivity within the industry

Table 9. Value added and capital expenditures in the tire industry: Ratios of "most efficient" to "least efficient" plants and to average plant, 1967

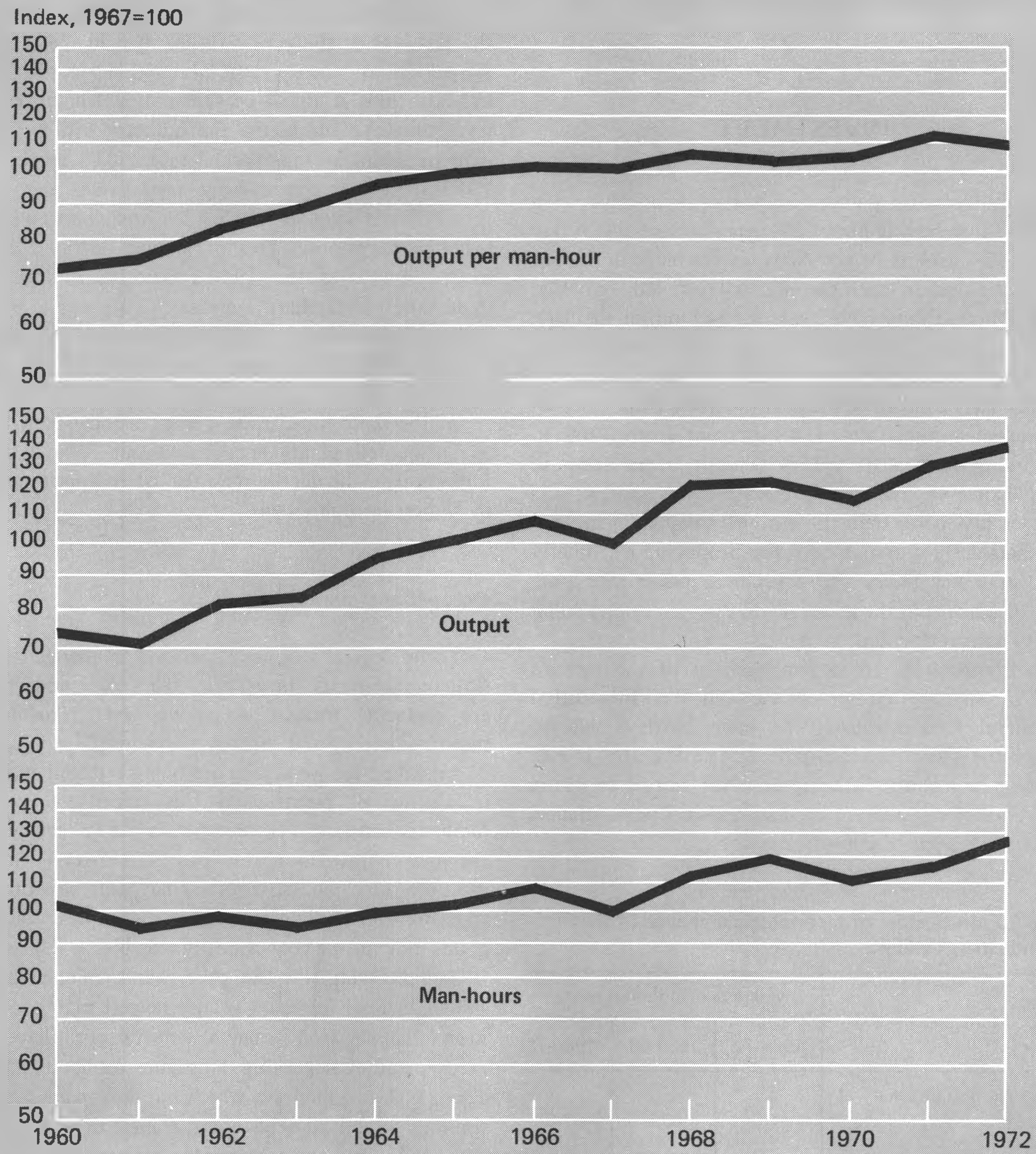
Measure	"Most efficient" to "least efficient" plants	"Most efficient" to average plant
	(Ratios)	
Value added per production worker man-hour	3.2	1.4
Capital expenditures per employee	1.8	1.2

NOTE: Establishments in each sector were ranked by the ratio of value added per production worker man-hour. The "most efficient" establishments are defined as those which fall into the highest quartile; the "least efficient" are those in the lowest quartile.

SOURCE: Based on unpublished Census Bureau data prepared for the National Commission on Productivity.

Chart 6

Output per Man-Hour, Output, and Man-Hours in the Tire Industry, 1960-72



Source: Bureau of Labor Statistics.

may reflect differences in size, management, labor, capital outlays, and other factors. Available data show, for example, that average capital expenditures per employee by the "most efficient" tire mills in 1967 were about 75 percent greater than by the "least efficient" plants and 20 percent greater than by the average plant.

Although not fully comparable, available data for 1958 on the productivity gap between the "most efficient," "least efficient," and average plants in the industry generally showed the same pattern.

INVESTMENT

Expenditures for plant and equipment rose sharply in the 1960's, averaging about 2½ times the annual outlay in the 1950's. Most of the outlays were made in the last half of the decade when the industry retooled for belted tire production, and hit a peak of $342 million in 1969. By 1972, they had declined to $296 million, still considerably above the average of the 1960's. As shown in table 10, outlays per production worker increased at an average annual rate of 4.1 percent from 1960 to 1966, and more sharply (5.4 percent) from 1966 to 1972. However, the real increase in investment was considerably lower than the current dollar data suggest. Price data are not available for tire-producing machinery, but overall machinery and equipment prices rose more than 20 percent in those last 6 years while current dollar outlays almost doubled.

The outlook is for a continuation of the upward trend in plant and equipment expenditures. In addition to general modernization, the larger outlays will be needed for radial tire equipment. The industry is also investing large sums in equipment for testing to insure safety, to meet government standards on performance, and in other areas of consumer concern.

Table 10. Indicators of technological change in the tire industry, 1960-72

Indicator	Average annual rate of change[1]		
	1960-72	1960-66	1966-72
Payroll per unit of value added	–1.6	–0.6	–2.3
Capital expenditures per production worker	7.4	4.1	5.4

[1] Linear least squares trend method.

SOURCE: Bureau of the Census.

EMPLOYMENT AND MANPOWER

Employment trends

Employment in tire plants rose to about 110,000 in 1973 (chart 7), the highest point in about 25 years. In the 13 years from 1960 to 1973, the annual rate of increase was 2.1 percent. Production worker employment increased somewhat less rapidly than total employment over this period. Most of the increase occurred in the last half of the period rather than in the early half. Projections of employment in 1980 developed by BLS indicate that, at the 4 percent national unemployment level, employment in the tire industry will be likely to increase at an average annual rate of 3.5 percent from 1973 to 1980, considerably faster than the rate of growth from 1966 to 1973. (See introductory note for other assumptions.) This projection of rapid employment growth in the 1970's is associated with the expectation of a sharp increase in automobile purchase and use; no adjustment has been made for the fuel shortage. The rate of growth from 1980 to 1985 is likely to be very slow.

At the same time, some worker dislocation will occur as antiquated plants are phased out. The pattern of imports over the decade may also be an important factor in domestic employment.

Occupational trends

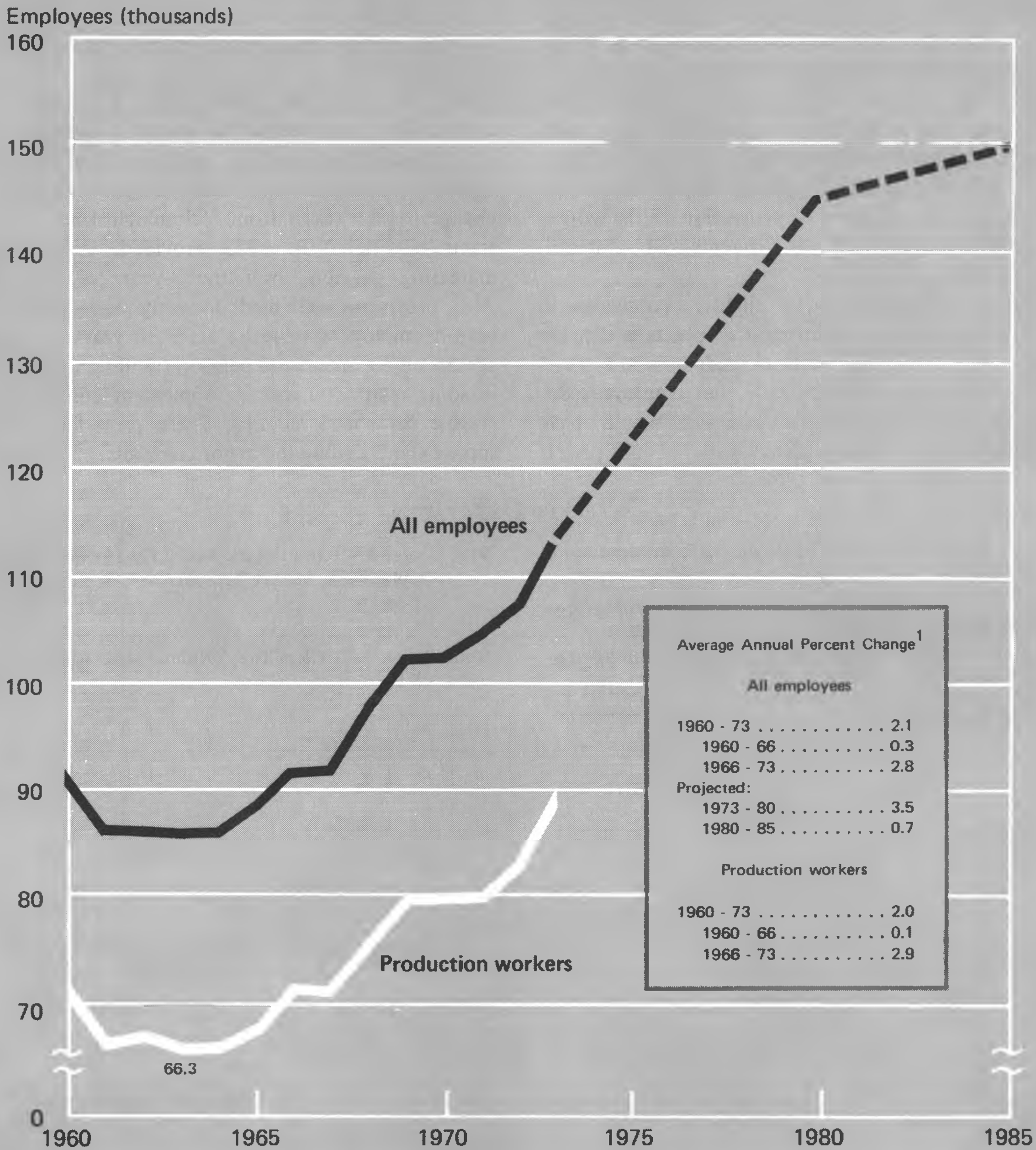
Technological advances continue to change labor and skill requirements. In general, the more modern plants are replacing manual skills, whenever possible, with machine tending and console monitoring.

Unskilled laborers' jobs are being reduced in number in almost all plants, and this trend will continue. Materials handling, for example, is highly mechanized in the newer one-floor tire plants. However, in older multiple-story plants, laborers may still be utilized for trucking and hauling jobs since mechanical transfer of goods may not be economically feasible.

Tire building, on the other hand, remains a highly skilled manual job even in the newest plants, although many associated manual operations have been mechanized. Calendering (applying rubber to cords) is also a highly skilled job which requires many months of training. Technical skills are also increasing in the use of advanced instrumentation involving electronics or hydraulics. Some highly complex machinery requires more skilled maintenance. Nevertheless, skilled employment may not increase as a proportion of total employment because complex machinery may be self-regulating,

Chart 7

Employment in the Tire Industry, 1960-73 and Projected for 1980 and 1985



[1] Least squares trend method for historical data; compound interest method for projections.

Sources: Bureau of the Census; Bureau of Labor Statistics.

have larger capacity, and may actually require fewer man-hours per unit of output.

Adjustment of workers to technological change

More than 90 percent of the tire and tube production workers are in plants covered by labor-management agreements with the United Rubber, Cork, Linoleum and Plastic Workers of America. In general, contract provisions relating to layoffs and plant closings do not specify technological change as the cause. However, mention is made in several contracts of "a reduction in requirements in a skilled trade classification" and similar references to changing requirements. Basically, the principle of seniority, carefully spelled out in these contracts, offers some measure of protection to the worker from problems associated with changing labor or skill requirements.

Although agreements differ slightly, provisions to help ease the workers' adjustment in plants which are being phased out have been extended in the 1973 contracts. Some contracts provide that employees displaced by plant closings or cutbacks would have preferential hiring at other plants, which would permit retaining seniority in respect to retirement and other benefits. Most of these new contracts also increased the maximum contribution to the supplemental unemployment benefits program which would be used in the event of a sizable cutback or closedown.

Concern about the closing of older marginal plants resulted in an unprecedented vote by some Akron local unions to revise contract provisions, yielding some established prerogatives in an effort to improve productivity. Of particular importance was the provision to increase the basic workwork to a standard 5-day 40-hour week from the 6-day 36-hour week started in the 1930's. Other concessions were also made to improve plant productivity, such as the tightening of piecework rules.

Retirement and pension provisions in the major tire company contracts also assist in the adjustment to changes which result from technological advance. Contracts negotiated in 1973 provided, in general, for increasing pensions over the 3-year contract period. Also, provisions were made for early retirement that will permit employees to retire after 30 years of service at age 55 on an unreduced pension (with limited reduction in some contracts) with a supplement continuing until eligible for social security. These provisions differ, to some extent, among the major contracts.

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Aluminum

SUMMARY

Improvements in the conventional electrolytic-reduction method are expected to continue to be the most prevalent technological changes in primary aluminum production (SIC 3334). These include the introduction of larger and better designed reduction cells and anodes and other innovations, such as computerization, designed to increase potline efficiency. The occupational skills of those workers affected by the introduction of computers are likely to be modified to include monitoring of process machinery and equipment. Most of the other technological changes expected to take place will not greatly affect existing worker requirements and skills. A new smelting process which uses aluminum chloride as the electrolyte may be introduced commercially in 1975. In addition to virtually eliminating pollution problems at reduction plants, this new process is expected to result in power savings of up to 30 percent.

Equipment used in fabricating aluminum (SIC 3352)—aluminum rolling, drawing, and extruding—is becoming much larger, operating at faster speeds and under computer control—factors tending to increase productivity. Continuous heat-treating and annealing are being introduced more widely to produce high strength aluminum sheet. Also, continuous casting of molten aluminum is growing in importance, eliminating many of the operations currently required in processing ingots into sheets and bars. These developments, which are likely to spread among aluminum fabricators, imply a reduction in unit labor requirements and a continued improvement in output per man-hour.

Trends in output and man-hours suggest that productivity, which has been rising in both primary aluminum production and in aluminum fabrication, may continue to improve during the 1970's. In both industry sectors, growth in output is likely to outpace growth in employment and man-hours each year, on the average. Average annual increases in output per man-hour may be somewhat higher in aluminum rolling and drawing than in primary aluminum production.

Between 1960 and 1971, average annual expenditures for new plant and equipment rose more rapidly in the primary aluminum industry than in aluminum fabrication. Capital expenditures are likely to increase over the next decade if the industry is to provide for improved pollution control equipment and maintain the current rate of modernization of plant and equipment.

During the period 1970 to 1980, employment in primary aluminum may continue to rise at a faster average annual rate than in aluminum rolling and drawing; between 1980 and 1985, however, employment in primary aluminum will probably level off while the annual growth rate of employment in aluminum fabrication may slow down. These projections are based on a 4-percent unemployment rate and other assumptions and the expected rates of change in output and in productivity. (See introductory note.)

TECHNOLOGY IN THE 1970'S

Primary aluminum production

The Bayer-Hall electrolytic reduction process, with improvements, continues to be the method employed to produce aluminum in the United States. Older aluminum reduction facilities as well as the newer plants have adopted advanced process technology and equipment innovations. Among the most significant advances in reduction plant operations are computer control of the process, use of automated pot-tending machinery, and improved rodding shop conveyor systems in plants using prebaked anodes. Improved techniques in the casting shops provide better quality metal. (See table 11 for a brief description of the major technology changes in the industry.)

