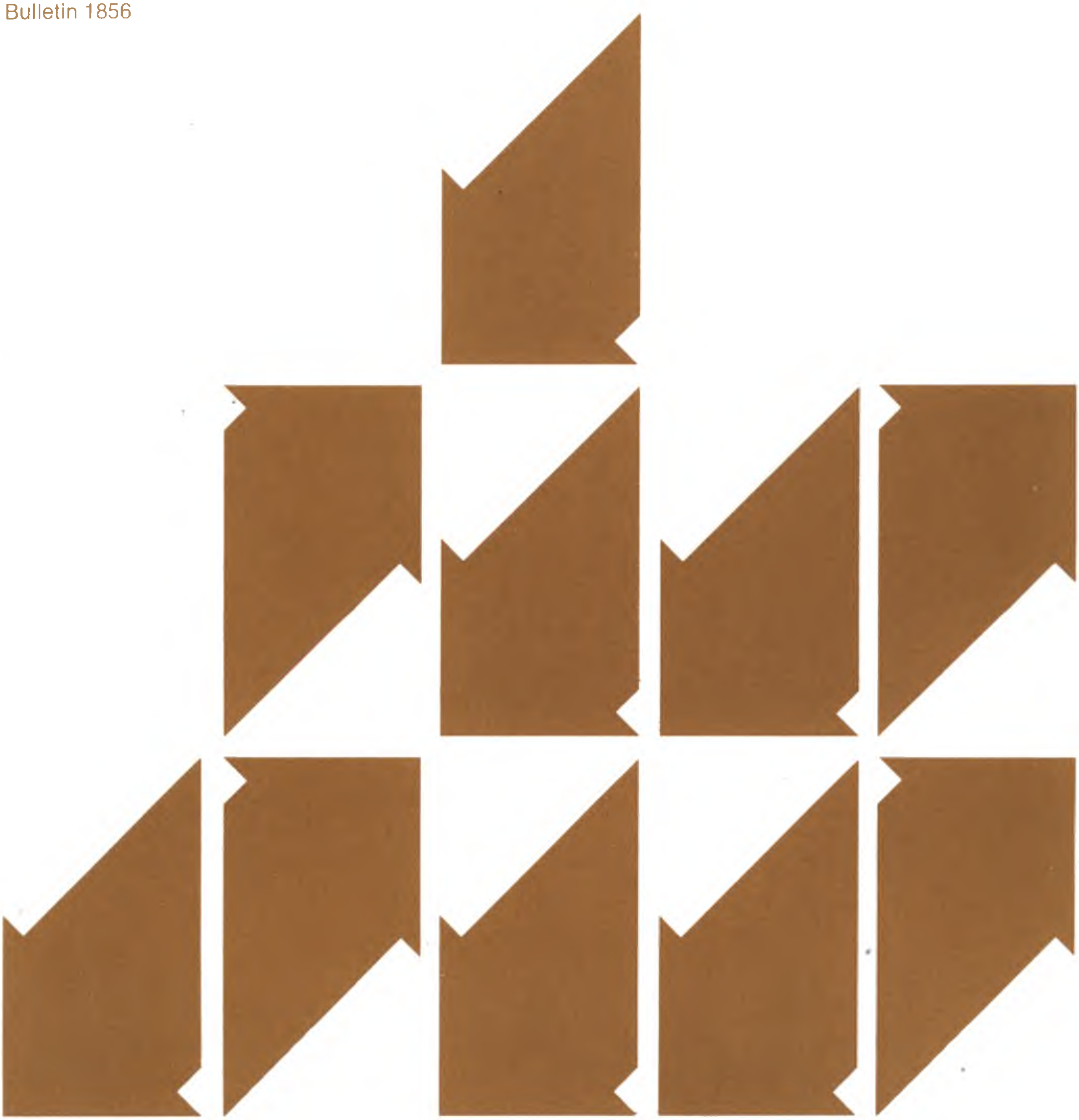
Technological Change and Manpower Trends in Five Industries

U. S. Department of Labor
Bureau of Labor Statistics
1975

Bulletin 1856



Library of Congress Cataloging in Publication Data

United States. Bureau of Labor Statistics.
Technological change and manpower trends in five industries.

(BLS Bulletin ; 1856)
Updates and expands in part Technological trends in major American Industries, published in 1966.
Bibliography: p.
Supt. of Docs. no.: L 2.3:1856
1. Technological innovations--United States. 2. United States--Industries. 3. Industrial productivity. I. United States. Bureau of Labor Statistics. Technological trends in major American industries. II. Title. III. Series: United States. Bureau of Labor Statistics. Bulletin ; 1856.
HC110.T4U5 1975 331.1'1'0973 75-619069

Technological Change and Manpower Trends in Five Industries

Pulp and Paper/Hydraulic Cement
Steel/Aircraft and Missiles
Wholesale Trade

U.S. Department of Labor
John T. Dunlop, Secretary

Bureau of Labor Statistics
Julius Shiskin, Commissioner
1975

Bulletin 1856

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.
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Price $1.20. Make checks payable to Superintendent of Documents.
Stock Number 029-001-01405-8
Catalog Number L2.3:1856

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 five industries: pulp and paper (SIC 261, 262, 263, 266), hydraulic cement (SIC 324), steel (SIC 331), aircraft and missiles (SIC 372, 1925), and wholesale trade (SIC 50).

This publication is the second of a series which will update and expand BLS Bulletin 1474, *Technological Trends in Major American Industries*, published in 1966, as a 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: Pulp and paper, David H. Miller; hydraulic cement, Larry G. Ludwig; steel, Rose N. Zeisel; aircraft and missiles, James D. York; and wholesale trade, Mary Vickery. 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: United States Steel Corp., Polysius Corp., The Black-Clawson Company, McDonnell Aircraft Company, and Cahners Publishing Co., Inc.

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Introductory Note

The appraisals of the effects of technological change in the five 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 this 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. In addition, since the effects of environmental protection regulations on technology, manpower, productivity, and investment are still uncertain, they 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.

Pulp and Paper

Summary

Major innovations in the pulp, paper, and board industry (SIC 261, 262, 263, 266) will include further mechanization of wood handling and finishing and shipping operations, the more widespread use of continuous digesters in pulping and the commercial adoption of new pulping processes, the extension of computer control and instrumentation, and the introduction of technology to control water and air pollution. In some instances, technology will bring about significant reductions in unit labor requirements, changes in job content, and a reduction in the number of jobs which require extensive manual effort. The expense of new pollution control technology is expected to continue to have an adverse impact on profitability and manpower, and may force some small mills to close.

Productivity is expected to continue to increase at relatively high rates during the 1970's—possibly by about 4 percent annually. In 1960-73, output per man-hour for all employees (BLS data) rose at an average annual rate of 4.4 percent, well above the 3.4 percent annual rate for manufacturing, and substantially higher than the annual growth rate of 2.9 percent recorded by the industry during the 1950's.

Expenditures for new plant and equipment (Census data) totaled $894 million in 1972, considerably higher than the $434 million outlay in 1960, but below the peak year of 1967 when new plant and equipment expenditures exceeded a billion dollars. The outlook is for increased capital spending to expand capacity and to meet pollution control requirements. Capacity expansion has been limited by the rising level and proportion of capital expenditures that have been spent on pollution control. The extent of energy and raw material shortages and the anticipated level of return on new capital investment will be factors which will determine whether planned capital expenditures are fulfilled.

Total employment in pulp and paper remained relatively stable during 1960-73, as gains in output were nearly matched by increases in output per employee. An annual employment growth rate of well under 1 percent is projected by the BLS for the period 1973-85. (See introductory note for assumptions underlying the projections.) Important shifts in the occupational structure also are anticipated. Between 1970 and 1980, the BLS projects employment gains for managers, officials, and proprietors; sales workers; professional and technical workers; and craft and kindred workers. Employment declines are projected for service workers, laborers, and operatives.

Technology in the 1970's

The innovations underway in the pulp, paper, and board industry, discussed in this section and summarized in table 1, generally involve modification and improvements to existing equipment and processes. The industry over the next decade also is expected to emphasize pollution control and the more efficient utilization of raw materials and energy supplies. Major efforts are underway to obtain more yield of fiber per acre of forest through more intensive forest management and practices such as "whole tree utilization." Recycling of paper and the use of wood chips and other residue are increasing, new pulping technology which can increase fiber yield and reduce pollution is being introduced more widely, and research is underway to improve existing tree species to accelerate growth, increase yield and fiber length, and reduce bark content. Products with special properties will continue to be introduced to broaden markets.

Materials handling

Materials handling systems in woodyards and woodrooms and in finishing and shipping departments are being improved and expanded. Some modern conveyor systems being introduced feature centralized control units which allow materials to move through processing with minimum manual handling. Industrial TV systems also are being used to monitor log conveying and other materials handling operations from remote stations. The handling and storing of wood in chip form rather than as logs have facilitated the transport of raw materials. Mills

Table 1. Major technology changes in the pulp and paper industry

Technology	Description	Diffusion
Mechanization of materials handling	Improved conveyor systems featuring centralized control are increasing productivity in wood handling and finishing and shipping departments. The storing and handling of chips instead of logs also have raised efficiency. Technology with the capability for "whole tree utilization" is expected to increase forest yields.	Mills increasingly will modernize materials handling functions.
Improved pulping technology	Innovations expected to improve yield and pulp quality include continuous digesters and more extensive use of computer control and instrumentation. Mechanical and semichemical pulping may increase in importance.	These innovations will continue to be introduced, particularly in larger mills.
Improved papermaking machines	Modifications of Fourdrinier and cylinder papermaking machines underway involve increase in machine speed and improved control. New technology in formation and drying also is improving performance and productivity. Twin-wire forming methods are being used more extensively.	These innovations are expected to continue.
Computer control and instrumentation	Electronic computers and advanced instruments increasingly are being introduced for control of pulp and papermaking equipment. Significant operating economies including gains in productivity and reduction in waste have been reported.	More widespread use of computer process control is expected. By 1973, more than 150 process computers were installed compared to 17 in 1965.
Pollution control technology	Technology to lessen air and water pollution is receiving increased emphasis and is being introduced more widely. The expense of pollution control equipment could contribute to the further closings of some small, marginally efficient mills.	Expenditures for pollution control equipment will increase significantly to meet new and more stringent anti-pollution regulations.

which have replaced obsolete woodrooms with modern facilities incorporating extensive and centrally controlled conveyor networks report substantial laborsavings and significant gains in output per worker. At one mill visited by BLS, for example, woodroom employment was reduced by two-thirds and output per worker was more than doubled after new facilities were introduced. Innovations in harvesting and transport of logs include the use of mobile harvesters and chippers which delimb, debark, and chip whole trees or logs at the site, thereby reducing transportation costs and waste of fiber resources.

Improvements in materials handling and related equipment in the labor-intensive finishing and shipping department include highly mechanized paper roll handling systems, high speed automatic paper cutter-sorters, and equipment for automatic roll wrapping. At an East Coast mill which introduced a new automatic cutter-sorter, for example, manual sorting and trimming were eliminated, and 2 operators are now required instead of 10 to 15.[1]

Pulpmaking

Innovations in pulping technology over the next decade are expected to improve yield and pulp quality and reduce pollution. Continuous digesters (equipment that manufactures pulp continuously rather than in separate batches) will come into more widespread use. Continuous digesters with automatic control eliminate the intermittent flow of wood chips and the manual starting and stopping of each batch of pulp required in batch pulping. Advantages of continuous pulping reportedly include increased tonnage throughput, improved quality, lower steam requirements, and higher yield. Computers are being introduced more widely in larger mills to control both continuous and batch pulping equipment, resulting in improved productivity, greater pulp uniformity, and raw material savings.