A new system for automatic control of individual pot voltages, feeding of alumina to the electrolyte, and suppression of anode effect has been introduced to afford better control of the pots and provide increased manpower efficiency. Control adjustments were previously made by hand. One large plant, for example, uses four minicomputers to monitor the position of the anodes in the pots and the level of alumina concentration in the electrolyte. Also, in a reduction plant recently started up, a new system was developed for tending the pots which utilizes three specialized fully automatic semigantry cranes and two semiautomatic pot-tending cranes for each room of pots in the plant. These cranes perform more than five operations traditionally handled with separate pieces of equipment, resulting in manpower savings and increased efficiency. The crust breaking and pot feeding are controlled automatically, backed up by manual controls.

In plants using prebaked anodes, anodes and suspension rods are assembled in rodding shops. Mechanical chain conveyors are used to carry the anode components from one assembly operation to another. In several plants, the introduction of an overhead monorail system has decreased downtime and the need for materials handlers, and has increased flexibility through the use of self-propelled trolleys that can be individually replaced.

In one new reduction plant, plantwide computerized management and quality systems have virtually eliminated all manual recordkeeping, requiring minimal clerical effort. In addition to performing financial and administrative tasks, the systems department computer maintains a production reporting system, processing the raw production data received from the carbon anode plant, potline, and cast house areas. In the area of quality control, product specifications are maintained in the computer which are compared with the properties of the metal in the research furnace batch as determined by spectographic analysis before casting. During the casting operations, every major variable is recorded on charts so as to maintain control of the pour and to provide a history for further study and analysis. After casting, products are immediately checked for defects visually and with an ultrasonic device to determine if the product should be processed further. Rolling ingots are cut by a giant circular saw and billets are cut, stacked, bundled, and weighed on an automatic and completely integrated line.

There is a continuing trend toward larger and better designed reduction cells and anodes. In addition, the grinding, blending, weighing, mixing of pitch binder, delivery of paste to the press, and forming of the anodes are becoming highly automated through the use of specially developed machines and materials handling equipment.

The concept of increasing aluminum potline efficiency by adding lithium fluoride to the cryolite bath is receiving new impetus. The addition of lithium fluoride increases the conductivity of the bath and thereby allows higher current to be used and more metal to be produced under conditions of bath temperature and thermal balance which are maximum for a pot design.

Currently, interest is focused on the development of a process for producing aluminum which would require

Table 11. Major technology changes in primary aluminum production and aluminum fabrication

Technology	Description and impact	Diffusion
Improvements in the Bayer-Hall electrolytic production process	Automatic control of electrolytic furnaces; fully automatic and semiautomatic cranes.	Used by major aluminum producers in their new and modernized plants.
"Prebake pots" (or cells)	Unlike the vertical or horizontal stud Soderberg pots which use self-baking carbon anodes, the "prebake pots" use prebaked carbon anodes. The carbon anode is used in the Bayer-Hall process to separate alumina into aluminum and oxygen.	Used by new plants; easier to collect emissions because the "prebake pot" can be hooded easily.
New smelting process	Alumina is combined with chlorine in a reactor to form aluminum chloride. The chloride is processed electrolytically, resulting in molten aluminum and chlorine. This process will require the use of considerably less electricity then the Bayer-Hall method.	Process tested in a full-scale development unit. Pilot plant using this process scheduled for completion in 1975.
Computer-controlled cold-rolled products mill	Maximum rolling speeds of 8,000 feet per minute compared with 2,000 to 5,000 f.p.m., range in older plants. Also capable of producing strip up to 60 inches wide.	Limited diffusion as of 1970.
Continuous casting of molten aluminum	Production of reroll stock at high speeds and at varying thicknesses. Casting, rolling, and coiling operations function with synchronization and electronic controls.	A recent development, not yet widely diffused.

less electricity, thus contributing to the national effort to conserve energy fuels. A new smelting process was announced recently which, if successful, will reduce by as much as 30 percent the electricity required by the most efficient units of the Bayer-Hall method. In this process, which has been tested in a full-scale development unit, alumina is combined with chlorine in a reactor to form aluminum chloride. The chloride is electrolytically processed in a completely enclosed cell which separates the compounds into molten aluminum and chlorine. The chlorine is then recycled back to the reactor in a closed loop. The first pilot unit of a smelting plant using the new process is scheduled for completion in 1975. Extension of the new smelting process to other plants of the company or its licensing to other producers depends on the success of full commercial operation. Moreover, by eliminating the need for the cryolite (a fluoride chemical) additional savings will result from the elimination of fluoride emissions (which are the main pollution problem at aluminum smelters) and the costly fume control equipment required for the recovery of cryolite for future use.

The Bureau of Mines has evaluated 17 processes involving the use of clays instead of bauxite in the aluminum refining process. For three of the most promising methods for treating clays, the Bureau indicated that aluminum production would be greater than from bauxite using the conventional Bayer-Hall method. However, capital costs for the clay process plants would range from 65 to 100 percent greater than for Bayer-Hall plants. With the presently indicated abundance of bauxite, it is unlikely, barring an emergency situation, that the substitution of clays for bauxite will occur in the next two decades.

Aluminum fabrication

In recent years equipment used in fabricating basic shapes (sheet and plate, extrusions, forgings, rods, bars, wire, tube) has become larger, faster, and increasingly under computer control—tending to increase productivity. A computer controlled cold-rolled products mill was started up in 1970, in which aluminum is rolled at a top speed of slightly more than 8,000 feet per minute on a practical production basis. Maximum rolling speeds in older large sheet mills are generally in the 2,000 to 5,000 f.p.m. range. The mill is capable of producing strip up to 60 inches wide. The new widths being rolled are useful in opening up additional market possibilities.

Also, a new continuous heat-treating and annealing line was put into operation in 1970 that is designed to produce high strength aluminum sheet with more uniform physical properties, greater strength and workability, and better surface appearance. Built for continuous operation, the massive computer-controlled installation is nearly a quarter of a mile long. Its sheet gauge is from .010 to .125 inches with a maximum finished width of 6 feet. Before the installation, sheets were cut in smaller sizes, clamped in racks, heat treated, and quenched in batches—a relatively slow, inefficient, and labor-consuming method.

Another recently developed process, continuous casting of molten aluminum, permits the production of reroll stock at great speeds and at varying thicknesses, depending on alloys. From the crucible the metal is siphoned into three tilting furnaces which pour the metal directly into the mouth of the caster. Casting of continuous ingot is done, using water to cool the metal at up to 8,000 gallons a minute. The thin ingot passes through the first of three hot rolling operations to reduce ingot thickness by up to 50 percent. Then it continues on to two other mills to complete the rolling process. Casting, rolling, and coiling operations function with synchronization and electronic controls. Two men at a control desk supervise the entire operation.

A new way of cold-rolling coiled metal sheet has been introduced which has important implications for the cold-rolling of particularly hard-to-roll metals such as stock for cans. The new system incorporates three main components: a device known as a stressometer, a special work-roll bending device, and a switching device. The stressometer "directs" the devices, one of which controls mechanical deflection of the strip as it passes through the work rolls while the second controls the temperature of the rolls. By substituting automatic control for adjustments previously made manually, there is an improvement in productivity, with concomitant manpower savings and increased output.

PRODUCTION AND PRODUCTIVITY OUTLOOK

Output

Output in the primary aluminum industry rose at an average annual rate of 6.9 percent between 1960 and 1972, more rapidly during the first half of the 12-year period than in the last half (7.4 percent between 1960 and 1966 on the average, compared with 5.7 percent a year between 1966 and 1972). Up to 1980, assuming energy requirements can be met, the average annual output growth in primary aluminum is likely to be at about the same rate as that which prevailed in the 1960 decade (7.6 percent).

In the fabrication sector (rolling, drawing, and extruding), output increased at an annual average rate of

Operator receives a continuous readout of data from the computer during the processing of aluminum plate.

7.2 percent between 1960 and 1972. Within this time period, output rose 11.5 percent annually between 1960 and 1966, and at a yearly rate of 4.5 percent between 1966 and 1972. The long-term rate of growth in output (7.2 percent a year) continued between 1970 and 1971. However, the rate of growth between 1971 and 1972 (nearly 20 percent) was far above the rate prevailing for the 1960-72 period. Again assuming energy requirements can be met, the average annual rate of increase in output to 1980 may continue to be relatively high, only slightly below the 1060-72 rate of increase.

Aluminum mill products are often used in place of 7.2 percent between 1960 and 1972. Within this time period, output rose 11.5 percent annually between 1960 and 1972. The long-term rate of growth in output (7.2 percent a year) continued between 1970 and 1971. However, the rate of growth between 1971 and 1972 (nearly 20 percent) was far above the rate prevailing for the 1960-72 period. Again assuming energy requirements can be met, the average annual rate of increase in output to 1980 may continue to be relatively high, only slightly below the 1960-72 rate of increase.

Aluminum mill products are often used in place of steel, plastics, wood, glass, and copper. For example, in 1972 the building and construction market accounted for 26.5 percent of total aluminum shipments in the United States; transportation accounted for 18.5 percent; containers and packaging, 15.2 percent; electrical and related products, 12.7 percent; consumer durables, 9.2 percent; machinery and equipment, 6.1 percent; other domestic markets, 7.0 percent; and exports, 4.7 percent.

According to the Aluminum Association, between 1960 and 1970 all major markets increased their use of aluminum each year, on the average: shipments for containers and packaging rose by 16.4 percent; electrical and related products, 9.9 percent; building construction, 6.3 percent; consumer durables, 6.2 percent; machinery and equipment, 6.1 percent; transportation, 6.0 percent; all other domestic markets, 8.8 percent; and exports, 6.5 percent. Future changes in market segments may reflect the decline in the use of aluminum stemming from recent cutbacks in the production of military aircraft as well as the growing demand for lighter weight cars because of the energy crisis.

Productivity growth

Productivity (output per employee man-hour) in both primary aluminum and rolling and drawing increased between 1960 and 1972, but at a much faster pace in the latter industry than in the former, 5.3 percent a year compared with 3.1 percent. (See charts 8 and 9.) Moreover, in the most recent period for which such data are available, 1971 to 1972, productivity gains in aluminum rolling and drawing outpaced those in primary production by a ratio of 3 to 1. The relatively higher annual rate of productivity increase in the aluminum rolling and drawing industry stemmed from a somewhat higher annual rate of increase in output compared with primary aluminum (as noted earlier) and a considerably lower rate of increase in man-hours (1.8 percent a year, on the average, compared with 3.8 percent in primary aluminum).

Productivity data available for all manufacturing for the period 1960-72 show a relatively slower annual rate of growth in primary aluminum production compared with all manufacturing and a faster yearly growth rate in aluminum rolling and drawing. For example, between 1960 and 1972, output per man-hour for all persons in manufacturing rose at an average annual rate of 3.3 percent; in primary aluminum production the comparable figure was 2.8 percent and in aluminum rolling and drawing 5.0 percent. On the average, productivity gains each year through 1980 are likely to rise significantly in primary aluminum; in aluminum rolling and drawing the annual rate of increase in productivity may continue roughly at the 1960 to 1972 rate of change.

Some insight into the proportion of labor required in the aluminum industry can be gained by deriving a ratio of payroll to value added. In the aluminum rolling and drawing industry this ratio was higher than in either primary aluminum or in all manufacturing industries considered together during the 1960 decade. However, as shown in table 12, during the period 1960 to 1971 the ratio declined on an average annual basis in

Table 12. Indicators of technological change in the aluminum industry. 1960-71

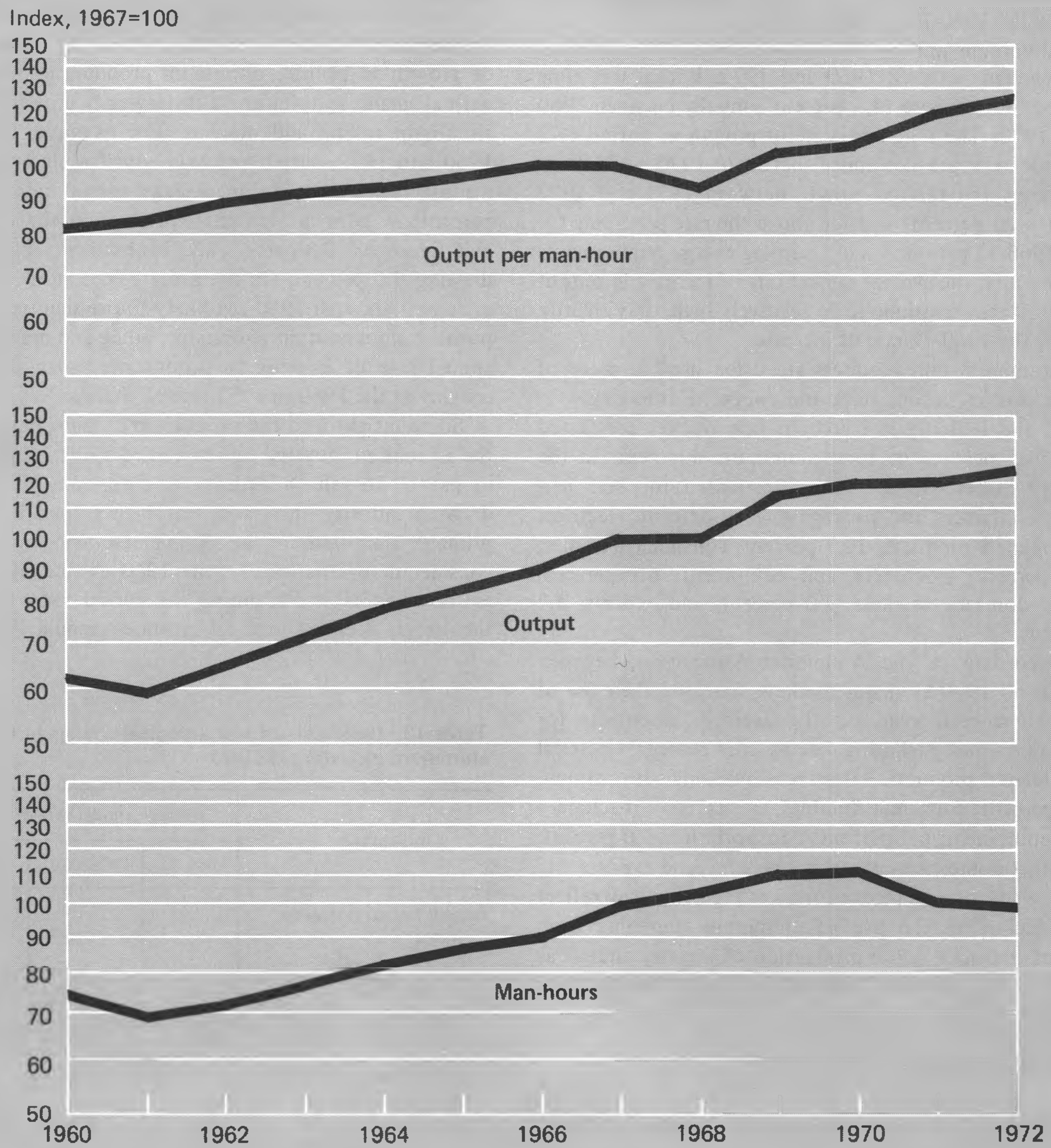
Indicator	Average annual rate of change[1]		
	1960-71	1960-66	1966-71
Payroll per unit of value added:			
Primary aluminum (SIC 3334)	1.5	–1.6	9.5
Aluminum rolling and drawing (SIC 3352)	–0.4	0.5	0.9
Capital expenditures per production worker:			
Primary aluminum	12.4	20.5	–8.7
Aluminum rolling and drawing	9.8	8.4	7.3

[1]Linear least squares trend method.

SOURCE: Bureau of the Census.