Most pulp will continue to be manufactured by chemical pulping processes, but mechanical and semichemical pulping methods, which give a higher fiber yield, could increase in relative importance as a means of conserving raw materials. The refiner groundwood process is a new form of mechanical pulping technology. Its advantages include the ability to use chips rather than solid logs, less water pollution, higher fiber yields, and the capability to process wood residue. However, paper made from mechanical and semichemical pulp generally has less strength than paper made from chemical pulp. New oxygen pulping and bleaching technology is being introduced to lessen pollution. At least one commercial installation in the United States uses oxygen bleaching.

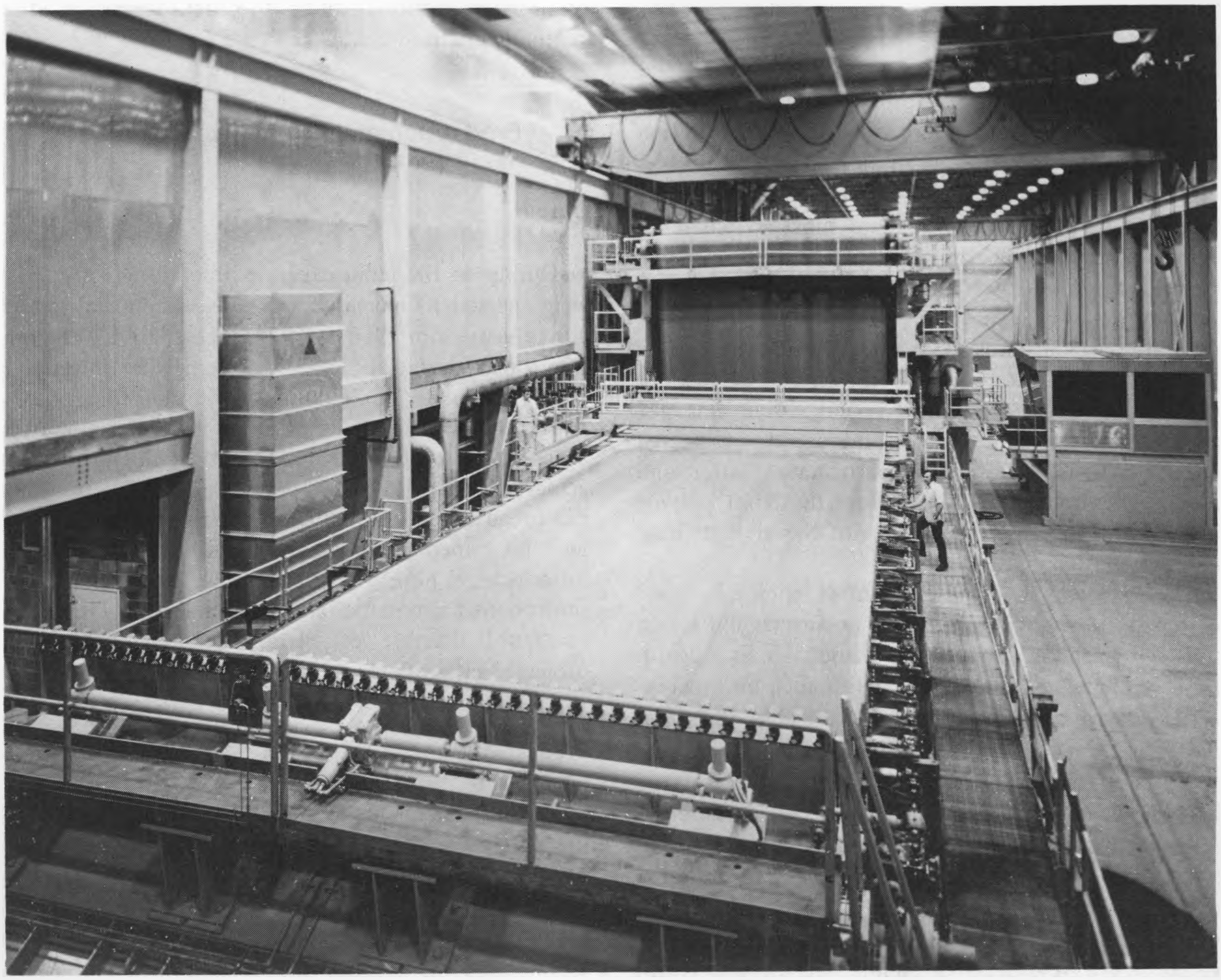
Papermaking

Innovations in papermaking technology include the modification of existing equipment to improve productivity and versatility and the introduction of several new twin-wire systems. Improvements in the basic papermaking machine, the Fourdrinier, have resulted in greater machine speed. The increase in Fourdrinier speed generally results in gains in output per employee, since crew size usually remains unchanged. At the "wet" end of the papermaking machine, where the pulp enters, twin-wire forming methods which improve paper quality are in limited use. Improvements to the wire screen which transports and forms pulp into paper or board also are continuing, including the substitution of plastics for metal. Existing cylinder machines which can use wastepaper for producing paperboard and other products also are being modernized. Wastepaper consumption in 1973 was approximately 35 percent above the 1960 level.[2]

Computer process control

Electronic computers increasingly are being used for process control in pulp and paper mills. More than 150 process control computers were in use in pulp and paper mills in 1973 compared to 17 in early 1965.[3] Computers are being applied to improve control on papermaking machines, batch and continuous pulpmaking equipment, and bleaching systems. More widespread use of process control is anticipated by industry experts as both computer technology and instrumentation systems are further improved.

Computer control systems are achieving significant operating savings at a number of mills. At one plant studied by the BLS, for example, installation of a process control computer and new instrumentation on a



Modern Fourdrinier paper machine.

papermaking machine reduced grade changeover time by 20 percent, increased machine speed by 15 percent, and improved machine efficiency by 2 percent, for a net increase in production of 19 percent. Computer process control also has changed the nature of some jobs. Generally, operators now do less manual manipulation of control devices and more monitoring of machine functions.

Advances in instrumentation have facilitated adoption of computer control. In some mills, for example, papermaking machines incorporate computers and advanced instrumentation such as beta-ray sensors to measure paper weight, infra-red sensors to determine moisture content, optical sensors to indicate opacity, and electromagnetic sensors to measure thickness. Measurements from these devices are transmitted to the computer, which compares them with programmed specifications. The papermaking machine's operations are modified automatically if adjustments are required.

Pollution control

Technology to control pollution in the pulp and paper industry is being improved and expanded to comply with new and more stringent antipollution regulations. The manufacture of pulp and paper involves the use of a large volume of water and numerous chemicals; pollution problems are most extensive in pulpmaking and in bleaching and papermaking machine operations. Research is underway to reduce water consumption by recycling.

Airborne pollution is receiving increased attention by the paper industry. Capital expenditures for water pollution control have traditionally exceeded those for air pollution, but a reversal of this trend is expected during 1974-75. Control of particulate matter and gaseous chemicals—particularly from the Kraft pulping process—is a major area of concern. Newer mills have built-in pollution control devices.

The expense of pollution control equipment (see section on investment) may have an adverse impact on profitability and employment in marginal mills. According to a study undertaken for the Council on Environmental Quality, 44 percent of all U.S. pulp and paper mills (which account for 15 percent of industry capacity) are economically marginal and could experience difficulty in meeting pollution abatement regulations.[4] Some small mills have closed and others may close, in part because of inability to finance required pollution abatement equipment. This may cost as many as 16,000 jobs in such mills by 1976.[5] The areas most affected would be the New England, Middle Atlantic, and North Central regions. However, regional losses in employment due to closings of small mills will probably be more than offset in the longer term by growth of employment in the industry.

Energy conservation

The pulp and paper industry is a major user of energy. Large paper companies are setting up special task forces to seek solutions to possible future energy problems, particularly for the planning of increased production and the selection of locations for new facilities. Fuel conservation programs and equipment are being introduced in a growing number of mills. Fortunately, the industry provides about 40 percent of its own energy requirements.[6] Industry sources predict that process wastes will be used more extensively for fuel and that dependence on purchased fuel will decline. Several large integrated mills, for example, produce more than two-thirds of their fuel needs from process wastes and other firms are expected to follow this trend. A number of firms are exploring alternative fuel sources including synthetic gas from treated coal.

Production and Productivity Outlook

Output

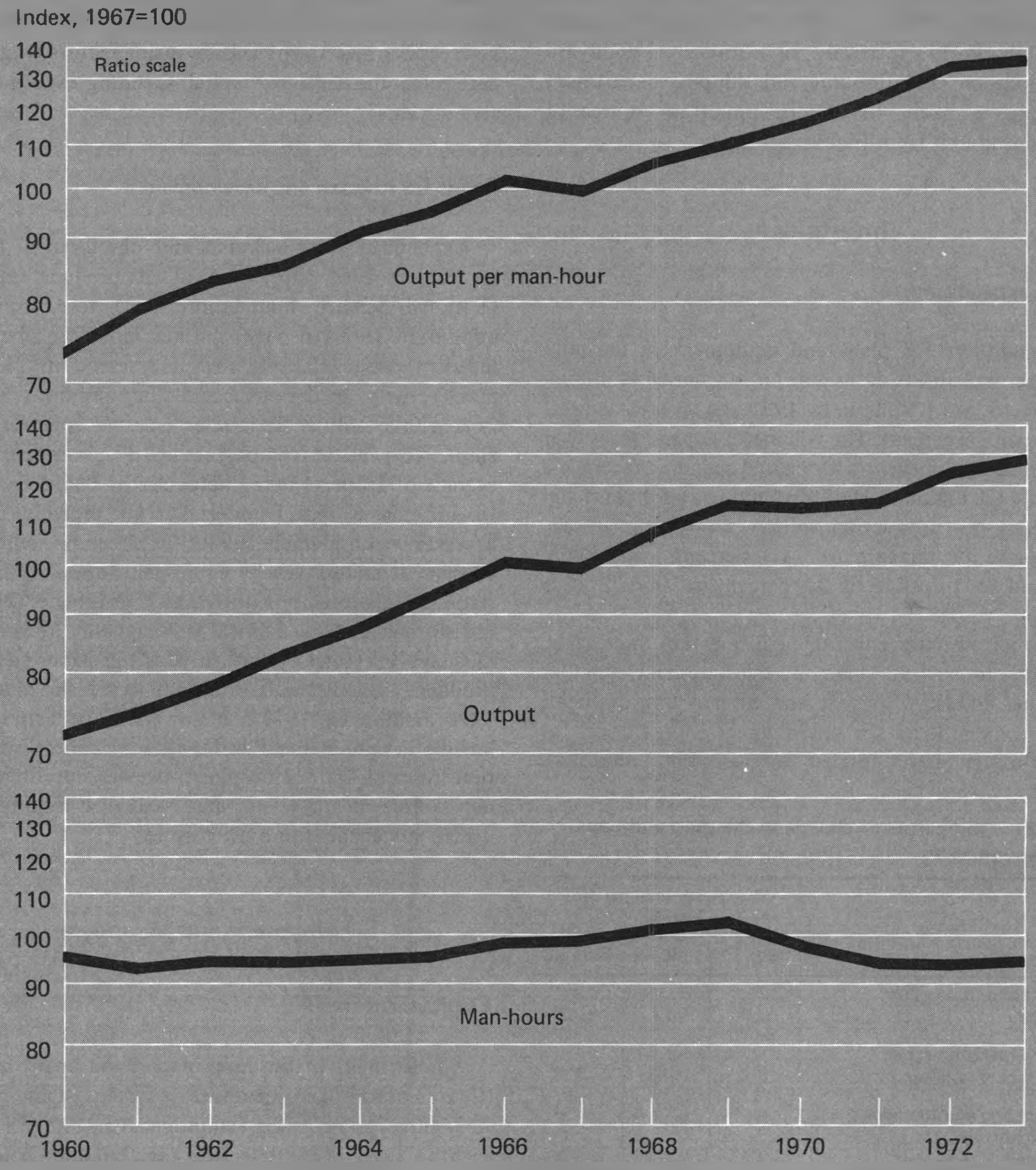
Output in the pulp, paper, and board industry (BLS weighted index) increased at an average annual rate of 4.6 percent from 1960 to 1973. (See chart 1.) The rate of growth during 1966-73 was somewhat lower, 3.6 percent annually. While output projections for the pulp, paper, and board industry are not published by the BLS, an annual rate of output growth below the 4.6 percent achieved during 1960-73 is projected during 1973-85 for the broader paper and allied products industry, excluding the paperboard container and box sector. (See introductory note for assumptions underlying these projections.) Economic factors, including an anticipated continued shortage of energy, however, could slow projected rates of growth in output and capacity.

Productivity

Output per man-hour for all employees (BLS data) increased at an average annual rate of 4.4 percent during 1960-73 (chart 1), well above the 3.4-percent growth rate for all manufacturing. This also was substantially above the average annual growth rate of 2.9 percent recorded by the industry during the 1950's. Output per production worker man-hour rose at a slightly higher

Chart 1

Output per man-hour, output, and man-hours in the pulp, paper, and board industry, 1960-73



Source: Bureau of Labor Statistics.

annual rate of 4.6 percent during 1960-73.

Productivity is expected to continue to increase at relatively high rates during the 1970's—possibly by about 4 percent annually. Whether this rate can be achieved and sustained, however, will depend on several factors including the future availability of energy, the rate of investment in new equipment, the state of the economy, adequacy of raw material supply, and the impact of pollution abatement requirements on production methods and costs. Continued introduction of new technology in the relatively labor-intensive woodyard and woodroom and finishing and shipping department operations is likely to be one important source of reductions in unit labor requirements.

Investment

Capital expenditures

Expenditures for plant and equipment in the pulp and paper industry (Census data) rose from $434 million in 1960 to $894 million in 1972, an average annual increase of 7.0 percent. The volume of expenditures over this period was uneven, with capital spending reaching a peak of $1.1 billion in 1967. Expenditures for plant and equipment per production worker showed an average annual rate of increase of 14.3 percent in 1960-66, compared to a decline of 2.2 percent in 1966-72. (See table 2.)

Expenditures to control pollution are increasing. According to a recent survey by the National Council of the Paper Industry for Air and Stream Improvement, capital expenditures for environmental protection for 1971 through 1973 totaled $893 million, increasing from $203 million in 1971 to $351 million in 1973. Projected 1974 environmental expenditures are $523 million.[7]

Table 2. Indicators of change in the pulp and paper industry, 1960-72

Indicator	Average annual percent change[1]		
	1960-72	1960-66	1966-72
Payroll per unit of value added	0.7	–1.0	2.2
Capital expenditures per production worker	6.8	14.3	–2.2
Research and development expenditures as a percent of net sales[2]	2.3	4.2	–1.3

[1] Linear least squares trends method.

[2] For companies in the broader paper and allied products industry which have research and development programs.

SOURCES: Bureau of the Census and National Science Foundation.

The outlook is for higher levels of capital spending. According to a McGraw-Hill survey, planned capital expenditures for new plant and equipment (including those for pollution control) are projected to increase 27 percent during 1973-77 for the broader paper and allied products industry.[8] The extent of energy and raw material shortages and the anticipated rate of return on new capital investment will be major factors which will determine the level of capital spending over the next several years.

Funds for research and development

Expenditures for research and development (R&D) by the broader paper and allied products industry (National Science Foundation data) rose from $56 million in 1960 to $186 million in 1972. The paper industry ranks relatively low in research and development activity. In the paper and allied products industry as a whole, only 8 R&D scientists and engineers were employed per 1,000 employees in 1972, compared to an average of 25 per 1,000 employees for all U.S. industry. In addition to R&D undertaken by individual firms, however, a considerable amount of research useful to the industry is undertaken by equipment suppliers, industry trade associations, private research groups, educational institutions, and the Federal Government. According to McGraw-Hill, total outlays for R&D in paper and allied products are expected to continue to rise and may reach $294 million in 1977.[9] Major areas of activity will include development of new products, control of pollution, research on dry forming processes, development of new sources of nonwood fibers, and new technology to utilize wastepaper more extensively.

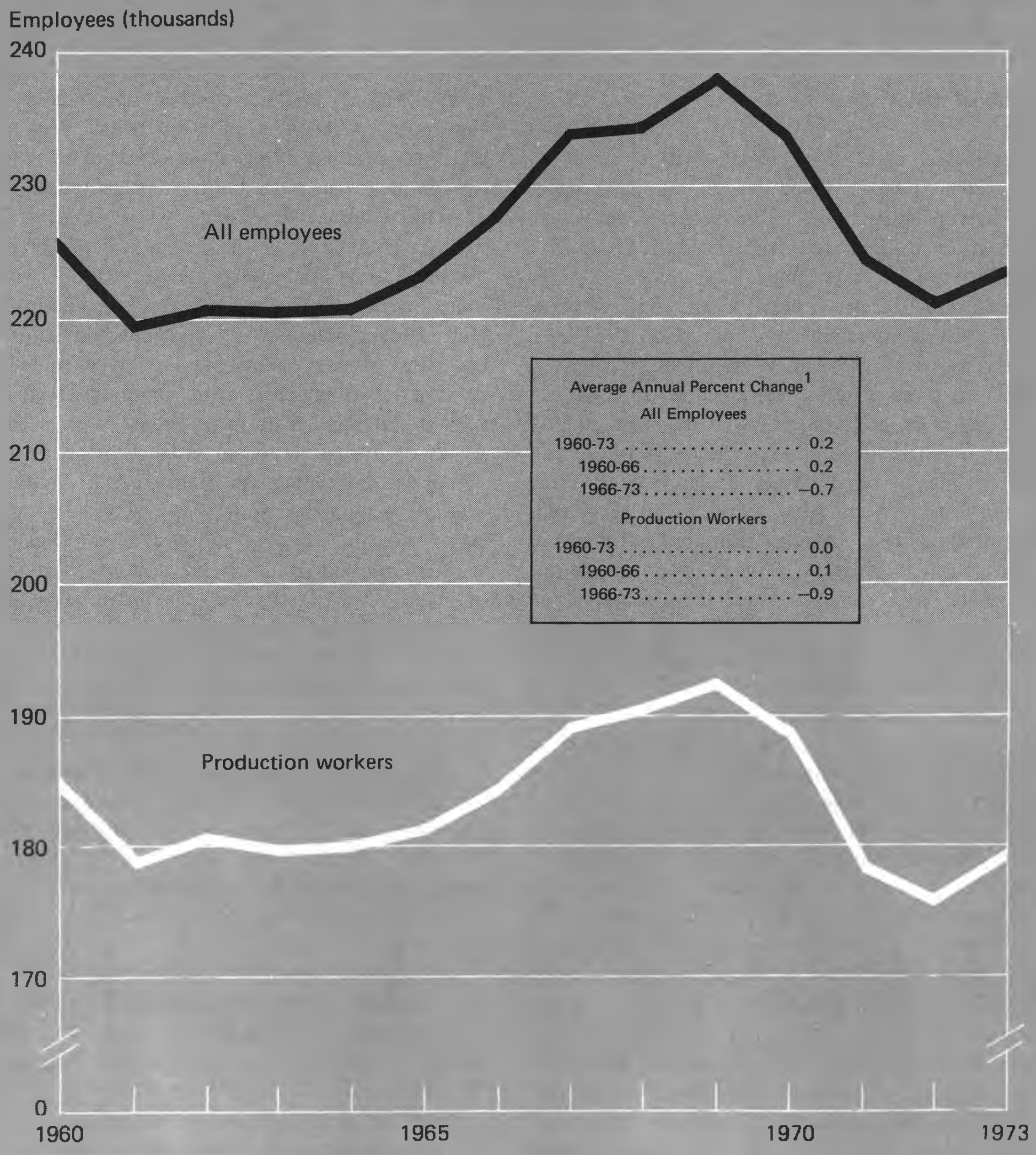
Employment and Manpower

Employment trends

Employment in the pulp, paper, and board industry (Census data) has remained relatively stable. About 224,000 workers were employed in 1973,[10] down slightly from the 1960 level of 226,000. The peak employment year was 1969 when the work force totalled 238,000 (chart 2). The average annual rate of employment growth for 1960-73 was 0.2 percent, well below the average of 1.5 percent for 1950-60. BLS employment projections to 1985 anticipate an average

Chart 2

Employment in the pulp, paper, and board industry, 1960-73



Average Annual Percent Change[1]	
All Employees	
1960-73	0.2
1960-66	0.2
1966-73	–0.7
Production Workers	
1960-73	0.0
1960-66	0.1
1966-73	–0.9

[1] Least squares trend method.

Source: Bureau of the Census and Bureau of Labor Statistics.

annual growth rate of 0.4 percent during 1973-85, both for the 1973-80 period and for 1980-85.[11] (See introductory note for assumptions.)

Trends in employment (Census data) in the major industry subgroups showed considerable disparity. The work force in paperboard mills increased 13 percent during 1960-71. Pulpmill employment showed little change, while papermill employment fell by 3 percent and building paper and board employment declined by nearly 25 percent.

Occupational trends

Technological and other changes will continue to alter the structure of occupations in pulp and paper mills. The proportion of all employees who were nonproduction workers rose slightly during 1960-73; this trend is expected to continue.

According to BLS projections, fewer service workers, laborers, and operatives will be employed in 1980 both absolutely and relatively, as new laborsaving technology is introduced more widely. (See chart 3.) In 1980, for example, laborers are expected to total only slightly more than one-half the number employed in 1960. Most of the decline in employment of laborers occurred during the decade of the 1960's as pulp and paper mills became more highly mechanized. Employment increases are projected for managers, officials, and proprietors; sales workers; professional and technical workers; clerical workers; and craft workers. Except for service workers, the projected employment changes for the eight occupational categories in chart 3 represent a continuation of trends underway during 1960-70.