Chart 8

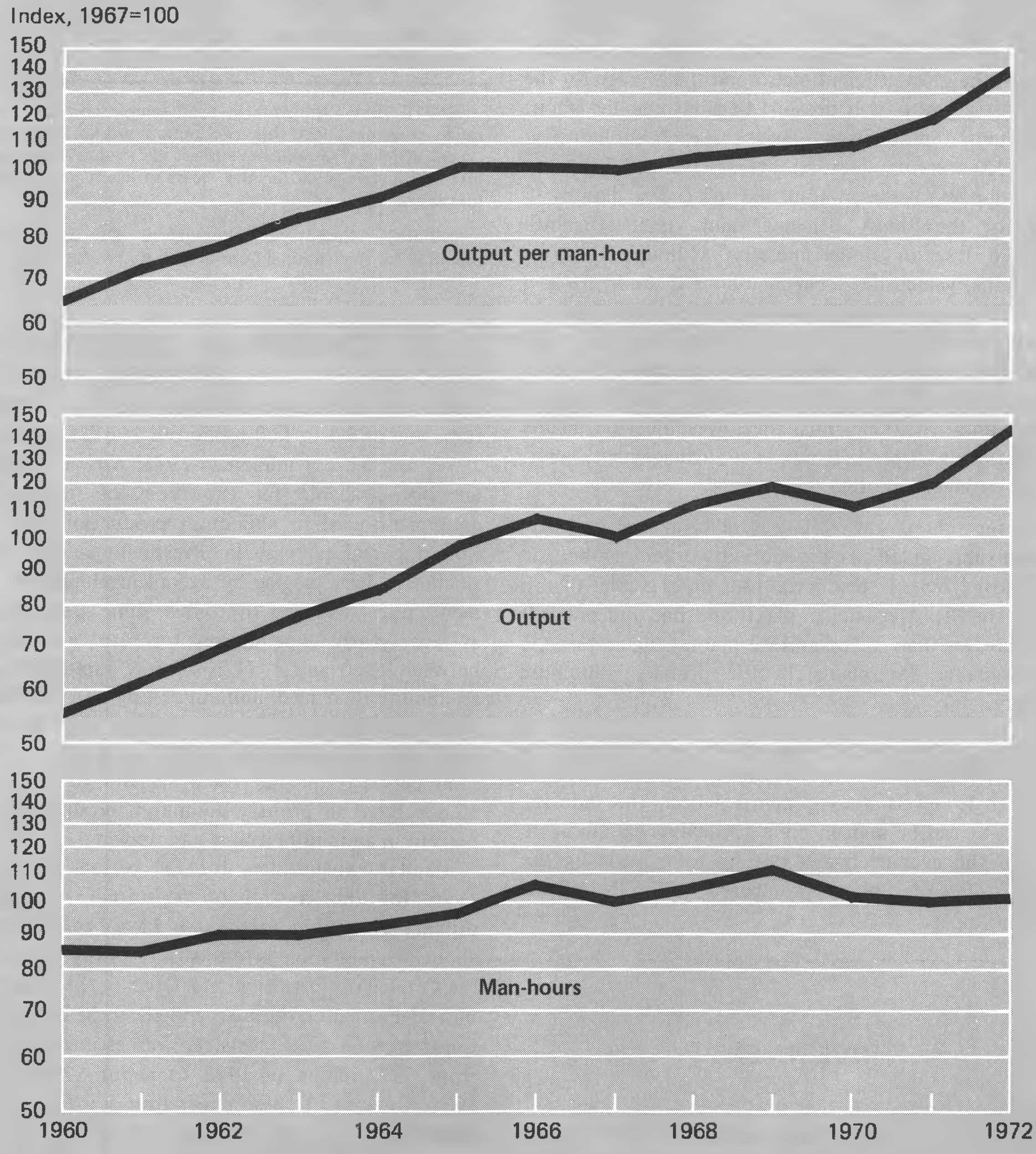
Output per Man-Hour, Output, and Man-Hours in the Primary Aluminum Industry, 1960-72



Source: Bureau of Labor Statistics.

Chart 9

Output per Man-Hour, Output, and Man-Hours in Aluminum Fabrication, 1960-72



Source: Bureau of Labor Statistics.

aluminum rolling and drawing and rose in primary aluminum.

During the 1960 decade, the average ratio of payroll to value added was .557 in aluminum rolling and drawing and .261 in primary aluminum. The comparable average ratio of payroll to value added in all manufacturing was .491.

Best plant practice

By looking at the difference between the productivity levels of the most efficient plants and the average for the subindustry group, it is possible to gain some idea about the potential productivity level for each subindustry. Table 13 presents data on average value added per production worker man-hour in 1967 (latest data available) for the "most efficient" and "least efficient" plants in a sector of the industry. Although it has its limitations, value added per man-hour is used here as a proxy for productivity. Those plants which fall into the highest quartile of plants ranked by the ratio of value added per production worker man-hour are defined as "most efficient;" the "least efficient" are defined as those plants which fall into the lowest quartile. Plants may differ as to product mix, size, management, labor, capital outlays, and other factors.

In the aluminum rolling and drawing industry, average value added per production worker man-hour in the "most efficient" plants was four times greater than it was in the "least efficient" plants and one and one-half times greater than in the average plant. Similar data are not available for plants in the primary aluminum industry.

Capital expenditures for plant and equipment undoubtedly help to explain the existing differences in productivity levels among plants within the industry sectors. As can be seen in table 13, census data indicate that on the average higher outlays were made by the "most efficient" plants compared with the "least efficient" ones.

Table 13. Value added and capital expenditures in aluminum rolling and drawing: Ratios of "most efficient" to "least efficient" plants and to average plant, 1967

Measure	"Most efficient" to "least efficient" plants	"Most efficient" to average plant
	(Ratios)	
Value added per production worker man-hour	4.0	1.5
Capital expenditures per employee	3.1	1.6

NOTE: Establishments in each sector were ranked by the ratio of value added per production worker man-hour. The "most efficient" establishments are defined as those which fall into the highest quartile; the "least efficient" are those in the lowest quartile.

SOURCE: Based on unpublished Census Bureau data prepared for the National Commission on Productivity.

INVESTMENT

Expenditures for plant and equipment varied greatly from year to year in both primary aluinum production and in aluminum rolling and drawing during the period 1960 to 1971. For example, in 1962, capital expenditures totaled $10.8 million in the primary aluminum industry; in 1967 they reached a high of $151.7 million and in 1971 they were $48.5 million. Similarly, in the aluminum rolling and drawing industry, these expenditures amounted to $60 million in 1961, $212 million in 1970, and $175.3 million in 1971. Although price data are not available for the types of machinery and equipment used in aluminum production and fabrication, the real increase in investment is probably considerably lower judging by overall machinery and equipment price changes over this same period. On the average, yearly expenditures for plant and equipment between 1960 and 1971 rose more rapidly in primary aluminum than in aluminum rolling and drawing--17.6 percent compared with 12.4 percent. Expenditures for plant and equipment per production worker during the same period (table 12) rose at an average annual rate of 12.4 percent in primary aluminum production and 9.8 percent in aluminum rolling and drawing.

Capital expenditures for the period 1972 through 1976 for the control of pollution associated with primary aluminum production have been estimated at about $935 million in one study jointly sponsored by the Council on Environmental Quality, the U.S. Environmental Protection Agency, and the U.S. Department of Commerce. Annual costs, it was estimated, may rise from $22 million in 1972 to about $296 million in 1976. Because of these expenditures for air and water pollution control equipment and others required to meet Federal safety regulations, energy conservation, and multifuel capabilities, overall capital expenditures for plant and equipment will have to rise during the 1970's just to maintain the current rate of modernization.

EMPLOYMENT AND MANPOWER

Employment trends

Employment in primary aluminum production was nearly 24,000 in 1972, up from about 18,000 in 1960. It rose at an average annual rate of 4.0 percent between 1960 and 1972, at a considerably faster pace during the first 6 years of the period (4.2 percent a year) than during the latter 6 years (1.6 percent annually). As can be seen in charts 10 and 11, employment of production workers followed a parallel trend.

In 1970, the operating rate of primary aluminum plants in the United States averaged 84 percent of yearend capacity. According to industry sources, in mid-1973 most aluminum producers were operating at 90 to 95 percent of capacity despite power interruptions in the Pacific Northwest. If, as in the past, new reduction plants are set up by producers to meet the heightened demand for primary aluminum, this will contribute to a rise in industry employment. On the other hand, larger cell and plant capacities may limit employment growth, especially for production workers. Moreover, the increase in size of cells and the development of improved cell lining methods are expected to extend the interval between cell rebuilding, thus saving labor. According to the Bureau of Labor Statistics, employment may grow between 1971 and 1980 at an annual average rate of 3.5 percent, assuming a 4-percent national unemployment rate. (See introductory note for other assumptions.) This rate of growth is about the same rate that has prevailed since 1947, but much faster than the 2.2 percent annual rate of employment growth expected for all manufacturing industries over the 1971-80 period.

In the aluminum rolling and drawing industry, employment is considerably greater than in primary aluminum, accounting for about 65,000 workers in 1972. Between 1960 and 1972, employment grew at an annual average rate of 2.3 percent compared with 2.8 percent between 1960 and 1966, and 0.5 percent between 1966 and 1972. The Bureau of Labor Statistics has projected an increase of 2.0 percent a year in employment in this industry between 1971 and 1980, assuming a 4-percent national unemployment rate. This growth rate is slightly below the 2.2 percent projected for all manufacturing during the same period. This slowdown in the employment growth rate stems, in part, from technological developments such as continuous casting and computer controlled rolling operations. Continuous casting eliminates the need for ingot casting, storage, and soaking pits, resulting in lower capital and labor costs.

Occupational trends

Available employment statistics for the nonferrous metals industries do not show the occupational structure separately for primary aluminum production and aluminum rolling and drawing. Thus, it is not possible to obtain precise information on occupational trends in these industries. Nevertheless, some information is available which sheds light on their current occupational structure.

About three-fourths of the workers in the aluminum industry work in a great variety of blue-collar jobs related to smelting (reduction) and to transforming aluminum into industrial and consumer products. Among the jobs found in aluminum reduction plants are anode man, potliner, potman, tapper, helper, hot-metal crane operator, scaleman, remelt operator, and d.c. casting operator. In fabricating, the important occupations are rolling mill operator, scalper operator, annealer, stretcher-leveler-operator, radiographer, wire draw operator, forging press operator, and extrusion press operator. One-fourth of the workers are employed in clerical, sales, professional, technical, administrative, and supervisory positions.

Women constitute roughly 2 percent of the workers in primary aluminum plants and are found mainly in secretarial and clerical jobs. By way of comparison, they represent 10 percent of the work force in rolling and drawing plants, working in such jobs as sorter, inspector, or clerk.

Most of the technological changes expected to take place in the aluminum industry will not greatly affect existing occupational requirements and worker skills. The primary aluminum industry is capital intensive and aluminum fabrication is already highly mechanized. In some cases, however, with the increased use of computer process control, operator requirements will include monitoring of equipment, processes, and instruments.

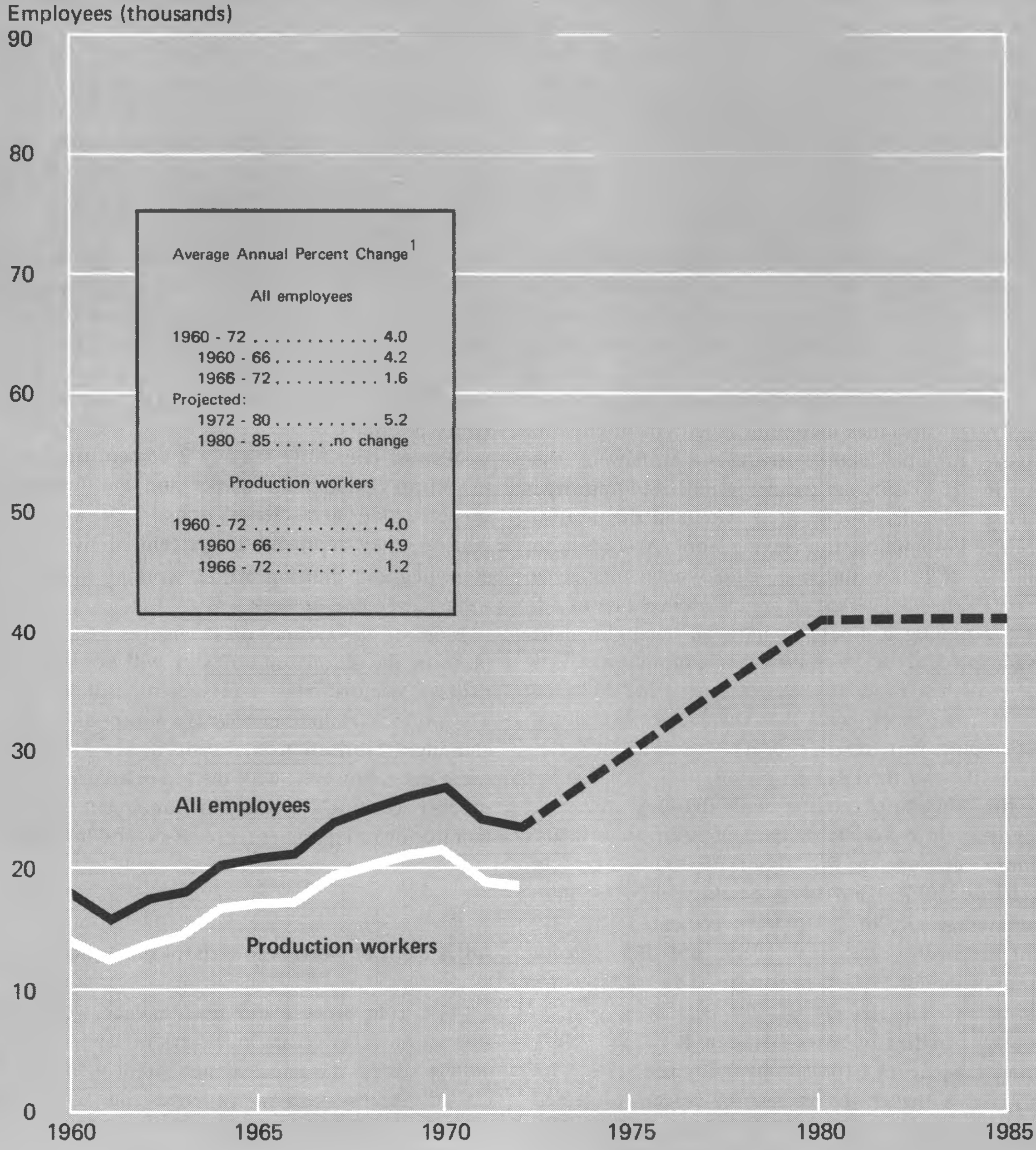
Adjustment of workers to technological change

As a rule process and maintenance workers in the aluminum industry are members of labor unions. The unions having the greatest number of members are the United Steelworkers of America and the Aluminum Workers International Union, both affiliated with the AFL-CIO.

The union agreements with the major aluminum companies provide for the use of grievance and arbitration procedures in disputes over new and changed jobs. Though specific adjustment provisions relating to technological change are not commonly found in the union

Chart 10

Employment in the Primary Aluminum Industry, 1960-72 and Projected for 1980 and 1985

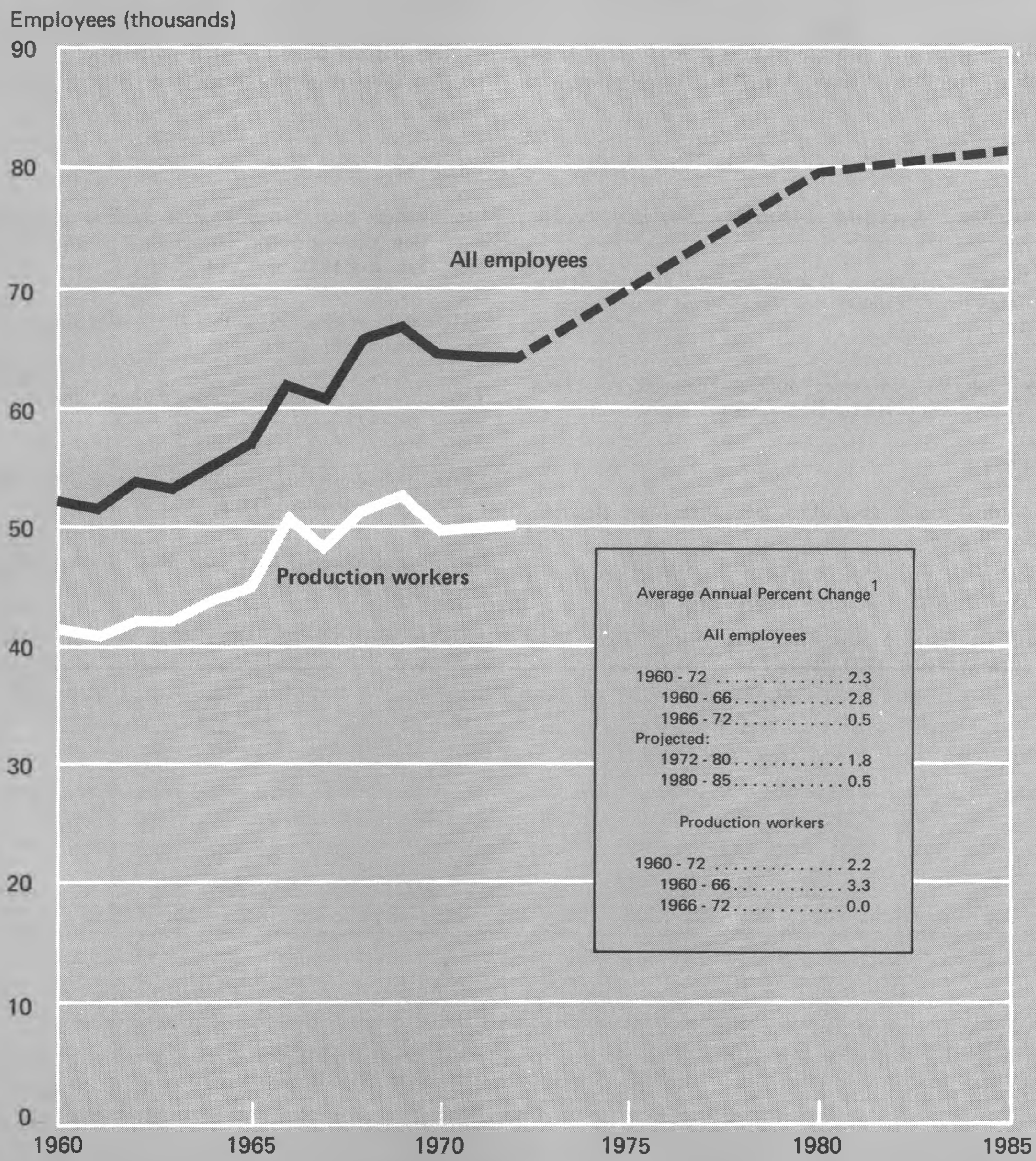


[1] Least squares trend method for historical data; compound interest method for projections.

Sources: Bureau of the Census; Bureau of Labor Statistics.

Chart 11

Employment in Aluminum Fabrication, 1960-72 and Projected for 1980 and 1985



[1] Least squares trend method for historical data; compound interest method for projections.

Sources: Bureau of the Census; Bureau of Labor Statistics.

agreements of the aluminum industry, it can be assumed that existing contract provisions relating to seniority, retirement, and supplementary unemployment benefits apply in these cases. For example, the seniority provisions of one agreement covering 11,000 workers state that, in general, company or departmental seniority governs when employees are to be demoted, laid off, or transferred, with certain exceptions such as for "essential employees with special training or ability" and after discussion with the union. The same agreement also establishes grievance and arbitration procedures for new or revised job classifications that alter wage arrangements.

Another collective bargaining agreement covering 9,000 workers provides for a specific grievance procedure that may be used should differences occur as a result of technological changes. The clause reads: "In the event that technological changes should take place which result in changes in existing classifications through the creation of significant duties which may be beyond the scope of those performed by employees in the existing bargaining units, the company will review the matter with the union. If such duties are assigned to employees in the bargaining unit, such employees will be given training opportunities to qualify them to perform the work."

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Banking

SUMMARY

Demand for banking services (SIC 60) is expected to continue to rise as population grows and the economy moves to anticipated higher levels. New services to customers will feature computerized billpaying and recordkeeping. Unattended banking stations incorporating automatic tellers, electronic computers, and data transmission equipment will be used more widely and facilitate the establishment of a nationwide electronic funds transfer system. Point-of-sale terminals in retail stores will be tied in with bank computers to permit transactions without the use of cash or checks. Regional check processing centers are being introduced by the Federal Reserve System to speed up check clearing operations. New technology which bypasses checks as a means of settlement is expected to come into increasing use; however, total check volume is projected to continue upward as business volume grows.

Because of limitations of available data, a productivity index for banking is not published by the Bureau of Labor Statistics. Trends in output and employment, however, suggest improvement in productivity during the past decade and favorable prospects for future growth. Reductions in unit labor requirements in check processing operations are expected to be a major source of productivity gains.

Banking employment is expected to rise, with a work force of 1.7 million persons projected by the BLS for 1985, assuming a 4-percent national unemployment rate. (For other assumptions, see introductory note.) More extensive use of computers and other laborsaving innovations will reduce the need for clerical positions including check sorters and bookkeeping machine operators. Because of turnover and projected growth in the banking sector, employees adversely affected generally will be reassigned to other duties including those related to the many new services which banks are introducing. More new computer data processing positions also will be needed as automation is extended. Women will continue to constitute a major segment of the work force.

TECHNOLOGY AND BANKING SERVICES IN THE 1970'S

Laborsaving innovations in banking are being introduced during a period of increasing demand for banking services. The result is a demand for additional manpower and a corresponding net gain in employment. Innovations such as unattended banking stations, new data transmission technology, and the more extensive use of computers, however, will eliminate some clerical and related occupations, change the job content and skill requirements of others, and create some new occupations. (Table 14 summarizes the major technology changes in the industry and their impact.)

Bank facilities

The number of bank facilities—both banks and branches—rose by 71 percent between 1960 and 1973 as banks expanded to meet the growing demand for bank services. Over this period, an expanding economy, a growing population, more widespread use of checks and credit, and higher levels of corporate and personal income stimulated growth in the banking sector. Although the total number of banks rose by about 5 percent between 1960 and 1973, from 13,986 to 14,653, the number of branches and related offices more than doubled over this period, increasing from 10,969 to 27,946. (See chart 12.)

New bank services

Banks are expanding customer services and public acceptance generally is favorable. Banking hours have been increasing and in many locations have been extended to "around the clock" with the introduction of automatic tellers and cash dispensers. Moreover, customers increasingly are carrying out banking transactions on these machines located in the branches of their banks. Some of these machines are also being

Customer completing banking transaction on an automated terminal.

placed in shopping centers and other convenient locations, thereby eliminating the need for a trip to the main bank.

In addition to new facilities, banks are making available a growing variety of services for individuals and businesses, including professional and retail store billing and accounting, free checking accounts and overdraft arrangements, bank credit card billing and accounting, preauthorized bill payments, automatic depositing of payrolls, mortgage servicing, insurance premium billing, and sales and inventory analysis. Without new computer technology and the thousands of workers in new computer-related occupations, many of these new customer services could not be offered.

Bank credit card plans are being offered by a growing number of banks. Between 1967 and 1973, the number of banks offering credit card plans increased from 390 to over 1,600, and charges outstanding rose from under $1 billion to over $5 billion. If agent banks are included, the number of banks offering credit card plans exceeds 8,500. Two major charge card plans account for nearly 95 percent of the charges outstanding. Both offer domestic and international coverage and each is in the process of improving credit checking procedures by setting up a nationwide authorization network, viewed by some bankers as an intermediate step towards electronic funds transfer systems. As discussed elsewhere, bank computers are being tied in with point-of-sale terminals located in retail outlets with a plastic card used to activate transactions.

Volume of checks handled

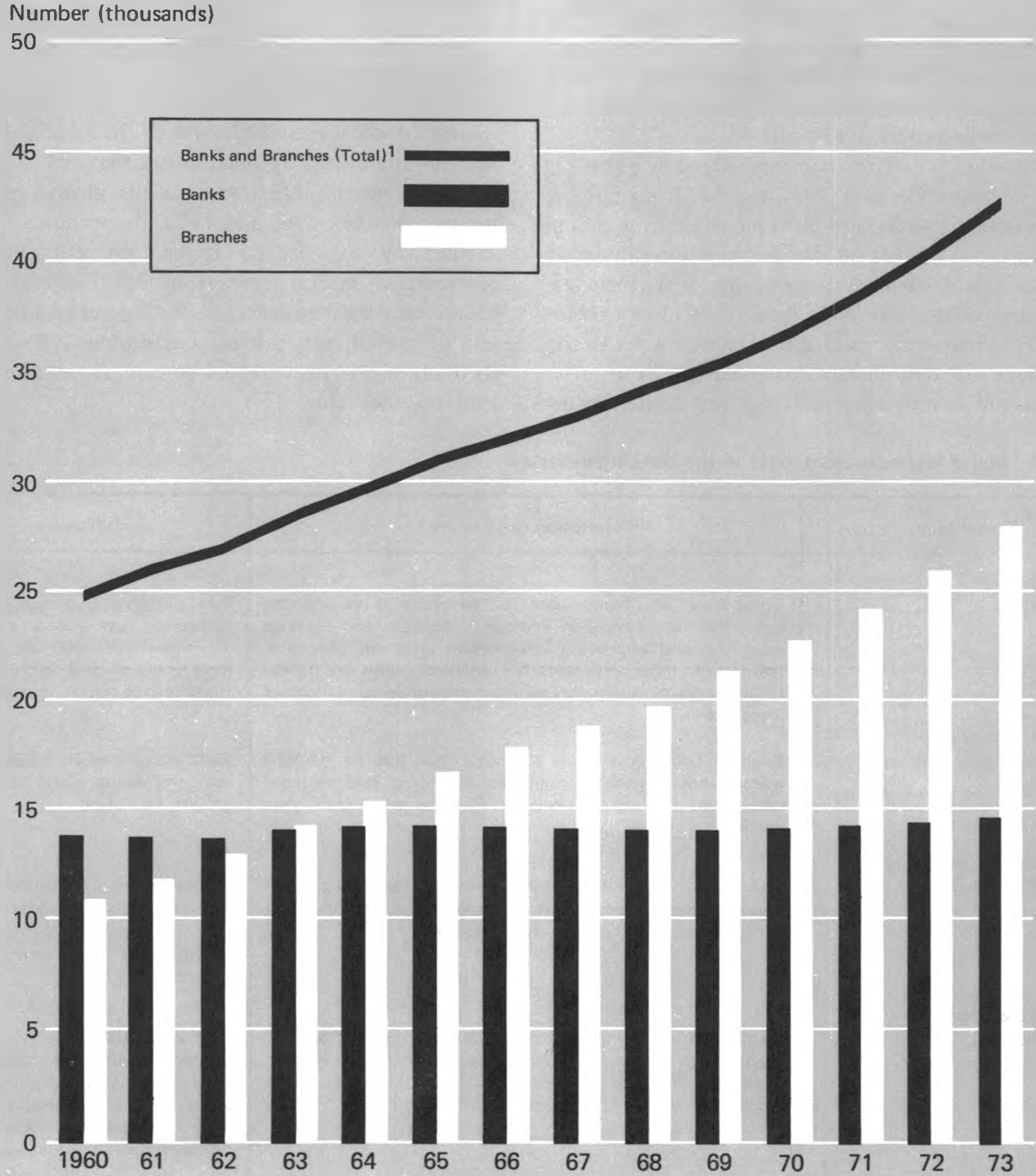
In 1973, an estimated 26 billion checks were written on commercial banks. By 1980, the volume of checks is expected to exceed 40 billion. An examination of the volume of checks handled through the Federal Reserve System—approximately one-third of the total in banking—provides insight into trends in the growth of check volume. Between 1960 and 1973, the volume of checks handled by the Federal Reserve System (excluding government checks) rose from 3.4 billion to 10.0 billion—an annual growth rate of 8.3 percent. The annual rate of growth was 9.9 percent during 1966-73, substantially higher than the 6.4 percent annual rate during 1960-66. (See chart 13.)

Table 14. Major technology changes in the banking industry

Technology	Description and impact	Diffusion
Electronic data processing	Computers are being used to automate such inhouse functions as managing demand deposit and savings accounts, and improving information retrieval. The automation of these processes has enabled banks to handle larger transaction volumes without proportional manpower increases.	The percentage of banks using computers rose from an estimated 7 percent in 1963 to approximately 56 percent in 1972. This trend is expected to continue.
Automatic tellers and cash dispensers	Enables bank customers to carry out limited banking transactions beyond normal banking hours and in some cases away from the main bank. Reduces teller manpower needs.	First introduced in 1969; 2000 in use in January 1974. Rapid growth expected.
Regional check processing centers	Check collection and processing centers that bring about overnight check clearing within regional zones. Minimize check handling and reduce check processing time.	Centers were first established in the late 1960's. Plans are for 47 to be established, with 41 projected to be in operation by the end of 1974.
Automated customer services	Computers are being used to broaden the range of services available to the public. Using excess computer capacity, banks can offer such services as professional billing services, payroll handling, and correspondent bank services.	Initially, these services were limited to the largest banks; with the increasing availability of computer services to smaller banks, these services are expected to receive increased emphasis.
Electronic funds transfer systems	Systems which substitute the electronic transfer of financial data for the actual transfers of checks or cash. Major variations include automatic payroll depositing, preauthorized bill payments, point-of-sale transfers, and large volume financial transfers.	Large-scale operations are currently being tested in several States and in some instances nationwide. Continued testing and expansion expected.

Chart 12

Number of Banks and Branches, 1960-73



[1] Includes offices and facilities.

Source: Board of Governors of the Federal Reserve System.

The rising volume of checks has brought about strains on present equipment and processing methods, with rising costs. Although the American Bankers Association forecasts that the present system will be able to handle this growth through 1980, techniques to improve productivity in check processing are being implemented in a wide range of banking operations. Despite productivity gains in check processing through more extensive use of faster handling equipment, labor costs still account for about two-thirds of total check handling expenses. It is in these operations that a large number of bookkeepers and other clerical workers are employed. As automation is extended, however, these jobs are expected to decline in importance.

Electronic computers

According to results of the 1972 National Automation Survey, 56 percent of all banks were using electronic computers in 1972; another 6 percent reported future plans to install them.[2] More than 80 percent of banks using computers in 1972 reportedly utilized off-premise facilities—primarily purchasing computer services from correspondent banks. Bank automation has been extended considerably since 1963, when an earlier survey discovered that only 7 percent of all banks were using computers.

The extent of computer use varies considerably by bank size. On-premise computer systems are being used by almost all banks with deposits of $100 million or more (about 5 percent of all banks), whereas only slightly more than one-third of banks with deposits of under $10 million (about 53 percent of all banks) use computers—almost always located off-premise.

Advances in computer design and lower production costs have brought the price of computers and software down to where smaller banks can afford to automate. Some larger banks are using third generation computers with multiprogramming, thereby expanding processing capability and the range of services that can be offered.

Banks allocate substantial funds and manpower to computer operations. Banks with extensive computer departments might budget $6 to $8 million for electronic data processing and employ over 300 persons in computer operations. Current trends suggest that investment and employment in computer operations may increase with the growing volume of data processing activity. As discussed elsewhere, bank computers increasingly will be central links to regional and national networks of information and funds transfer. The more widespread use of computers in banking will require thousands of workers to plan, program, and operate them. However, the more intensive use of computers will also decrease the demand for some traditional clerical occupations such as bookkeepers and check sorters.

Regional check processing centers

A total of 47 regional check processing centers (RCPC's) are being considered by the Federal Reserve System; 41 are projected to be in operation by the end of 1974. At these centers, high speed reader/sorters process incoming checks for computer processing of encoded information. The intent of the RCPC program is to reduce check collection time, with the long-range goal being to maximize overnight clearing within and between regional zones. One factor favorable to the success of regional check clearing centers is that approximately three-fourths of all checks received by a typical bank are written within 150 miles of the bank. Improvements in the transportation of checks between banks and regional check processing centers are underway which could lead to further gains in check handling productivity. The Federal Reserve provides arrangements for nonmember banks to participate in the regional check processing centers in each zone, thereby extending coverage of the processing network. The Federal Reserve is employing a computer model of the check collection system to analyze the impact of future policy and operational changes. The RCPC's may become key elements in the emerging electronic funds transfer network.