Job duties in some occupations are expected to continue to undergo modification because of new technology. At one large mill which introduced computer control of papermaking machine operations, for example, the computer sets production variables such as temperature, pressure, and flow rates; before computer control, they were set by the machine tender. The machine tender still performs some control and monitoring duties and is available in case of emergency. Other mills which introduced new materials handling and continuous processing technology also report some modification of job duties of woodyard and woodroom workers, digester operators, and others. In general, duties involving the manual movement of materials and manipulation of machinery are being reduced and workers in some positions increasingly are required to oversee a greater workflow, to relate one processing step to another, and to regulate operations by pushbutton control.

In instances where continuous digesters replace batch digesters, two occupations are affected. Jobs involving the manual unbolting, removal, and replacement of heavy steel covers on batch digesters are being eliminated. New positions in which an operator monitors a continuous process by means of a central control panel are being added.

Adjustment of workers to technological change

Training to operate new equipment will continue to be an important means for adjustment of workers to new technology. BLS and other plant studies disclose that most workers whose job duties have been modified and those reassigned to new positions are being retrained by company personnel and by representatives from the equipment supplier to operate new equipment. Depending upon the nature of the change and the job affected, training can be brief and provided on the job, or can be more extensive, involving lectures, classroom instruction, and training manuals. At one mill which introduced computer process control, 16 employees including process systems engineers, the computer manager and related staff, and instrument engineers received 2 to 6 weeks of formal classroom instruction on Fortran and computer concepts and methods. In addition, 84 workers including members of the project task force, paper machine crews, and instrument maintenance workers received from 6 hours to 2 weeks of on-the-job and classroom instruction on instrument functions, maintenance, and related topics.[12] Training of instrument repairers may be more intensive in the future since new instrumentation and control devices are more sophisticated and increasingly require a higher level of technical skill.

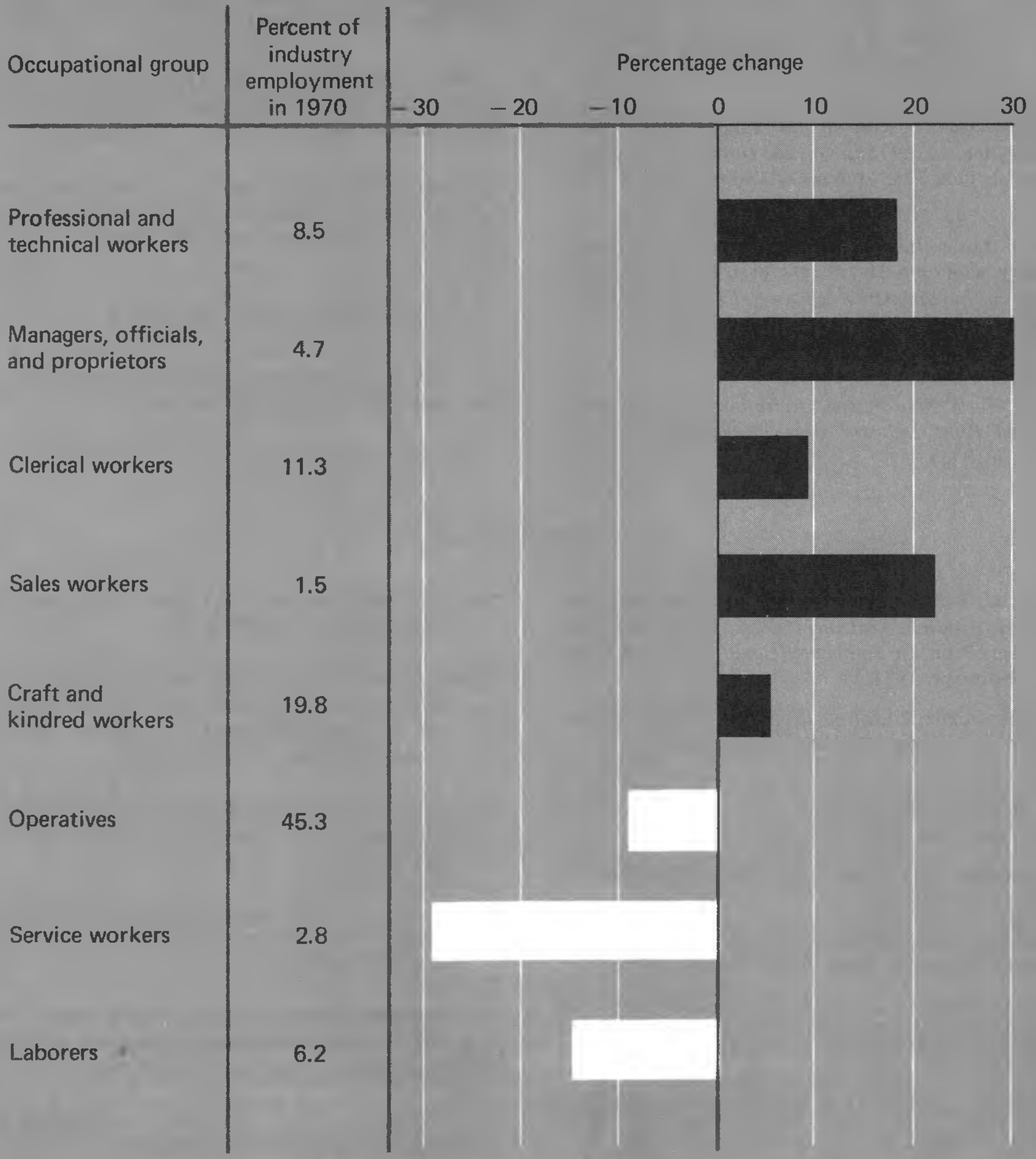
The industry is highly unionized. According to a BLS survey of pulp, paper, and paperboard establishments (excluding building paper and building board mills) with 50 employees or more, more than 90 percent of all employees worked in establishments where collective bargaining agreements covered a majority of the work force.

The largest union in the industry is the United Paperworkers International Union (AFL-CIO). In the Western States, a large number of workers are represented by the Association of Western Pulp and Paper Workers.

Some labor-management agreements contain specific provisions relating to worker adjustment to technological change. A review of 41 major collective bargaining agreements in the paper and allied products industry, each covering 1,000 workers or more, located 9 agreements, covering more than 15,000 workers, that contained provisions requiring advance notice of technolog-

Chart 3

Projected changes in employment in the pulp, paper, and board industry by occupational group, 1970 to 1980



Source: Bureau of Labor Statistics.

ical change. One such provision reads: "Whenever the Company has made plans for substantial technological changes or the closing of departments which will result in permanent reduction of the work force, advance notice and consultation will be held with the Local Union Standing Committee . . . ."

–FOOTNOTES–

[1] Robert C. Tate, "The Secret of Westvaco's Accu-Trimmed Papers," *Paper Trade Journal*, Vol. 156, No. 45, Oct. 30, 1972, pp. 20-25.

[2] *Pulp, Paper, and Board, April 1971; April 1974,* (U.S. Department of Commerce, Bureau of Domestic Commerce), p. 36; p. 21.

[3] "Measurex' Wild Success in the Papermaking Market," *Business Week*, Jan. 27, 1973, p. 38; and *Outlook for Computer Process Control*, Bull. 1658 (Bureau of Labor Statistics, 1970), p. 12.

[4] Arthur D. Little, Inc., *Economic Impact of Anticipated Paper Industry Pollution-Abatement Costs*, Part 1: *Report to the Council on Environmental Quality, Executive Summary* (November 1971), p. 4.

[5] Ibid., p. 10.

[6] Ronald J. Slinn, *Sources and Utilization of Energy in the U.S. Pulp and Paper Industry* (New York, American Paper Institute, March 1973).

[7] National Council of the Paper Industry for Air and Stream Improvement, Inc., *A Survey of Pulp and Paper Industry Environmental Protection Expenditures and Operating Costs–1973* (New York, July 1974), p. 3.

[8] McGraw-Hill Publications Co., Economics Department, *Business' Plans for New Plants and Equipment, 1974-77*, 27th Annual McGraw-Hill Survey (New York, May 1974).

[9] McGraw-Hill Publications Co., Economics Department, *Business' Plans for Research and Development Expenditures, 1974-77,* 19th Annual McGraw-Hill Survey (New York, May 1973).

[10] Based on Census and BLS data.

[11] *The U.S. Economy in 1985: A Summary of BLS Projections,* Bull. 1809 (Bureau of Labor Statistics, 1974), p. 59.

[12] *Outlook for Computer Process Control,* p. 45.

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Hydraulic Cement

Summary

The broad application of new technological developments in the hydraulic cement industry (SIC 324) may significantly affect productivity growth in the 1970's. However, most of the technological changes taking place are primarily modifications to conventional machinery, while more radical technologies are only gradually being adopted. Economies of scale, in conjunction with the adoption of advances in equipment technology from abroad, may result in increased productivity and laborsavings.

Between 1960 and 1973, output per man-hour rose by an average annual rate of 4.2 percent while man-hours for all employees declined by 1.9 percent annually. Man-hour and output trends in the industry, considered together with current technological advances, suggest a continued rise in productivity.

Investment in plant and equipment is expected to show a steady upward movement in the 1970's, unlike the sharp ups and downs characterizing the 1960's. Anticipated outlays may be sufficient to reduce obsolescence in the industry and match industry capacity to domestic demand.

Cement plants employed almost 29,800 workers in 1973, compared to about 39,400 in 1960. A BLS projection for 1985 (see introductory note for assumptions) indicates that employment in the industry will continue to decline between 1973 and 1985, at about the same rate as during the 1960's. The proportion of production workers is expected to continue to decline in the 1970's, particularly among semiskilled workers. At the same time, the proportion of skilled craft workers providing maintenance will grow.

Technology in the 1970's

Recent industry trends towards plants of greater capacity with larger, more highly automated equipment, often using central process control, have continued through the early 1970's. The newer equipment consumes less fuel and uses less manpower per unit of output. The use of the latest technological advances has had dramatic results. Industry studies, for example, show that in a new plant with a 2-million barrel annual capacity, using the latest processes, production costs can be 40 percent less than for an older plant of the same capacity, and, for a new 4-million barrel plant, up to 50 percent less. Similarly, labor costs for new 2-million and 4-million barrel plants are reduced up to 60 and 70 percent, respectively, compared to older plants of the same capacities (one barrel equals 0.188 tons).[1]

Since the late 1960's there has been a gradual shift from wet process to dry process plants, the latter consuming substantially less fuel per ton of cement produced. This trend has been aided substantially both by rising fuel costs and by increased utilization of waste heat within newly developed production equipment.

Specific equipment advances which may significantly stimulate productivity growth range from modifications of conventional equipment to radical changes in equipment concepts. Modifications of conventional equipment affect speed, capacity, automaticity, energy consumption, and blending, storage, and analyzing of materials. These changes account for most of the improvement that has taken place in recent years in basic cement manufacturing. The changes have reduced unit manpower requirements, particularly for semiskilled and unskilled workers, but have not significantly changed job content. Newer radical innovations that have similar manpower implications and which have been gradually adopted—primarily since the early 1970's—by larger modernized and newly built plants include roller mills, preheater counterflow kilns, and comprehensive application of central process computer control. Some of the major innovations in the industry, their manpower impact, and their rate of diffusion are presented in table 3.