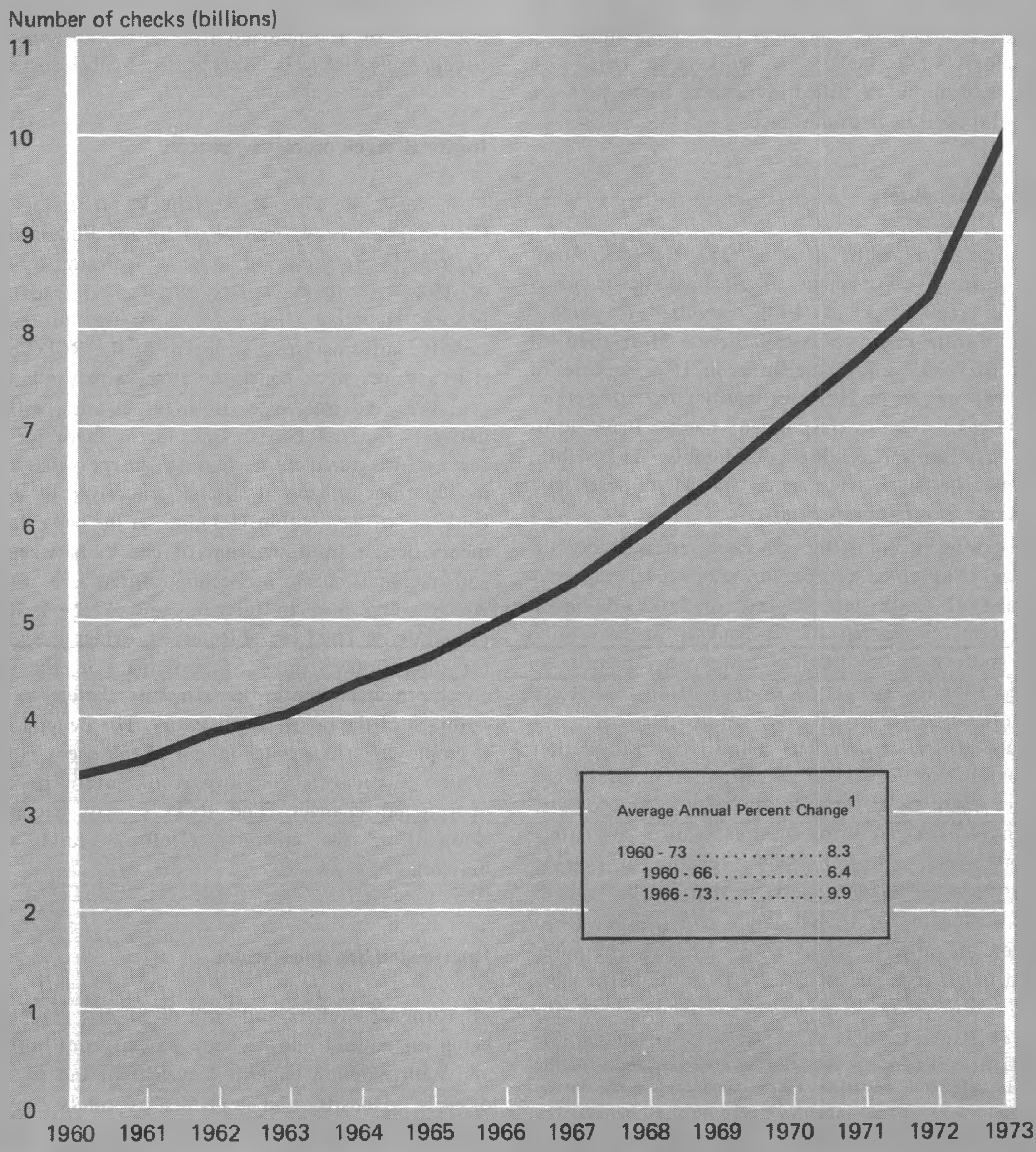
Unattended banking stations

Automatic tellers and cash dispensing machines are being introduced more widely to carry out both single and multifunction banking transactions including withdrawals, deposits, and transfers of funds between a customer's checking and savings account. The more recently developed automatic teller offers a wider range of bank services to customers than single operation cash dispensing machines. To initiate a bank transaction using these unmanned automatic tellers, the customer generally inserts a special card coated with a magnetic stripe

[2] The National Automation Survey is an industrywide survey carried out by the American Bankers Association and the Bank Administration Institute. Questions in this latest survey were sent to 2,945 banks (about 23 percent of all banks). The degreee of survey coverage varied by bank deposit-size category, ranging from complete coverage of all 1,101 banks with deposits over $50 million, to 14 percent coverage of banks with deposits of less than $25 million. A total of 1,327 or 45 percent of the 2,945 to whom questions were sent provided information. See *Results of the 1972 National Automation Survey,* published by the American Bankers Association, Washington, D.C., 1973.

Chart 13

Number of Checks Cleared Through The Federal Reserve System, 1960-73



[1] Least squares trend method.

Source: Board of Governors of the Federal Reserve System.

and enters his account identification number. The customer generally is provided a written record of the transaction. Unattended banking stations significantly reduce the manpower requirements for these traditionally labor-intensive customer services.

The first unmanned banking station which returned the customer's activating card—a higher level of sophistication than earlier models—was introduced in the United States in 1969. Since then, unmanned banking stations—both cash dispensing machines and the more sophisticated and versatile automatic tellers—have been introduced more widely; 2,000 units were reported installed by January 1974.

Based on the 1972 ABA-BAI automation survey, automatic tellers and cash dispensing machines are presently in relatively limited use and considerable potential exists for future adoption. Automatic tellers, for example, were reported installed by less than 2 percent of the 1,131 banks which provided information on this innovation for the survey, and cash dispensing machines by just under 4 percent of the 1,175 banks which provided information on the status of cash dispensing machines. About half of the reported cash dispensers and automatic tellers were installed in the larger banks having assets of $500 million or more.

The pace of adoption of unmanned banking stations is generally expected by banking experts to increase as improvements are made in equipment and methods. One bank on the East Coast, for example, recently converted 22 separate, automatic teller machines into an online system utilizing minicomputers tied in with the bank's central computer system. All of the bank's checking account and credit card customers have access to the system. Customers are able to perform 10 key banking transactions involving their checking, savings, and credit card accounts. The transactions include withdrawing cash, making deposits, transferring money between accounts, and paying any bills that are normally accepted at the teller's window.

In addition to developments in technology, the rate of diffusion of unmanned banking stations will depend on factors such as rulings of government regulatory agencies pertaining to locations for unmanned stations and the extent to which sharing of teller units by several banks is ultimately undertaken.

Electronic funds transfer systems (EFTS)

Electronic funds transfer systems are being developed to ease the growing workload associated with an increasingly costly, labor-intensive check payments system. Essentially, EFTS involves the debiting and crediting of funds by electronic methods without the use of checks, although the definition of what constitutes EFTS varies. Although there is some disagreement among banking experts as to whether EFTS ultimately will bring about a "checkless society", it appears unlikely that checks will be eliminated to a marked degree in the near future. One present barrier to widespread diffusion of EFTS is a reported reluctance by some consumers and businesses to enter into arrangements involving electronic transfers of debits and credits which eliminate the traditional check as a means of settlement. Nonetheless, EFTS approaches increasingly will bring about significant changes in traditional banking methods and manpower requirements for check processing personnel.

EFTS programs. Some major experiments are underway which could bring about more widespread use of EFTS in the future. A well-publicized project involving elements of electronic funds transfer was initiated in 1968 by two California clearing house associations and was known as the SCOPE project—an abbreviation of Special Committee on Paperless Entries. The project resulted in the creation of the California Automated Clearing House Association (CACHA), which developed the Automatic Payments and Deposit Program with approximately two-thirds of all banks in California participating in the project. More banks are expected to join. The goal is to reduce the number of checks written by 8 percent, or approximately 14 million checks a month. The applications involved are automatic payroll depositing and preauthorized bill payment.

The COPE system (Committee on Paperless Entries) of the Atlanta Payments Project also has an ambitious EFTS program. Two aspects of automated payments are under limited development in the COPE system; automatic depositing of payrolls—which began in May 1973—and "Bill Check", a flexible form of preauthorized payment of utility and other bills, involving debiting and crediting of accounts by electronic methods, thereby eliminating the use of checks.

The SCOPE and COPE programs differ from earlier bill payment plans in that a network of banks is tied in to automated clearing houses which provide transfer between participating banks instead of limiting transactions to a single bank.

Bank officials participating in the 1972 ABA-BAI automation survey anticipated continued extension of electronic debiting and crediting of customer accounts over the next decade. As indicated in table 15, 89 percent of banks providing views on the future of "paperless" debits (electronic methods to pay utility bills, insurance premiums, and related obligations) and 91 percent of those who provided views on paperless credits (electronic methods to enter payrolls, dividends, and related credits into customers' accounts) stated that industrywide adoption has occurred or is likely to occur within 10 years.

Point-of-sale terminals. Point-of-sale terminals are another element of EFTS which has great potential for replacing checks. These card-activated terminals—now being tested in several major metropolitan areas—are located in retail establishments and are linked to credit authorization and data processing networks. Point-of-sale terminals make possible instantaneous credit checks and electronic transfer of funds with the sales receipt the only paper generated at the time of sale.

Check truncation. Although aspects of EFTS discussed above will eliminate checks, other arrangements including "check truncation" are being considered which, while not eliminating the check completely, provide significant laborsavings by reducing the number of times that checks are handled. The average check is processed by 2.6 banks, often handled several times within each bank. One form of check truncation that improves check handling efficiency involves entering information about the check on magnetic tape and electronically transferring this information to the appropriate bank either directly or through a central clearing center. The check may then be filed and stored at the bank of initial deposit. The reluctance of some customers to accept a descriptive statement required for these systems rather than a cancelled check as the record for a transaction could limit their rate of diffusion. As indicated in table 15, only about 22 percent of bankers who responded to the ABA-BAI survey expect industrywide acceptance of descriptive checking account statements in lieu of checks within 5 years; 38 percent predict that industrywide acceptance is not likely.

Data transmission. Data transmission technology is being used to transfer funds electronically by means of the Federal Reserve's communications network and the commercial banking system's "Bank Wire". In 1973, the Federal Reserve transferred about $23.5 trillion for member banks and their customers, compared with $9.8 trillion in 1969. In the Federal Reserve's communica-

Table 15. Bankers' views on prospects for industrywide adoption of selected innovations in banking

Innovation	Percent of responding banks stating that industrywide adoption of innovation is—			
	An accomplished fact now	Likely to occur: Within 5 years	Likely to occur: In 5-10 years	Not likely to happen
Automated central information file	26	33	30	11
A single nationwide authorization network for all charge cards	4	28	39	29
Computerization of all credit inquiry functions nationwide (other than charge card)	2	13	42	42
Use of computer output microfilm systems	26	29	32	13
On-line cash dispensing machines	15	35	32	18
Cash dispensing machines in conjunction with deposit machines (automatic teller systems)	16	31	37	16
Magnetic media (tape, disc, etc.) accompanying clearing checks	6	37	39	18
Nationwide network to exchange paperless entries	4	18	54	24
Preauthorized paperless debits (utility bills, insurance premiums, etc.)	19	35	35	10
Preauthorized paperless credits (payroll, dividends, etc.)	26	35	30	8
Descriptive checking account statements in lieu of cancelled checks	3	19	39	38

NOTE: Because of rounding, sum of individual percentages may not equal 100.

SOURCE: American Bankers Association.

tions network, 36 Reserve Banks and branches and 7 remote regional check processing centers are linked to a high speed computer switching center located in Culpeper, Virginia. By mid-1974, all of the 12 Federal Reserve Banks should have their own computer switches, which ultimately may serve as separate regional centers linking participating Federal Reserve member banks into a nationwide electronic funds transfer system. The Bank Wire system is a nationwide data transmission network linking approximately 250 large commercial banks to computer centers located in New York and Chicago. A reported $25 billion a day is transferred between banks in the system. Internationally, billions of dollars are being transferred daily through CHIPS (Clearing House Interbank Payments System), a computerized data communication network located in New York.

PRODUCTIVITY

Because of limitations in available data, a productivity index for banking is not published by the BLS. However, limited evidence indicates that productivity in banking rose during the decade of the 1960's. As indicated earlier, the volume of checks processed through the Federal Reserve System, a partial measure of output in banking, accounts for approximately one-third of total checks handled by the banking system and, between 1960 and 1972, increased at an average annual rate of 8.3 percent. Although an official annual series on total checks handled by all banks is not published, the rate of growth is estimated by the Federal Reserve Board to be about 6 to 7 percent annually. Other measures of bank output which have been increasing in recent years include the number of deposit accounts and the volume of trust and loan department activities.

During 1960-73, total bank employment rose by 4.5 percent annually, less than the rate of growth in several major measures of bank output over the same period; this trend is expected to continue. It should be recognized that banks offer a growing range of new services to individuals and businesses which constitute an important but difficult-to-measure component of bank output.

EMPLOYMENT AND MANPOWER

Employment trends

More employees will be needed as the number of bank offices and volume of activities increase during the 1970's. Population growth and economic growth will lead to expansion in production, sales, and income with a corresponding sharp gain in volume of financial transactions the Nation's banks will handle for individuals, businesses, and governments. Although electronic computers and other technological innovations will continue to achieve significant laborsavings in check handling and in a wide range of other banking operations, expansion in demand for an ever-increasing variety of banking services will more than offset employment declines.

In 1973, 1.2 million persons were employed in banking—over 490,000 more than in 1960. Between 1960 and 1973 employment increased at an average annual rate of 4.5 percent. The employment growth rate varied within this period, increasing at an average annual rate of 3.4 percent during 1960-66, and 5.1 percent during 1966-73. (See chart 14.) According to BLS projections based on a 4-percent national unemployment rate and other assumptions, a 3.3-percent annual growth in employment between 1973 and 1985 is likely, increasing the number of bank employees from 1.2 million to 1.7 million. (See introductory note.)

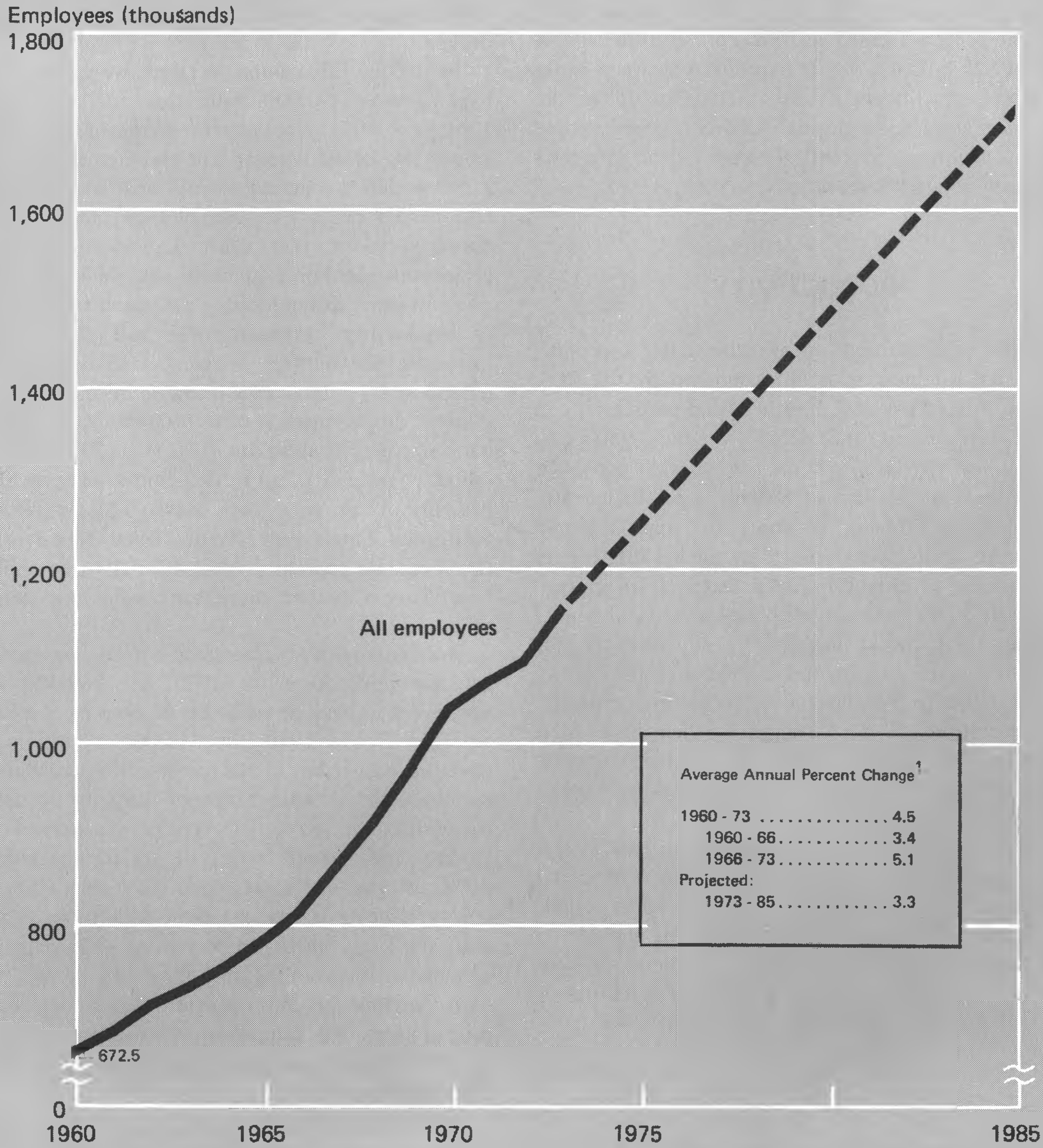
Bank employment is concentrated according to both bank size and location. In 1971, the 1,235 largest banks (about 9 percent of all banks) employed more than 70 percent of all employees. Seven States—New York, California, Illinois, Pennsylvania, Texas, New Jersey, and Ohio—contain approximately half of all bank employees. New York City had more bank employees than any other city.