Central process control

The adoption of central process control and the increased use of electronic instrumentation are significantly improving product quality, increasing utilization of equipment, reducing equipment downtime and main-

Table 3. Major technology changes in the hydraulic cement industry

Technology	Description	Diffusion
Central process control and computer process control	Wiring of major production processes—especially raw and finish grinding, kiln, and material storage processes—into a central control panel, permitting total production control by one or two control room operators. Results in substantial manpower savings, reducing number of semiskilled employees.	Widespread diffusion as of mid-1974.
Dry process plants replacing wet process plants	New dry process uses recently developed preheater kilns and large roller mills (see below) and makes use of kiln waste heat to process raw materials of up to 15-20 percent water content. Older long-kiln dry process system was suitable only for materials with less than 8 percent water content. Total fuel and power consumption is substantially reduced—by 30-40 percent, in some instances—compared with either the traditional dry or wet process systems.	In 1968, wet process plants constituted 65 percent of all U.S. plants; at the start of 1974, 58 percent. Downward trend is expected to continue.
Roller mills	Large hydraulically controlled grinding rollers on a rotating grinding track inside a large chamber. Mills are vertically shaped, utilizing hot waste preheater kiln gases to dry and sweep ground raw material to storage areas. Can crush material up to 4 inches in thickness in one operation; with conventional grinding and crushing equipment several operations are required. Consumes up to 30 percent less power (KWH) than conventional grinders/mills. Fully automatic.	Limited diffusion as of mid-1974.
Preheater kilns	Vertical 4-stage counterflow heater, over 200 feet in height, empties into a short rotary kiln averaging 150-220 feet in length compared to long dry process kilns 500-600 feet in length. Utilizes exit gases of kiln to dry and heat raw material, resulting in fuel savings of up to 40 percent over the long dry process kilns.	Up to 1973, 9 preheater kilns were in operation in U.S. In 1974, 29 were in use or under construction.[2] Upward trend expected to continue.

[1] Portland Cement Association, *The U.S. Cement Industry—An Economic Report* (Skokie, Ill., March 1974), p. 42.

[2] Portland Cement Association; unpublished information.

tenance, and reducing fuel costs. Control panels, previously scattered throughout the plant at the site of each production process, are being eliminated in increasing numbers. The latest development is the wiring of entire plants into a single central control room which contains control panels and recording instruments covering all the production processes. The control room permits total control of the raw and finish grinding and kiln processes, including the material storage and blending operations involved before and after each process. Only the quarrying-crushing, raw material storage, and final packaging and bulk loading processes generally remain outside of total production control.

The manpower savings resulting from central process control are very substantial. Only one control room operator and one utility worker assistant are needed for each 8-hour shift to monitor and operate the control panels and to make minor adjustments on operating equipment. These two workers replace most of the production workers needed for all processes prior to the introduction of total production control.[2] Typical occupations eliminated in the kiln process are miller, oiler, burner, shift laborer, cooler tender, material handler, stack cleaner, water tender, and waste heat powerplant operator; in the grinding processes the occupations eliminated are lorry room worker, tube miller, hercules miller, dryer, furnace tender, oiler, and box tender. The job of control room operator is very complex and is the only new one created by the introduction of central process control. Conversion to central process control usually occurs when a plant modernizes and introduces laborsaving equipment. Thus, the manpower savings directly attributable to central process control will be lessened by the amount of laborsavings resulting from the installation of the new equipment.

Central computer process control

Computerization of the cement production process has been greatly facilitated by central process control. It is a relatively simple procedure for a plant to convert from central process control to central computer process control—a procedure followed by many plants when production volume and financial ability justify the additional substantial capital investment in computer systems. The trend until recently has been for installation of complete on-line, closed-loop computer control of the raw and finish grinding and kiln processes, including the material storage and blending for each process. A decade of experience has shown that computer closed-loop control has been very successful in the raw grinding process, moderately successful in the finish grinding process, and unsatisfactory in the kiln process. Consequently there is now a gradual industry movement to minicomputers—computer control designed with a separate minicomputer for each operating process rather than on the central total closed-loop computer basis.

Once central process control has been installed, the few additional jobs needed for the changeover to computer process control usually include the part-time services of an electrician and a programmer; no additional production jobs are eliminated by computerization.

Dry and wet production processes

Dry process plants are gradually replacing wet process plants throughout the cement industry. Traditionally, the rule of thumb employed by the industry to decide when to use the wet process has been that when the raw quarry material had 8 percent or more water content, the wet process was used. In this process additional water is added to the raw material, raising the water content up to about 35 percent and creating a slurry which is dried out primarily during the kiln production stage. For raw material with less than 8 percent water content, the dry process, in which raw material is dried out primarily in the grinding and milling processes, was used. This rule was based on the technologies and fuel costs prevalent up through the early 1970's, when it was cheaper to dry raw material with 8 percent or more water content in long horizontal rotary kilns rather than in the raw grinding and milling processes.

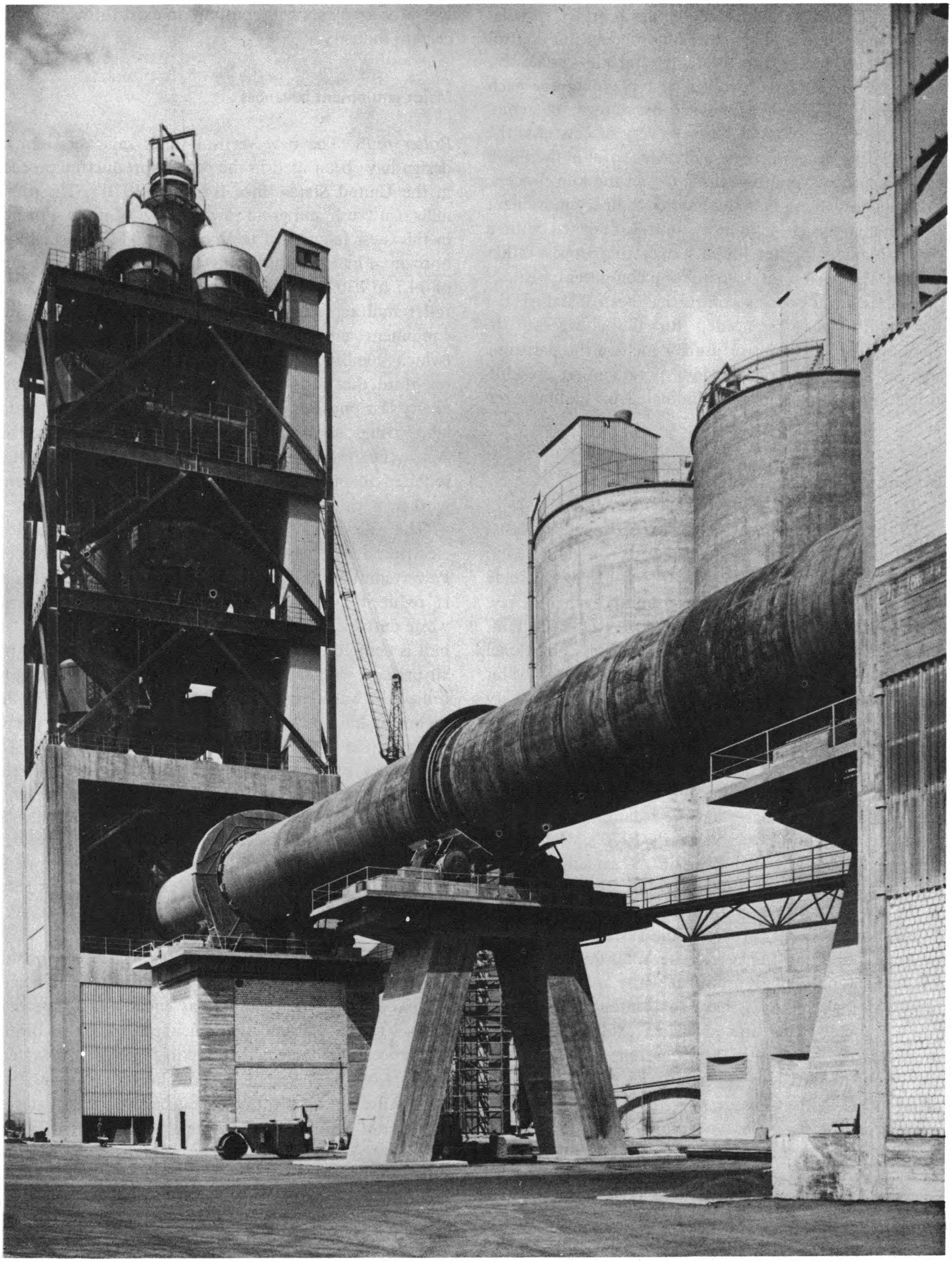
New technologies, primarily the vertical short-length preheater kilns and the larger roller mills designed to use less fuel and particularly to utilize waste heat, along with rapidly rising fuel costs, have substantially revised this rule of thumb. Dry process plants utilizing the latest preheater technology can now consume as little as half the energy required to produce a ton of cement in the wet process plants. Consequently, as of 1973-74, the dry process can be used for raw material with up to 15-20 percent water content, still consuming less fuel per ton of cement produced than in the wet process. Not all quarry raw material contains less than 20 percent water content, however, and not all quarry raw material has chemical and physical properties suitable for the dry production process. As a result, a substantial number of wet process plants will continue to exist throughout the cement industry.

Major equipment advances

Roller mills. The new vertical roller mills of German design have been used in the cement production process in the United States since the early 1970's. The roller mills can crush and grind raw material of up to 4 inches in thickness (compared to thicknesses of ½ to 1 inch for horizontal ball and tube mills) into fine powder at a rate of 115 to 130 tons per hour in one single operation. The roller mill replaces several older pieces of production equipment: crushers, impacters, and ball and tube mills (which combined have an output rate often as low as one-third that of the roller mill). Consequently, considerably less physical plant space is needed and substantial laborsavings are achieved once the roller mill is installed. Approximately only one worker per 8-hour workshift is required to operate the roller mill compared to several workers per shift for the older machines.[3]

The roller mill also consumes up to 30 percent less electric power than the ball and tube mills it replaces. Power consumption in the grinding process in particular is reduced by as much as 50 percent. In addition, waste-dust air pollutants are minimized since the roller mill is completely enclosed and operates under negative air pressure. Finally, the roller mill has been designed to utilize the waste heat of the suspension preheaters of the preheater kilns which has enabled many cement plants to switch to the less fuel consuming and less expensive dry process method of cement production. Raw material limitations as well as considerations of the energy efficiency of roller mill peripheral equipment such as fans, however, limit the extent of usage of the roller mill throughout the cement industry. Roller mills operate at their optimum with raw material which is moist, sticky, and relatively nonabrasive in composition.

Kilns. The trend since the 1950's to ever-increasing horizontal rotary kiln sizes, from 150-250 feet in length to 500-600 feet and longer, has ended for dry process kilns. The firm advent of the new suspension preheater dry process kiln system occurred in 1972-73. The system consists of a 4-stage counterflow heater, averaging 215 to 230 feet in height, built in successive vertical stages. The heater empties into an attached rotary kiln of about 150 to 220 feet in length. Heated exit gases from the kiln are drawn up through the preheater stages while the raw material feed is introduced at the top of the preheater. The feed comes in contact with the hot gases and the resulting heat exchange raises the feed mix temperature to approximately that of the kiln exit gases



The suspension counterflow preheater and short rotary kilns are coming into increasing use in the production of hydraulic cement.

at the kiln entry point. The high mix temperature allows the length of the kiln to be drastically reduced, since a high percentage of the mix has already been calcined prior to entering the kiln. In the long dry process kiln system, the kiln must be longer in order to effect a total calcination of the raw material inside the kiln.

The combination of efficient utilization of the waste gases and the shorter length of the preheater kiln results in substantial fuel savings in BTU per barrel, up to 40 percent less fuel usage in some instances, than in the comparable conventional long dry process kiln. Also, more efficient mixing and blending of the raw material feed occurs during the contact of feed and kiln exit gases in the preheater than usually takes place in the long kilns. Retention time of the raw material in the preheater kiln system is somewhat less than in the long kiln, but output capacities are essentially the same in both kiln processes, averaging approximately 2.25-3 million and 3 million barrels per year for the long and preheater kilns respectively. This could be changed, however, if a recent Japanese innovation developed and implemented in 1973-74, the reinforced suspension preheater or 'flash furnace', is adopted in the United States. Essentially a burner chamber located between the base of the preheater and the kiln, the furnace permits either greater output for the same kiln length or further shortening of kiln lengths.

Production and Productivity Outlook

Output

Output in the cement industry increased at an average annual rate of 2.3 percent between 1960 and 1973. This was less than the 1950-60 average of 3.2 percent a year and is under the long-term (1947-73) industry average rate of output of 2.6 percent (BLS data).

Total domestic output was insufficient to meet domestic demand in the early 1970's, and U.S. producers purchased large amounts of imported cement to supplement their output at full-capacity operation in order to satisfy this rising demand. Imports as a percent of total domestic consumption rose sixfold between 1960 and 1973 and nineteenfold between 1950 and 1973, ranging from 0.4 percent in 1950 to 1.2 percent in 1960, 1.3 percent in 1965, and 7.9 percent in 1973 (Bureau of Mines data).

In 1973 U.S. plants were operating full time at about 90 percent of capacity, the approximate maximum rate for efficient production of cement. This was a substantial improvement over the excess-capacity situation prevalent during the 1960's when U.S. plants operated at a low 77-80 percent of capacity.

Finished capacity in 1973 was 93 million tons a year (Cost of Living Council data), down from 95 million tons in 1969 (Bureau of Mines), despite the construction of new, large-capacity modern plants. The decline reflected the shutdown or slowdown of several inefficient older plants and the 2- to 3-year lead time needed to construct and start operation of a new plant. This downward trend came to a halt in 1972-73 and capacity is expected to climb throughout the 1970's and into the early 1980's. Industry capacity is expected to be as high as 112 million tons in 1983.[4]

Domestic demand for cement is expected to increase at a compound rate of 3 percent per year, reaching approximately 100 million tons per year by 1980-83.[5] Consequently, if industry operating rates average about 90 percent of capacity, domestic output may well meet domestic demand during the 1980-83 period.

Productivity

Output per man-hour (productivity) for all employees in the 13 years ending in 1973 rose by an average annual rate of 4.2 percent, while total man-hours declined 1.9 percent annually for the same period (BLS data). (See chart 4.)

For the 1960-73 period, the rate of increase in output per man-hour for the cement industry was substantially larger than the 3.4 percent average annual rate for all U.S. manufacturing industries (BLS data). This favorable rate of growth of output per man-hour in the cement industry is primarily due to the shutting down of old, outdated, and inefficient plants, the updating of some older plants with new laborsaving equipment, and the construction of new, large-capacity plants incorporating the latest machinery and equipment.

The ratio of payroll to value added remained relatively constant in the 1960-72 period (Census data). (See table 4.) Between 1968 and 1972 the ratio rose

Table 4. Indicators of change in the hydraulic cement industry, 1960-72

Indicator	Average annual percent change[1]		
	1960-72	1960-66	1966-72
Payroll per unit of value added	0.7	−0.3	1.1
Capital expenditures per production worker	4.6	2.1	[2]15.3

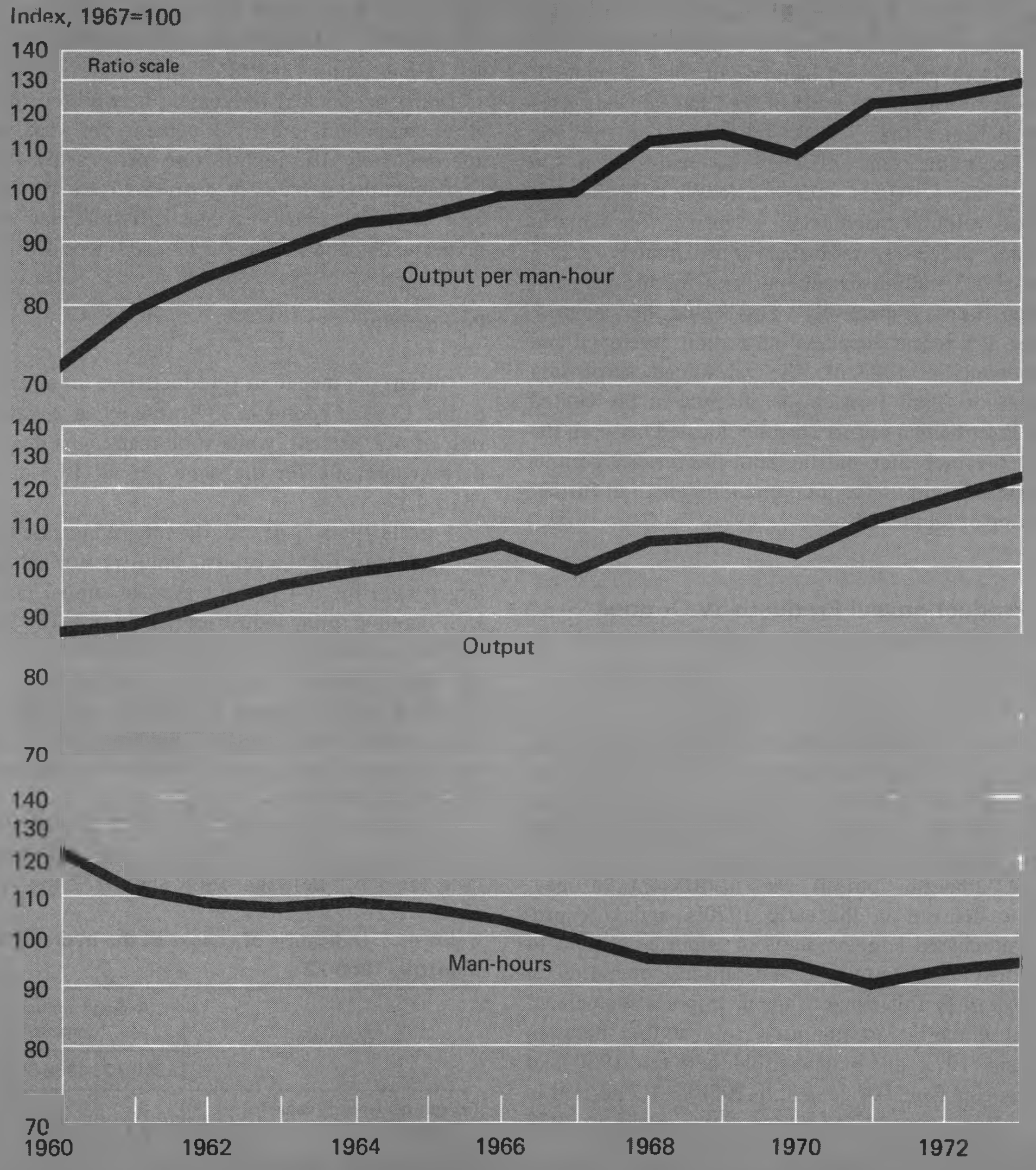
[1] Linear least squares trends method.

[2] For the subperiod 1968-72 the average annual rate of change was 29.1 percent.

SOURCE: Bureau of the Census.

Chart 4

Output per man-hour, output, and man-hours in the hydraulic cement industry, 1960-73



Source: Bureau of Labor Statistics.

slightly, reflecting higher wage costs and the changing composition of the cement industry work force, but it was still considerably below the 1960-70 average ratio of value added for all manufacturing industries, confirming that the cement industry is much more capital intensive than U.S. industry generally.

Best plant practice

While no general conclusions can be drawn from one year's data, some indication of the potential productivity levels for the cement industry is suggested by the difference between the productivity levels of the "most efficient" plants and the industry average. Census data are presented in table 5 for 1967 on average value added per production worker man-hour for the "most efficient" and "least efficient" plants of the cement industry. Although this measure has limitations, since plants may differ in productivity due to size, management, labor, capital outlays, and other factors, value added per man-hour is used here as an approximate indicator of productivity. The "most efficient" plants 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.

Capital expenditures for plant and equipment undoubtedly help to explain the existing differences in productivity levels among the plants, as can be seen in table 5. In the cement industry, average value added per production worker man-hour in the "most efficient" plants was almost 3 times greater in 1967 than in the "least efficient" plants, and almost 2 times greater than in the average plant. Capital expenditures per employee of the "most efficient" plants were over 1½ times those of the "least efficient" ones.

Table 5. Value added and capital expenditures in the hydraulic cement 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	2.97	1.71
Capital expenditures per employee	1.63	1.43

NOTE: Establishments 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 data from the Bureau of the Census prepared for the National Commission on Productivity and Work Quality.

Capital expenditures

Expenditures for plant and equipment rose from $114.3 million in 1960 to $179.9 million in 1972 (Census data), an average annual increase of 1.9 percent. Investment fluctuated during the 1960's; the high was in 1963, at $120.8 million, and the low was in 1968, at $67.6 million. Expenditures rose steadily after 1968, by an average annual rate of 27.8 percent for the 1968-72 period. Although price data are not available for the types of machinery and equipment used in cement production, the real increase in investment is probably considerably lower judging by price changes for all machinery and equipment over this same period.

Expenditures for plant and equipment per production worker rose at an average annual rate of 13.4 percent in the 1950 decade and at 4.6 percent annually between 1960 and 1972, although in the 1968-72 period these expenditures rose at the rate of 29.1 percent a year. (See table 4.) The rate for 1973-74 was estimated at 39 percent.[6]

Capital expenditures required to meet extensive air and water pollution control requirements for the cement industry are expected to total at least $122 million and possibly as much as $284 million during the 1972-76 period, with annual expenditures for this purpose estimated to rise from $3 million in 1972 to at least $43 million in 1976, according to both private industry sources and a government study.[7] According to an industry association estimate,[8] approximately 10 percent of total capital investment required to build new, large-capacity cement plants is spent on pollution control devices.

Funds for research and development

Expenditures for research and development (R&D) in the cement industry declined substantially from approximately $4.3 million or 0.4 percent of gross sales in 1958 to $3.2 million or 0.2 percent of gross sales in 1973, according to an industry estimate. R&D expenditures are expected to remain relatively constant at 0.2 percent of gross sales during 1973-75.[9]

Compared to other manufacturing industries, the cement industry's outlays for R&D are very small and are primarily concentrated on improving product quality and developing new products. R&D in new equipment technology, such as the large roller mill and the preheater kiln, has occurred almost exclusively abroad, primarily in Western Europe and Japan.