Women employees constitute a major segment of the banking work force. In 1973, the 762,000 women employees in banking made up 65 percent of total bank employment. In 1960, the 410,000 women in banks made up 61 percent of the total work force. Women are employed in a wide range of banking occupations, particularly as secretaries, typists, clerks, and tellers. Women staff about 9 out of 10 clerical and teller positions, the key areas of banking where new technology is being introduced most widely. Women, however, staff only about 20 percent of all managerial and administrative positions and about 25 percent of the new computer specialist occupations including computer programmers and systems analysts. Women fill nearly one-third of total computer and peripheral equipment operator positions.

The banking industry is making significant progress in the employment of minority groups. A U.S. Treasury Department study found that, of 1,414 banks which file data on employment of minority groups with the Federal Government, employing approximately 780,000 persons, a total of 109,385 Negroes, Spanish-surnamed Americans, Orientals, and American Indians were

Chart 14

Employment in Banking, 1960-73 and Projected for 1985



[1] Least squares trend method for historical data; compound interest method for projections.

Source: Bureau of Labor Statistics.

employed in 1972. This was an increase of 170 percent over the 40,493 persons in these minority groups employed in 1966.

Occupational trends

New banking technology is expected to continue to have a threefold effect on banking occupations; namely, the elimination of some positions, the modification of job duties in others, and the creation and staffing of entirely new ones. As mentioned earlier, these occupational shifts will take place during a period of steadily rising total employment. Without the installation of new laborsaving banking technology, the level of employment likely would be significantly higher.

Clerical occupations account for nearly two-thirds of total bank employment and will be particularly affected by computers and other new bank technology. Although the total number of bank clerical employees is expected to increase between 1970 and 1980 as the volume of work and bank facilities rise, this gain will be slower than the 45 percent increase projected for total bank employment over this period. (See chart 15.) Within the clerical group, bank tellers—who account for slightly more then one-fourth of total bank employment—are expected to increase by 40 percent. New technology is expected to eliminate some routine operations carried out by bank tellers and bring about overall gains in the number of customers handled per teller. On-line computer terminals, for example, reduce the time required by tellers to verify checks and retrieve information.

The decline projected for bookkeeper positions continues a past trend. A BLS survey covering about one-third of a million bank employees, for example, found that bookkeeping machine operators totaled only 3,000 in 1969, compared with 7,000 in 1964, and 18,000 in 1960. Electronic bookkeeping machines reportedly require one-half to two-thirds the personnel to do the same job as conventional bookkeeping machines, with electronic computers achieving even more substantial laborsavings.

New positions related to electronic data processing will lead to additional employment opportunities in banking over the next decade as automation is extended. Employment of computer specialists (computer programmers, computer systems analysts, and other computer specialists) and computer peripheral equipment operators is expected to increase at a rate substantially above the rate of employment gain for total banking.

Employment gains above the industry average are also expected for the professional, technical, and kindred workers and for managers, officials, and proprietors. Combined, these two occupational categories account for about 30 percent of banking employment. Employment prospects for the remaining major categories of employees presented in chart 15 vary considerably, but combined they account for only about 5 percent of total bank employment.

Adjustment of workers to technological change

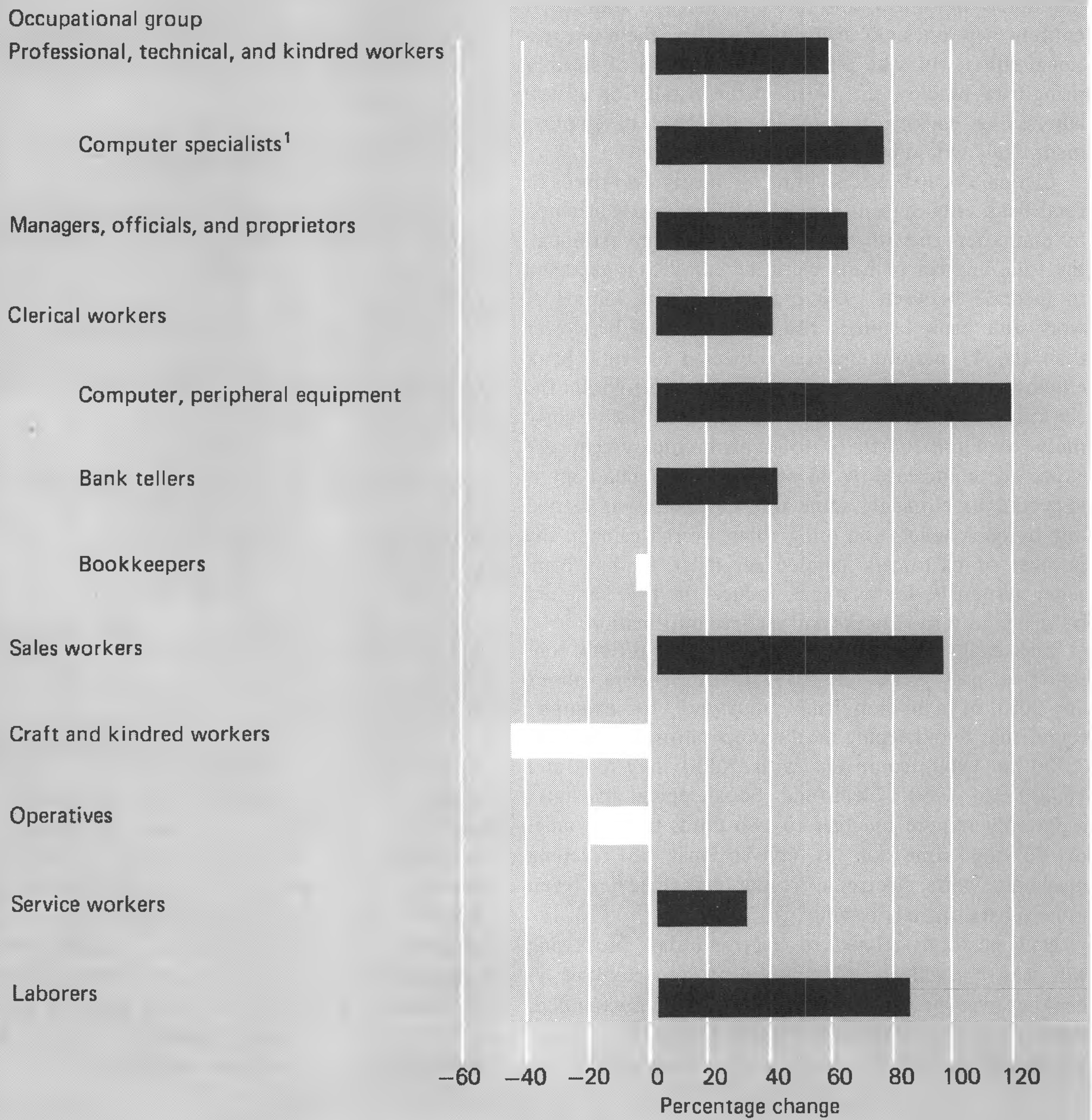
Relatively few workers in banking are affiliated with unions. Although precise data on union membership are not available, it is estimated that less then one-half of 1 percent of all banks have employees covered by union agreements. Some observers expect that the labor movement may step up organizational activity in the banking industry during the 1970's, partially because of concern over automation.

The traditionally high attrition rates in clerical and teller positions affected by new technology over the period that automation is introduced are expected to enable banks to continue their policy of training and reassigning employees displaced by new technology to other positions in the bank. Moreover, the projected moderate increase in clerical and teller positions which will be required as the demand for bank services increases also will facilitate retention and placement of displaced employees.

It should be noted that computers already have been introduced in the vast majority of large banks which employ the major portion of the work force. Consequently, substantial manpower adjustments already have taken place over the past decade. As automation is extended, banks will continue to encourage and provide financial support to employees to acquire new skills by completing specialized courses on banking offered by local colleges and universities and the American Insitute of Banking. These courses could assist employees to adjust to changing job duties and to qualify for new positions which may become available.

Chart 15

Projected Changes in Employment in Banking by Occupational Group, 1970 to 1980



[1] Includes computer programmers, computer system analysts, and other computer specialists.

Source: Bureau of Labor Statistics.

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Health Services

SUMMARY

New technology will continue to be a source of efficiency and productivity gains in health services (SIC 80). Electronic computers will be introduced more widely for business and administrative operations, centralized medical information systems, patient monitoring, computer-aided diagnosis, and clinical laboratory computerization. These innovations will improve health care delivery, but will require manpower to plan, program, and operate computer systems. Computer-operated multiphasic screening centers offering rapid, mechanized physical exams are also expected to bring about significant savings in manpower. Innovations in hospital food service units and laundries will continue to reduce man-hours. The more widespread use of disposable items is another important trend underway in hospitals.

Demand for health services is expected to continue upward during the next several years. Methods to provide health care more efficiently and to improve manpower utilization will receive emphasis with the increasing acceptance of the prepaid group practice concept.

Because of the nature of the medical services industry and limitations in available data, a productivity index for health services is not published by the BLS. However, information on the number of hospital employees per patient indicates that this ratio has been rising in recent years, suggesting that this segment of the industry is becoming more labor intensive. The more widespread availability of intensive care units and other specialized patient facilities will probably continue to require more manpower per patient. Yet, such new diagnostic and therapeutic procedures, not in existence a decade ago, contribute effectively to higher quality patient care.

The outlook is for higher levels of employment in health services but a slowdown in the annual growth rate. BLS projects a work force of 6.1 million in health services (private sector) for 1985—up 66 percent over 1973. (See introductory note for assumptions underlying these projections.)

Advances in medical technology will alter occupational patterns. Positions related to computer operation and electronic equipment maintenance will be among the new jobs created. In addition to creating new positions, computers and new types of test and monitoring equipment will continue to modify job duties of medical technologists, nurses, and others. Displacements and layoffs are not likely because continued growth in the health services industry is expected. Paramedical positions such as "physician assistant" are a potential source of manpower.

TECHNOLOGY AND HEALTH CARE IN THE 1970'S

Technological innovations in the health services industry will take place along with important changes in health care delivery and financing. Technology will continue to contribute to higher quality patient care and, in some instances, bring about significant savings in health manpower. (For a brief description of major innovations in the industry and their impact, see table 16.)

Improving health care delivery

Methods of providing improved health care at lower cost are receiving increased emphasis by health care providers—hospitals, nursing homes, clinics, and physicians. The medical care component of the BLS Consumer Price Index (CPI) rose by about 75 percent between 1960 and 1973. Another health care problem receiving attention is that access to health care, particularly for the disadvantaged, is uneven—some rural communities and the crowded inner cities are without adequate medical staff and facilities.

Health maintenance organizations

New developments in health care delivery include health maintenance organizations (HMO's), which are a form of prepaid group practice providing comprehensive medical service to enrolled members for an annual fee. The President signed a bill in December 1973 which will provide funds to assist HMO's to start up, preempt State laws which restrict the introduction of HMO's, and allow employees covered by minimum wage laws the option of joining an HMO, using their firm's health insurance contributions for the premium. The Department of Health, Education, and Welfare (HEW) has helped a substantial number of the approximately 125 HMO's in

Table 16. Major innovations in the health services industry

Innovations	Description and impact	Diffusion
Health maintenance organizations (HMO's)	Health maintenance organizations are a form of prepaid group practice featuring a full range of medical services to participants. Medical care costs reportedly are lower because of centralization of administration and consolidation of facilities and staff.	HMO's already cover about 8 million persons and recent legislation provides funds and other stimuli to their further growth.
Automation in clinical labs	Computers and advanced automatic test equipment are being introduced in clinical labs to handle tests more rapidly and more accurately. Some advanced systems involve online processing of data fed directly to the computer from lab test equipment.	Automation in clinical labs is expected to continue with computers increasingly integrated with modern lab equipment.
Computer data processing	Computers are widely used for routine business applications such as billing, payroll, and inventory and increasingly for medically oriented applications including patient recordkeeping. A few hospitals have introduced "total information systems" involving a network of patient care and business applications.	Computers will be used more widely with more hospitals expected to introduce "total information systems". Small, special-purpose minicomputers increasingly will be introduced in health care institutions.
Advances in patient monitoring and diagnosis	Computers are being used along with closed circuit TV, EKG machines with oscilloscope and alarm devices, blood pressure indicators, and other devices to monitor patient condition. Savings in medical staff manpower have been reported. Computers are being used on a limited basis for diagnosis and to select forms of treatment.	Computers and electronic devices will be used more widely for patient monitoring and diagnosis but more experience will be needed to evaluate their potential fully.
Multiphasic screening centers	Multiphasic screening centers carry out physical exams more rapidly and at lower cost than conventional methods. Computers and advanced laboratory testing equipment save manpower.	About 170 multiphasic screening centers were in operation in 1973 with substantial growth in use expected.
Mechanization in laundry and food service departments	Innovations in hospital laundries include larger and more productive equipment and automatic materials handling. Mechanization in hospital kitchens includes microwave ovens, more extensive conveyorization, and the combining of kitchens to form central commissaries. In both areas, significant laborsavings have been reported.	Further adoption of these innovations in hospitals is expected.
Use of disposables	Products which can be thrown away after one use are replacing items that require cleaning, sterilization, or other reprocessing. These include paper and plastic dishes, examination gowns, linens, hypodermic needles, surgical trays, scalpels, and specimen collection sets. Significant savings in supply and service manpower have resulted.	Disposable items are in widespread use in health care facilities.
Improved design of health facilities	The design and construction of health care facilities are being improved to provide more efficient movement of staff, patients, and supplies. Specialized facilities, including intensive care units and inhalation therapy departments, are being introduced more widely.	These innovations are expected to continue.

existence to become operational. The prepaid group practice concept is not new, however; the Kaiser-Permanente plan, the Health Insurance Plan of Greater New York, and others already cover some 8 million persons. New HMO's will extend the option of prepaid group practice to the general public and offer the potential of lowering medical costs through centralization of administrative activities and consolidation of facilities and staff.

Automation in the clinical laboratory

Automation is well established in the clinical laboratory and is achieving noteworthy productivity gains. More than 1 billion tests are performed annually in clinical labs, with the workload projected to increase significantly. Computers and advanced laboratory testing equipment introduced more widely in clinical labs over the past decade perform a wide range of tests of body fluids and tissues at a much faster rate and with fewer errors compared with former methods. Thus, medical technologist man-hours per test are now significantly lower. An example of laborsaving lab equipment is an automatic counter used to count blood cell particles which reportedly requires 80 percent fewer man-hours per test compared with manual methods. The automatic chemical analyzer is another device in general use to achieve productivity gains in glucose tolerance and other common lab tests.

Clinical laboratories are using automatic test equipment in conjunction with a computer to further automate the lab. Computers are being used both for batch processing of lab test data and online processing of data fed directly to the computer from lab test equipment without manual intervention. Some experts foresee significant future productivity gains as computers are integrated more widely with modern laboratory equipment.