Employment and Manpower

Employment trends

About 29,800 persons were employed in cement plants in 1973, of whom approximately 24,300 were production workers. In 1960, about 39,400 were employed, of whom about 33,200 were production workers (Census data). This represents an average annual decrease of 2.1 percent for all employees and 2.4 percent for production workers in the 1960-73 period, an acceleration over the 1950-60 average annual rates of decline of 0.8 percent and 1.1 percent respectively.

The BLS projections for 1980 and 1985 (see introductory note for assumptions) indicate that employment in the industry may decline at an average annual rate of 2.2 percent between 1973 and 1985. Between 1973 and 1980, it may decline at an average annual rate of 1.7 percent, and for the 1980-85 period, at a rate of 2.9 percent. (See chart 5.)

Occupational trends

New types of equipment have eliminated many jobs—primarily those of production workers—as previously noted in the section on technology. Production workers dropped from 85.7 percent of all employees in 1950 to 81.5 percent in 1960 and 78.4 percent in 1973 (BLS data). The drop in production workers has occurred exclusively in on-line production occupations, primarily semiskilled operatives, transport equipment operatives, and laborers. The number of skilled craft workers providing maintenance, however, has remained essentially the same, dramatically increasing as a percentage of total production worker employment.

Trends in technology have brought about relatively minor changes in occupational requirements. These changes are primarily increases in the skills necessary for maintenance of new equipment such as roller mills and preheater kilns.

According to industry sources, the above trends are expected to continue throughout the 1970's.[10]

Centralized process control is responsible for the only major occupational change among the production workers. The semiskilled job of the control panel operator who monitored individual panels immediately adjacent to the various production processes scattered throughout the cement plant has been replaced by the console operator who monitors in one room a series of panels and consoles for all or a large part of the production processes. This is a highly skilled job requiring a thorough knowledge of all aspects of cement production and is generally the highest paid of all the production occupations.

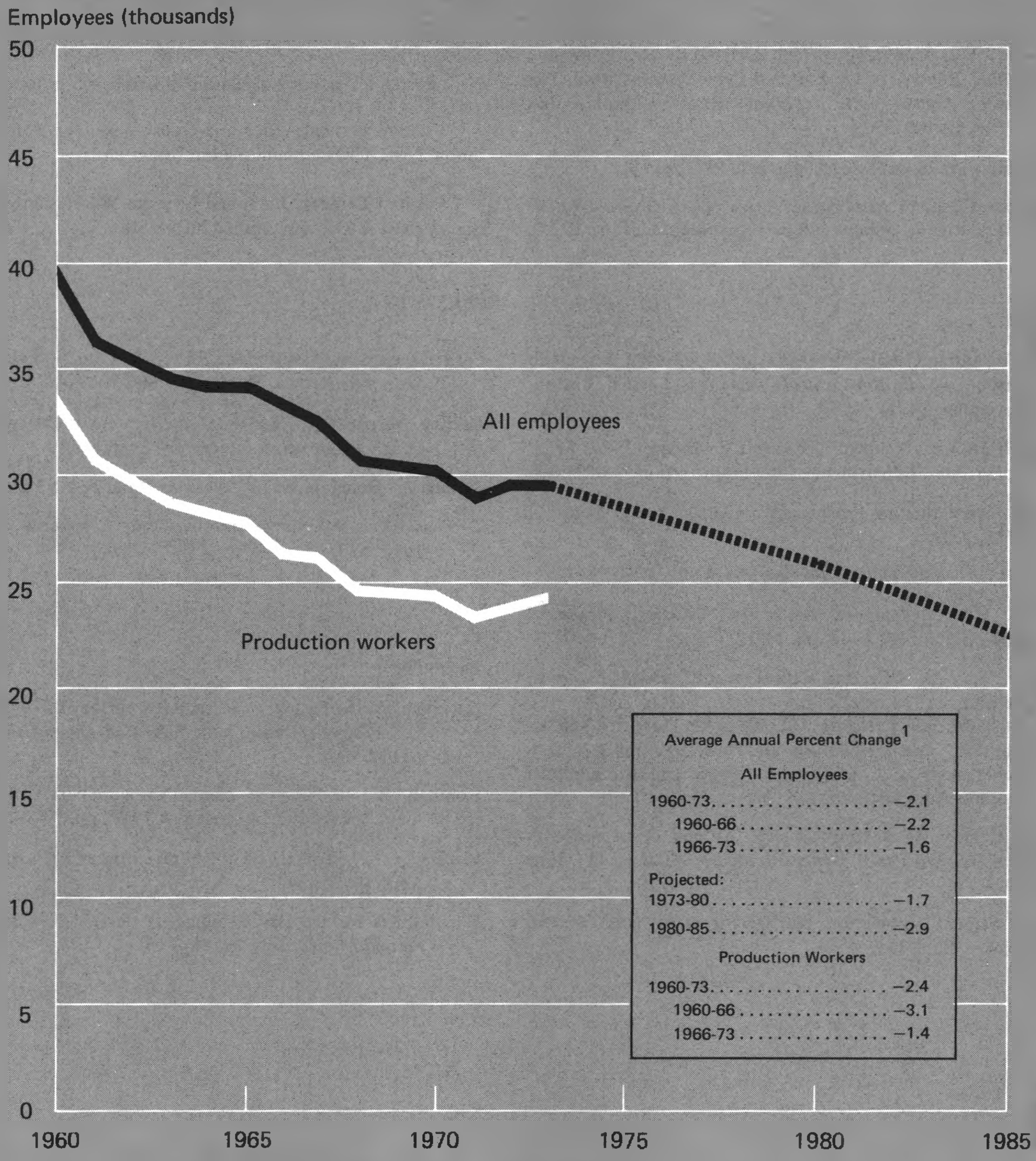
Adjustment of workers to technological change

The degree of union organization in the cement industry was estimated by the Bureau of Labor Statistics to be over 75 percent for all production workers in 1970. The average for all manufacturing was 44.3 percent. In 1974, at least 90 percent of all cement production workers were organized.[11]

The principal union organizing the industry, the United Cement, Lime and Gypsum Workers International Union (AFL-CIO), covers approximately 75 percent of the cement workers in the United States.[12] Available information indicates that labor and management, through collective bargaining, are giving more attention to the adjustment of workers to technological change. For example, the majority of agreements of the United Cement, Lime and Gypsum Workers International Union stipulate that workers will not automatically be terminated when "mechanization, automation, change in production methods, the installation of new or larger equipment or the combining or elimination of jobs" eliminates the need for employees on their regular jobs. Instead, affected employees have the right to apply for any jobs on which an incumbent has less seniority and for which they could reasonably be expected to qualify within a 90-day on-the-job training period. These workers are to receive a rate of pay no less than 95 percent of the rate for the regular job from which they are displaced. Employees with insufficient seniority to retain a job are either placed in layoff status with recall rights for all future job vacancies according to seniority status or are given stipulated cash termination benefits.

Chart 5

Employment in the hydraulic cement industry, 1960-73 and projected for 1980 and 1985



Average Annual Percent Change[1]	
All Employees	
1960-73	–2.1
1960-66	–2.2
1966-73	–1.6
Projected:	
1973-80	–1.7
1980-85	–2.9
Production Workers	
1960-73	–2.4
1960-66	–3.1
1966-73	–1.4

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

Source: Bureau of the Census and Bureau of Labor Statistics.

–FOOTNOTES–

[1] D. L. Thomas, "Concrete Improvements," *Barrons*, May 27, 1968, p. 3.

[2] Unpublished data based on BLS field visits.

[3] Unpublished data based on BLS field visits.

[4] Lehigh Portland Cement Company, *1973 Annual Report*, p. 13.

[5] Roy A. Grancher, "Cycling with Cement," *Rock Products*, December 1972, pp. 67–68; Lehigh Portland Cement Company, *1973 Annual Report*, p. 13; Portland Cement Association, *The U.S. Cement Industry–An Economic Report,* (Skokie, Ill., March 1974), pp. 28–30.

[6] *Engineering News Record*, March 7, 1974, p. 10.

[7] Portland Cement Association, *Energy Use and Conservation in the U.S. Portland Cement Industry* (Skokie, Ill., June 1974), p. 23; Chase Econometrics Associates, Inc., *The Economic Impact of Pollution Control, A Summary of Recent Studies*, prepared for the Council on Environmental Quality, the U.S. Dept. of Commerce, and the Environmental Protection Agency, March 1972, (See "Cement" summary).

[8] Portland Cement Association, *The U.S. Cement Industry–An Economic Report*, (Skokie, Ill., March 1974), p. 39.

[9] Portland Cement Association, unpublished information.

[10] Portland Cement Association, unpublished information.

[11] United Cement, Lime and Gypsum Workers International Union, (AFL-CIO), unpublished information.

[12] United Cement, Lime and Gypsum Workers International Union, (AFL-CIO), unpublished information.

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Steel

Summary

More widespread use of recent technologies and the introduction of newer technologies should tend to improve productivity gains in the steel industry (SIC 331). In general, these changes reduce unit labor requirements and alter occupational distribution and job content. Developments which may have an impact on the industry include the direct reduction of iron ore, the advanced basic oxygen process (Q-BOP), continuous casting, and computer process control. It is also possible that the combination of direct reduction, the electric-arc furnace, and continuous casting can, in time, substantially supplement the traditional system of steelmaking.

While investment in new plant and equipment was very heavy from 1964 to 1970, it fell sharply in the succeeding 3-year period. Some industry specialists believe that to meet expected demand in 1980, improve productivity, and reduce pollution, the industry would have to more than double the annual outlays of the 1960's for the rest of this decade.

Productivity advances were moderate from 1960 to 1973 (2.4 percent annually), but reflected very diverse movements over the 13-year period. While the average annual gain was 4.1 percent from 1960 to 1966, it declined to 0.5 percent annually in the next five years. In 1972 and 1973, however, productivity jumped 5.8 and 10.8 percent, respectively, as many of the conditions associated with the late 1960's changed.

Steel mills employed 607,800 workers in 1974, only slightly more than in 1973, but substantially above 1972, when employment was at the lowest point in the post-World War II period. Overall, from 1960 to 1974, the average annual rate of employment change was −0.3 percent. A projection by BLS (see introductory note for assumptions) suggests that steel employment may not change significantly by 1980.

Technology in the 1970's

Several innovations in steel manufacture have improved productivity and affected manpower. These can be divided into three types. The first includes machinery or techniques which have been widely adopted, such as the basic oxygen furnace. The second group includes technologies which are relatively newer and not yet widely used. One such example, the continuous casting process, is becoming more productive as technical operating problems are solved. The third type includes new technological breakthroughs, in some cases still in the pilot state, but which, it is thought, will be of importance in the future. This group includes the direct reduction process which bypasses the blast furnace operation. These and other innovations of the last few years, their manpower impact, and their general rate of diffusion are presented in table 6.

Iron manufacture

Blast furnace smelting—the first step in steel production—is the reduction of iron ore to iron with the use of coke as fuel. On completion, the molten iron is used in steelmaking furnaces. Although the basic production method has not changed, many significant improvements have greatly increased the efficiency of the process. These include sharply increased use of sintered ore and pellets of uniform high grade iron content, injection of hydrocarbons to partially replace coke, superlarge blast furnaces, higher operating pressure, and greater instrumentation (e.g., automatic fuel oil injection). In 1964, the largest blast furnaces in the United States produced 3,000 tons a day; in 1973 the rate was up to 6,000 tons.