Computer data processing

Computers increasingly are being applied to a wide range of applications in hospital administration and information handling. According to a survey by the American Hospital Association, 846 hospitals in the United States had onsite computer installations in 1970; an additional 2,041 employed the services of offsite computer facilities. In 1962, only 39 hospitals reported onsite computer installations.

Computers initially were introduced in hospitals for billing, payroll, inventory, and related business applications. Subsequently, computer use was extended to patient and medically oriented applications of hospitals including medical records maintenance. Although computer use has increased significantly, only a few hospitals presently are using or developing "total information systems" embracing an integrated network of computer applications involving patient care as well as business and research activities. The trend toward total information systems is beginning, however, as small, lower cost minicomputers are introduced more frequently for special-purpose applications.

Significant manpower and other savings have been reported by some hospitals which have introduced computer systems. A hospital in Colorado, for example, recently installed an online computer system to improve inventory control and accounting and expects to save 5 percent of overall operating expenses by reducing inventory and manpower. The automatic patient billing feature of the system, for example, is projected to reduce business office staff by more than 50 percent.

Automation in diagnosis and monitoring

Computers and advanced electronic equipment are being used more widely for patient diagnosis and monitoring. At 13 centers throughout the country, for example, computers are being used to interpret electrocardiograms based on data received by telephone from distant localities including those without a cardiologist or physician. One such center in Denver, for example, serves 20 hospitals in a four-state area, analyzing electrocardiograms by computer methods and transmitting the results to an attending physician within minutes.

Computers are being used more widely for patient monitoring in hospital operating rooms and intensive care wards, along with closed circuit TV, EKG machines with oscilloscope and alarm devices, blood pressure and temperature indicators, intravenous solution alarms, and other electronic and electric devices introduced more widely over the past decade. At one hospital, for example, a computer monitoring system instantly notifies a nurse when blood pressure, pulse rate, or any of 10 variables is developing a dangerous trend. At the same facility, an experimental program is underway whereby the computer monitoring system suggests a therapy to counteract a particular variable indicating a problem.

Computers are performing other diagnostic functions on a limited basis. At one hospital, a computer is being used to select the best type of radiation treatment for a particular type of cancer, evaluating thousands of possible treatment plans in 5 minutes. Researchers also are setting up computer models of diseases and body systems which may enable physicans to select the best

Automatic patient monitoring system.

course of treatment by testing various approaches on the computer. Although the use of computer diagnosis and patient monitoring systems is expected to increase, more experience will be necessary before computer methods can be evaluated fully.

Multiphasic screening centers

Computer operated multiphasic screening centers, staffed primarily by paramedical personnel, carry out swift and comprehensive physical exams with significant savings in man-hours. In 1973, about 170 automated clinical laboratories and electronic screening centers, utilizing computers and advanced laboratory testing equipment, examined more than 500,000 persons. At these centers, patients record answers to questions flashed on a screen concerning their medical history and status by pushing a button which stores their answers in the computer for subsequent printout and analysis. Patients then follow prerecorded instructions and proceed through a series of test stations where blood pressure, EKG, chest X-ray, vision checks, lab tests, and the numerous other examinations associated with a physical checkup are undertaken at a cost substantially lower than for an equivalent conventional exam.

Significant productivity gains have been reported by hospitals and other health care facilities which have adopted multiphasic screening centers. One clinic in North Carolina, for example, reported that productivity rose by about 60 percent after installation of an automated examining system, and patient backlog was eliminated. The use of multiphasic screening centers is projected to increase over the next decade, offering increased capacity for early detection of disease and more effective utilization of physician manpower. Multiphasic screening centers enable physicians to spend a greater share of their effort in diagnosis and therapy rather than in the detection phase of health care.

Innovations in hospital food service units and laundries

Innovations in hospital food preparation and service continue. In hospital kitchens, improved ranges and refrigerators, microwave ovens, and conveyor systems are among changes being introduced. Other trends underway include the contracting out of food preparation, the combining of kitchens among hospitals to form a central commissary, and the use of computers to plan menus and control inventories. At one hospital which modernized food preparation and service during an expansion of hospital facilities, meals served rose by 20 percent, while requirements for food service workers increased only 3 percent—a significant productivity gain.

Technological innovations in hospital laundries include larger, more productive equipment and more automatic materials handling. At one hospital laundry which replaced separate washers and extractors with modern, combination units, three employees who were no longer required were subsequently transferred to other hospital units. Conveyors, slings, chutes, and other devices are being used more frequently to move laundry through washing, drying, and ironing steps with minimum manual handling. New equipment also is being introduced to inspect, sort, fold, and bundle linens and other laundered articles. The trends toward increased use of disposables and contracting out of laundry workload also are expected to reduce manpower requirements in hospital laundries.

Use of disposables

Products which can be thrown away after one use will continue to replace items that require cleaning, sterilization, or other reprocessing. Significant savings in supply and service manpower are already occurring. In hospitals for example, the more widespread use of paper and plastic dishes, examination gowns, and linens have cut back the man-hours involved in cleaning and storing activities. Other disposable items being used extensively include hypodermic needles, surgical trays, scalpels, specimen collection sets, catheters, and blood lancets. These and other disposable items reduce contamination and improve patient safety and comfort. Disposables probably will continue to increase in use over the next decade.

Improved planning and design of health facilities

The internal organization of health services facilities will continue to receive attention to further improve patient care. More emphasis is being given to the design and construction of hospitals to permit the efficient movement of staff, patients, and supplies. Improved floor layouts are being introduced to cut down the distance hospital staff must travel in caring for patients. The use of circular nursing units, for example, reduces travel distances and staff time and improves visual inspection of patient status. Modern hospitals are including specialized facilities such as intensive care units and inhalation therapy departments to improve patient care. Hospitals also are being constructed to facilitate electronic monitoring methods which increasingly augment visual observation of patients.

Demand for health care

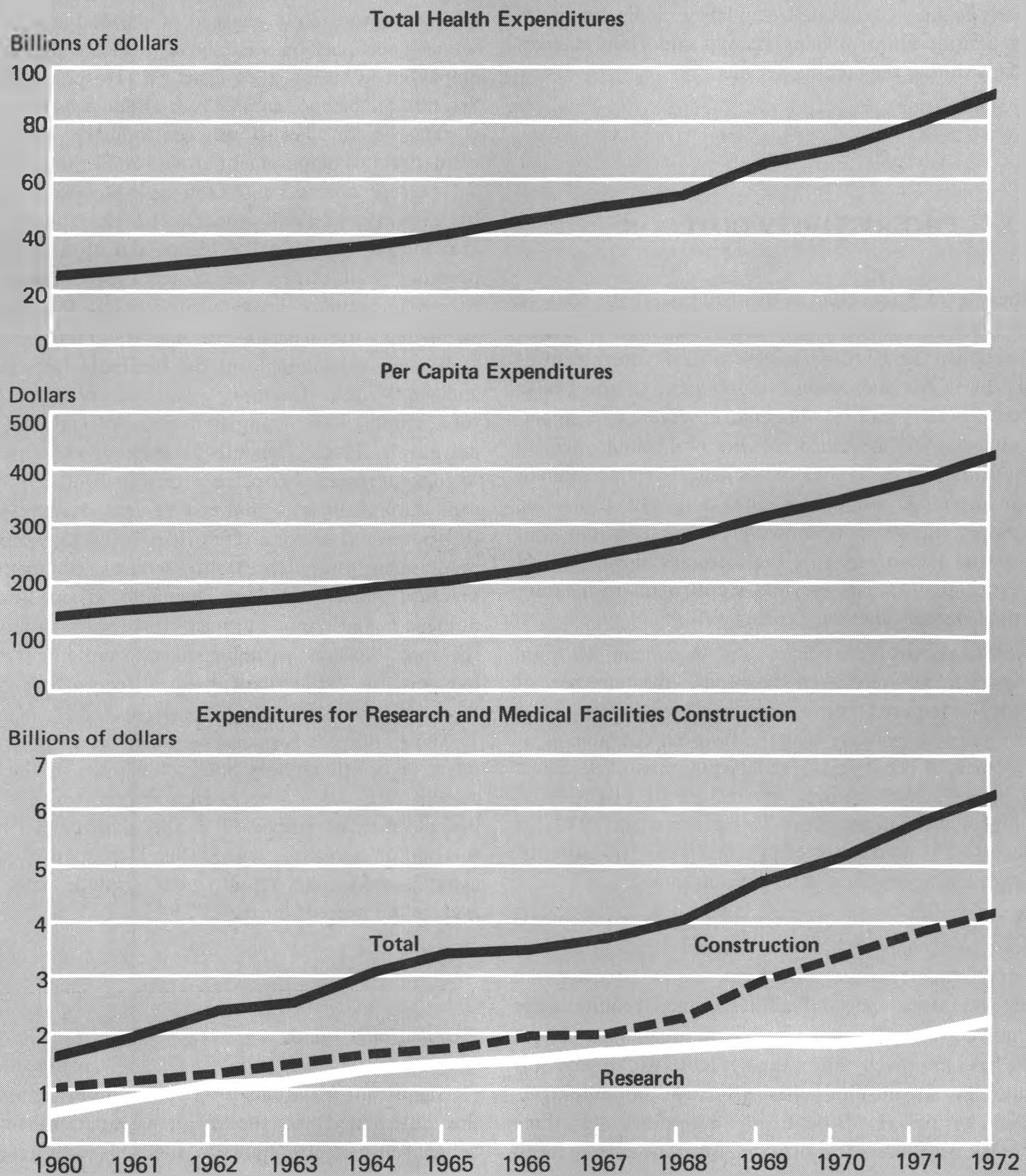
Total health care expenditures more than tripled between 1960 and 1972, rising from $26.9 billion to $89.5 billion. (See chart 16.) The annual rate of gain in spending for health care during 1960-72 (10.8 percent) exceeded the rate of gain in gross national product (GNP) over the same period (7.3 percent). Total health care expenditures accounted for 7.7 percent of GNP in 1972, compared with 5.3 percent in 1960. Per capita expenditures totaled $422 in 1972, significantly higher than the $146 average in 1960.

Rising expenditures for health care have resulted from many factors including a growing population, rising costs per unit of services, increased longevity, rising personal income, advances in quality of medical services, and expanded public and private health insurance programs. In 1972, expenditures for health services and supplies accounted for 93 percent of total outlays; hospital care and physicians' services constituted the largest components of expenditures. Spending for research and medical facilities accounted for the remaining 7 percent of total spending.

Private sector expenditures for medical care accounted for 60 percent of total expenditures in 1972; public expenditures, 40 percent. Public sector spending for health care has been rising significantly since 1960 when it accounted for 25 percent of total health care outlays. In recent years, a large share of public spending

Chart 16

Health Care Expenditures, 1960-72



Source: Social Security Administration.

has been for hospital and nursing care for the elderly under the Medicare and Medicaid programs.

The outlook is for continued high levels of health expenditures. According to the Bureau of Domestic Commerce, the level of national health care expenditures in 1980 will depend largely on the growth and success of the practice of preventive medicine and new regulations for publicly financed health care programs; spending in 1980 may range from $155 to $179 billion. New methods to finance and deliver quality medical care are under consideration in Congress and important changes are likely during the coming decade.

PRODUCTIVITY OUTLOOK

Because of limitations in available data, an index of productivity for the total health services industry is not published by the BLS. An insight into the movement of productivity for the hospital component of the health services industry can be obtained, however, by comparing changes in the ratio of hospital employees to patients. This type of measure, which uses employment as an input, is useful for analyzing and projecting manpower requirements. However, a major limitation of this partial measure is that the increases in quality and variety of patient care services are difficult to measure and thus are not taken into consideration.

According to data from the American Hospital Association for registered hospitals, the number of employees required per patient has been increasing in recent years, suggesting that the hospital component of the industry is becoming more labor intensive. (See chart 17.) In 1960, for example, an average of 114 hospital employees were utilized per 100 patients; in 1972, an average of 221 employees were utilized per 100 patients, a gain of 94 percent in manpower required.

A major reason for the increase in labor requirements appears to be new techniques of medical care in modern hospitals, such as more widespread use of intensive care units and other special facilities, which require more manpower. The degree to which the quality of patient care has improved and the extent to which new technology in hospitals has affected the employee-patient ratio are difficult to determine. In some instances, computers and other innovations have reduced labor requirements significantly. On the other hand, modern technology requires personnel to operate and maintain equipment and makes possible new patient services which, in turn, require more hospital manpower.

EMPLOYMENT AND MANPOWER

Employment trends

Employment in the health services industry more than doubled during 1960-73 as demand for medical care intensified. BLS data indicate that, in 1973, 3.7 million persons were engaged in a wide range of health services occupations, well above the 1.5 million persons employed in 1960.[3] (See chart 18.) Hospitals employed 2.1 million persons in 1973, or about 3 out of every 5 workers in the health services industry. The average annual rate of employment growth in health services was 7.1 percent during 1960-73 compared with 4.5 percent for employment in all services. The rate of employment growth was significantly higher during 1966-73 (7.4 percent) than during the earlier 1960-66 period (6.1 percent), partially because of demand for manpower associated with Medicare and other programs.

Women predominate in the health services industry and, in 1973, at 3 million, accounted for 81 percent of total employment, compared with 1.2 million, or 77 percent in 1960. The rate of employment growth for women averaged 7.6 percent during 1960-73, 7.7 percent during 1966-73, and 6.4 percent during 1960-66. Registered nurses total more than 700,000; women also predominate in such health services occupations as practical nurse, radiologic technologist, medical technologist, dietitian, physical therapist, occupational therapist, speech pathologist and audiologist, dental hygienist, dental assistant, medical record librarian, and secretarial and office clerical positions.

The outlook is for continued higher levels of employment in health services but a slowdown in the annual growth rate. According to BLS projections, 5.3 million persons may be employed in the industry in 1980 and 6.1 million persons in 1985. (See introductory note for assumptions.) The employment growth rate would average 4.3 percent during 1973-85.

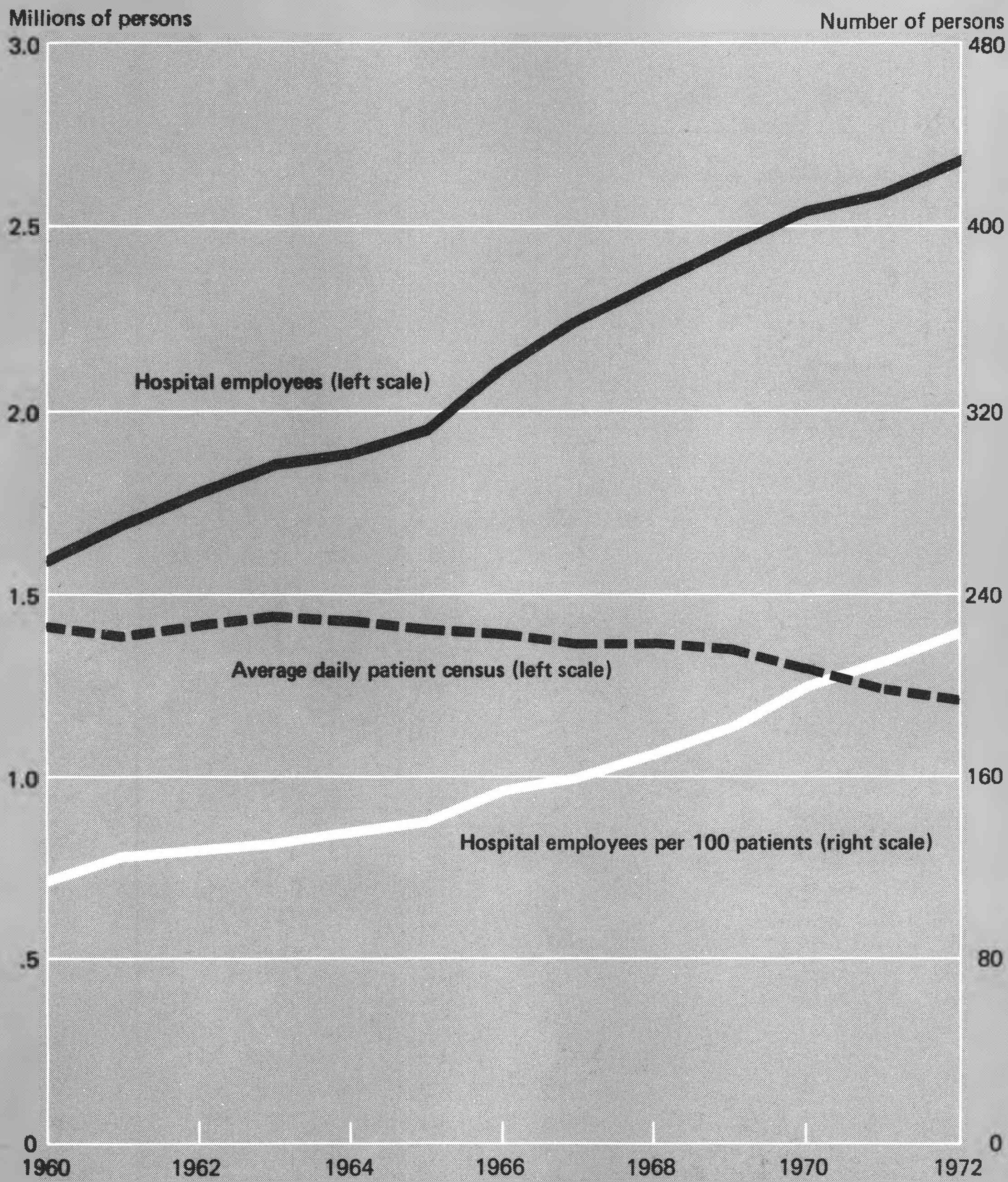
Occupational trends

Significant variations in rates of employment growth are anticipated for the major occupations in health services. Chart 19 indicates the following projections

[3] Employment is for private sector wage and salary employees only; excludes persons employed in Federal, State, and local health service occupations.

Chart 17

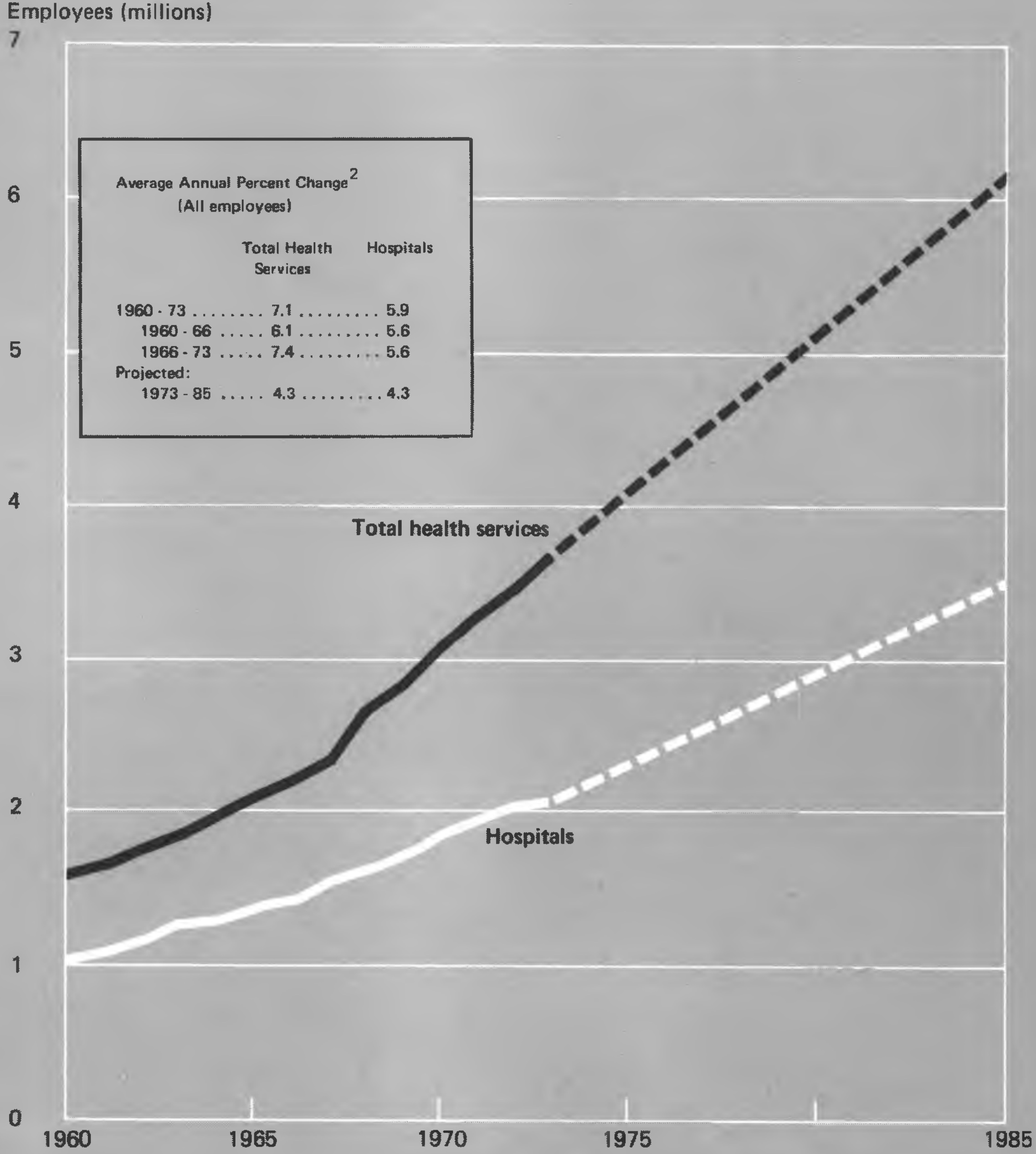
Number of Employees and Patients in Hospitals, 1960-72



Source: American Hospital Association.

Chart 18

Employment in Total Health Services and Hospitals, 1960-73 and Projected for 1985[1]



Average Annual Percent Change[2] (All employees)	Total Health Services	Hospitals
1960-73	7.1	5.9
1960-66	6.1	5.6
1966-73	7.4	5.6
Projected:		
1973-85	4.3	4.3

[1] Private sector wage and salary employees only; excludes persons employed in Federal, State, and local health service occupations.
[2] Least squares trend method for historical data; compound interest method for projections.

Source: Bureau of Labor Statistics.

during 1970 to 1980; professional, technical, and kindred workers, up 55 percent; managers, officials, and proprietors, up 72 percent; clerical workers, up 59 percent; sales workers, up 59 percent; craft and kindred workers, up 50 percent; operatives, up 67 percent; service workers, up 46 percent; and laborers, up 61 percent.[4] Within the professional and technical group, employment in 1980 for health technologists and technicians, clinical lab technologists, and those in computer specialist occupations is projected to be 80 percent higher than in 1970. Less rapid growth is projected for dentists, 39 percent; physicians and M.D. osteopaths, 41 percent; and registered nurses, 51 percent. Food service worker employment is expected to rise by only 3 percent between 1970 and 1980, probably because of technological and other changes previously discussed.

Advances in medical technology will continue to alter traditional occupational patterns. Computers, automated lab equipment, and other innovations underway in health services will result in new positions, modifications in duties of existing jobs, and reductions in unit labor requirements in routine clerical data processing and other tasks.

Use of the electronic computer has resulted in the need for thousands of persons to plan, program, operate, and maintain the computer systems being introduced in hospitals and other health care facilities. New types of electronic monitoring and test equipment and other devices have brought about a need for new positions such as medical electronic engineer and electronic instrument technician to carry out equipment design, maintenance, and related functions. Other new positions being added in hospitals include surgical technician, respiratory therapist, and medical emergency technician. In some areas, paramedical positions such as "physician assistant" are helping to improve health services delivery. Veterans with medical experience, for example, are being trained as physician assistants in such areas as obstetrics, pediatrics, and surgery.

In addition to new positions, innovations in health activities will result in changing job duties, as routine tasks are increasingly carried out automatically by computers and other new devices. Medical technologists in hospital labs, for example, are carrying out more complicated tests and research and acquiring new skills in computer programming and data processing. Although laborsavings have occurred in a number of health care activities, ranging from business office activities to food preparation activities, displacement and layoffs are not expected because of the substantial prospective growth in the industry.

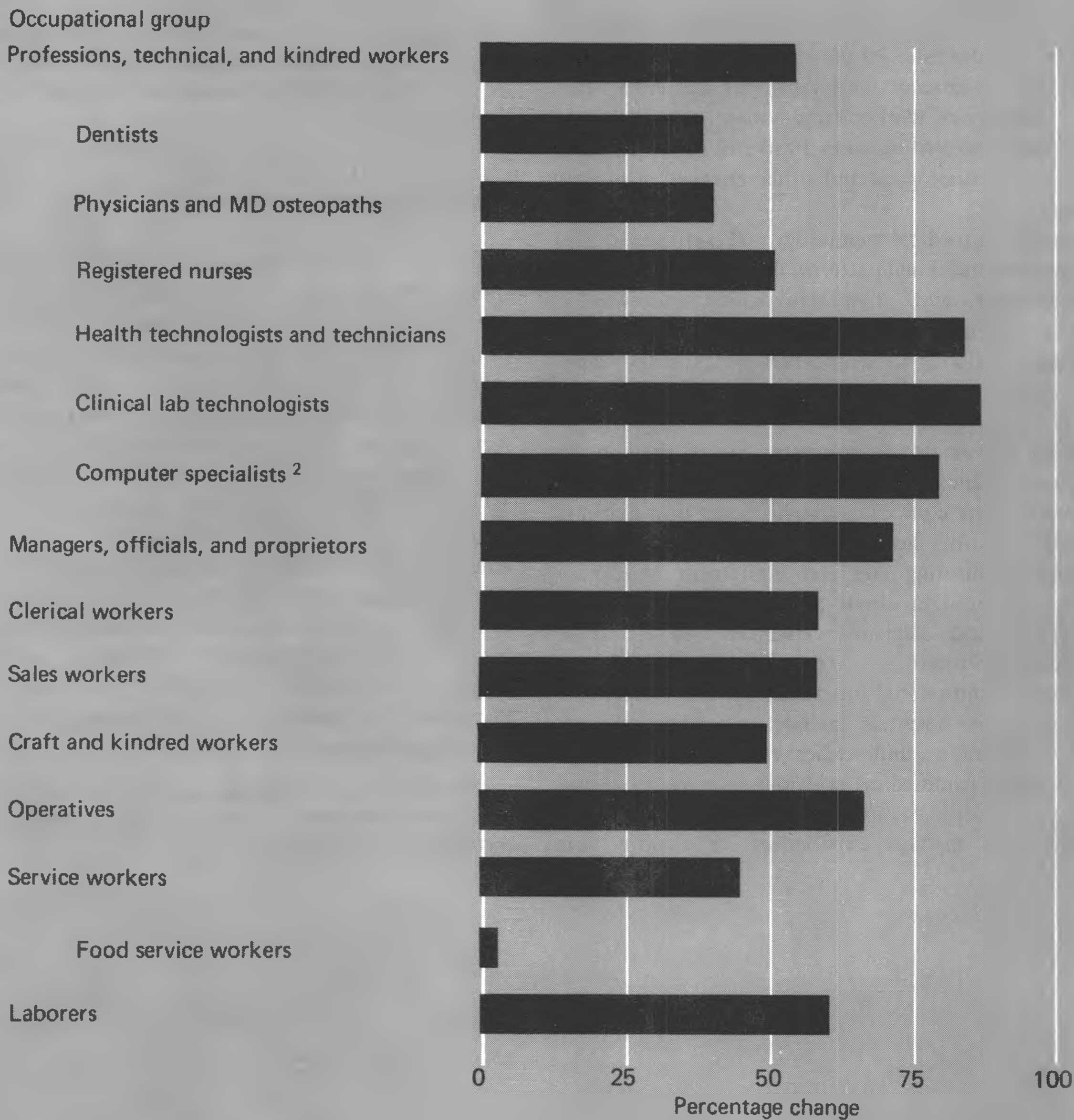
Supply of health service workers

The Federal Government has undertaken important measures to increase the supply and improve the quality of manpower in the health service field. Specific programs which have given support to improving health manpower training programs facilities result from legislation including the Manpower Development and Training Act, Vocational Education Act, Nurse Training Act, and the Comprehensive Health Manpower Training Act of 1971. The Health Resources Administration of the Department of Health, Education, and Welfare administers the Health Professions Educational Improvement Program which is empowered to make funds available to improve the output and quality of education in the health professions. Government and private programs to improve the supply of trained health manpower will continue to be required to meet a growing population's health care needs.

4 Data in chart 19 include persons employed in Federal, state, and local health service occupations as well as private sector wage and salary employees.

Chart 19

Projected Changes in Employment in the Health Services Industry by Occupational Group, 1970-1980[1]



[1] Includes both private sector and government.

[2] Includes computer programmers, computer system analysts, and other computer specialists.

Source: Bureau of Labor Statistics.

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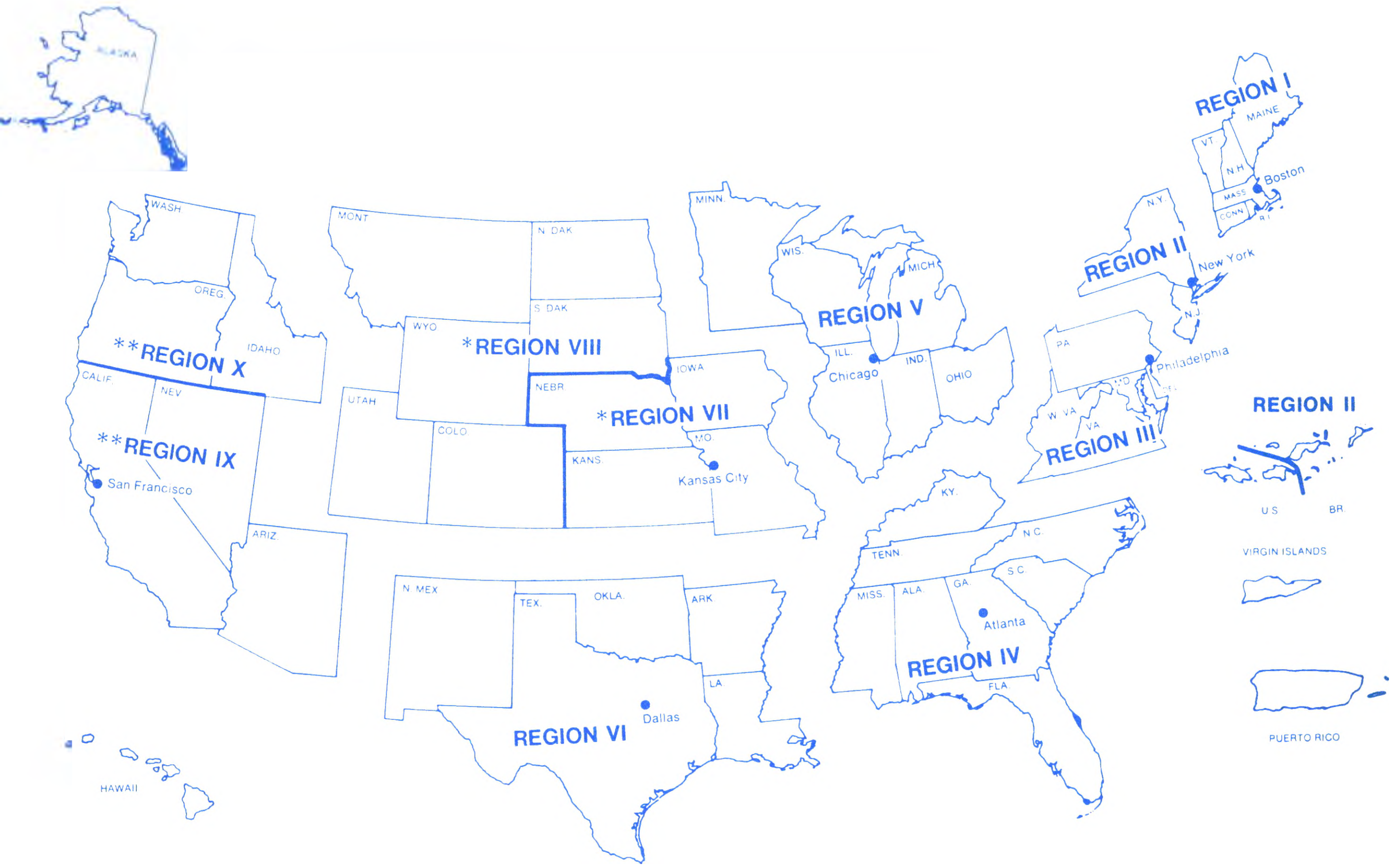

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