Two large steel companies are currently installing modern giant blast furnaces designed to produce four times as much hot metal as the average furnace produces. These superfurnaces will probably require almost 50 percent fewer operators (keepers, first helpers, etc.), fewer unskilled laborers, and about the same number of supervisors as the regular blast furnace.

Coke is the fuel used with iron ore in the blast furnace to produce iron. It is "baked" from special grades of soft coal in long high narrow ovens; the solid matter left is cooled and becomes a very porous fuel. Several problems are associated with the coke ovens, in part because relatively little technological advance has

Table 6. Major technology changes in the steel industry

Technology	Description	Diffusion
Beneficiation and pelletization	Improves quality and uniformity of iron ore for use in blast furnace; forms pellets of uniform high grade from rock of low iron content. Changes improve productivity and reduce operating costs.	Pellets accounted for 47 percent of ore consumed in 1973;[1] 70 percent anticipated in 1980.[2]
Direct reduction process	Processes ore into pellets of 90-95 percent iron content by treating with hot reducing gases; mostly used in electric-arc steelmaking furnace.	Three installations in operation.
Basic oxygen process (BOP)	Steelmaking process using about 75 percent molten iron and 25 percent scrap in which oxygen is injected directly onto the iron, increasing the rate of reaction; 45 minutes to process a heat (the furnace capacity) compared with 9-10 hours for older open-hearth process. Requires roughly one-fifth the labor.	Accounted for 55 percent of production in 1973.[3] Expected to increase sharply by 1980.
Q-BOP	More productive refinement of the basic oxygen process; produces higher yields.	Two installations in operation. Still considered experimental.
Electric-arc furnace	Steelmaking process using 100 percent scrap or other solid-state iron; less capital required than for the oxygen process.	Accounted for about 18 percent of production in 1973;[4] expected to be 25 percent by 1980.[5]
Vacuum degassing	Removes impurities from the molten steel; increases manpower requirements but additional cost may be offset by increased yield.	Installed in a few mills.
Continuous casting	Steel is poured directly from furnace ladle into the caster from which it emerges a semifinished slab, billet, or bloom; requires 10-15 percent less manpower in this stage than traditional method for the same output by eliminating ingots and subsequent processes.	Accounted for less than 10 percent of steel produced in 1973;[6] by 1985 may approach 50 percent.[7]
Computer controls	Controls operations automatically; manpower requirements not significantly affected.	Less than 10 percent of all steel operations;[8] largest number in rolling mills.

[1] American Iron and Steel Institute, *Annual Statistical Report 1973*, pp. 65 and 72.

[2] H. Stuart Harrison, "Small Ore Pellets Help Keep U.S. Industry Competitive," *Steel Facts*, Summer 1973, p. 12.

[3] AISI, *Annual*, p. 53.

[4] Ibid.

[5] *Iron and Steel Engineer*, June 1971, p. 81.

[6] American Iron and Steel Institute, *Blast Furnace and Raw Steel Production*, AIS-7, Yearend 1973.

[7] *Iron Age*, April 1, 1974, p. 53.

[8] "Steel Takes Many Mini Steps in Control," *Iron Age*, April 5, 1973, pp. 63-68.

been made in several decades, other than the increase in size. These problems include the advanced age of equipment in the United States, serious gas and dust emission, and the high capital cost for modernization or new equipment. New coke ovens being built are considerably larger and are equipped with advanced pollution control equipment. In addition, several companies are experimenting with radically different cokemaking processes, which, if successful, will eliminate some of the problems associated with the ovens now in use.

One of the most important innovations in recent years—the direct reduction process (DR)—bypasses the coke oven/blast furnace smelting system. It reduces iron ore and ore pellets chemically, without melting, into products of 90-95 percent iron content for use in electric-arc steelmaking furnaces. These metallized products can be handled and stored easily in contrast with molten iron—the product of blast furnace smelting. Capital outlays for any of the available DR processes are lower than for the coke oven/blast furnace system, and less labor is required.

Only a few large-scale direct reduction facilities have as yet been installed in the United States. The technology is still developing, but at some future time, the direct reduction process could have sufficient capacity to be an important supplement to the blast furnace system. The growth of direct reduction plants will be affected by the availability and cost of different fuels, particularly natural gas. Some people in the industry believe the breakthrough will come when alternatives to natural gas are available through technologies such as coal gasification.

Raw steel production

The basic oxygen process (BOP) for making steel now accounts for 55 percent of production, surpassing output from open-hearth furnaces since 1970.[1] In the BOP furnace, oxygen is injected directly onto the molten pig iron and scrap and increases the rate of reaction, so that it takes about 45 minutes to process a "heat" compared with 9-10 hours with the older open-hearth process. The BOP requires roughly one-fifth the labor, largely that of semiskilled operators, while the open-hearth process requires many unskilled laborers for physical jobs. The BOP also requires a somewhat smaller investment and results in lower production costs because of greater productivity. On the other hand, the open-hearth furnace permits greater flexibility in the use of pig iron and scrap. Although still accounting for more than a fourth of U.S. steel production, the open-hearth process is expected to be slowly phased out.

The latest advance in steelmaking is the Q-BOP, a West German refinement of the BOP, which results in higher yields, according to some industry sources. This process can utilize slightly higher density scrap in place of hot metal—an advantage of particular importance when there is a shortage of domestic iron ore or ironmaking capacity. Also, the Q-BOP may be cheaper to build than the BOP. Although the amount of air pollution is reduced with Q-BOP, pollution control systems are nevertheless required. Manpower requirements are approximately the same for both. However, the industry is not in agreement on the advantages of the Q-BOP over the BOP, and by 1975 only two Q-BOP's were in operation.

Another very significant technological advance, the high power electric-arc furnace, can greatly increase the industry's productivity. Although not a new development, the electric furnace was being used in 1973 to produce 14 percent of carbon steel and 18 percent of all steel whereas in 1960, it accounted for 6 and 8 percent respectively.[2]

This process was considered more particularly suited for stainless and other specialty steels. Today, however, the major advantage of the electric furnace over the oxygen process in carbon steel production is that the former can use 100 percent scrap or pellets in place of hot metal. Recently, scrap was in short supply and interest in substituting the metallized pellets made by the direct reduction process (see description above) greatly increased.

The electric furnace, using scrap or metallized pellets, permits steel manufacture in smaller plants which are not associated with a blast furnace complex. In such miniplants, capital investment is lower and startup time may be one-fourth that of the BOP, but total operating costs may be higher. About 40 miniplants have been built since 1960, and they are becoming increasingly important in the industry.

Expectations are that the use of the electric-arc furnace will increase sharply in the next decade—to 25 percent of total steel production by 1980, according to one expert.[3] In combination with the direct reduction process discussed above, the electric furnace can, in time, greatly supplement the traditional steelmaking process.

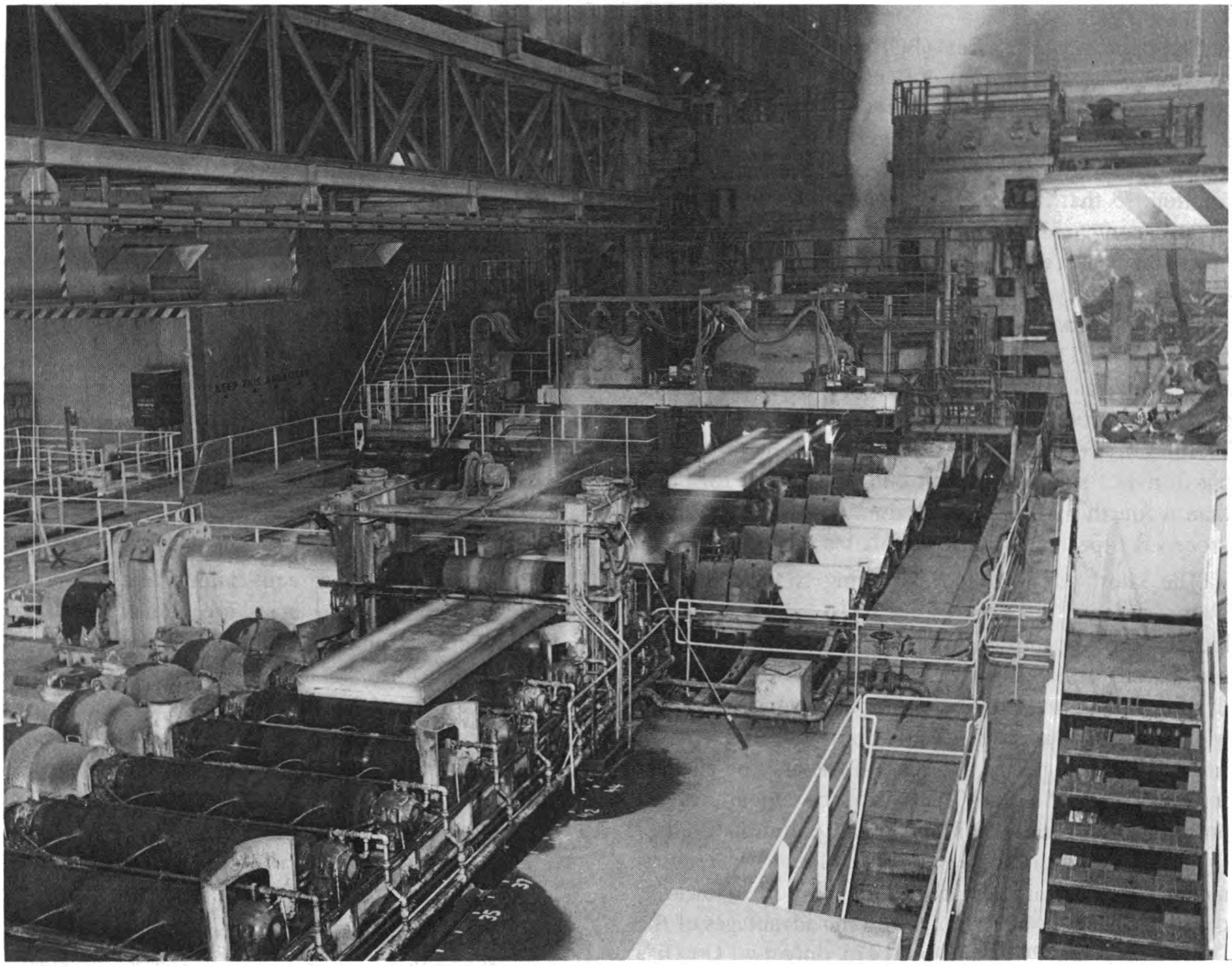
Vacuum degassing

Several new refining processes known as vacuum degassing are expected to have an impact on steel manufacture. In these processes, the steel is refined by degassing in vacuum chambers or other methods as it comes from the steel furnace and before it solidifies. This removes trapped gaseous impurities. Manpower requirements and refining costs are increased but are usually offset by savings in the finishing department. Of major importance is the fact that vacuum degassing may be combined with the BOP or the electric furnace process prior to continuous casting to improve quality and yield of semifinished steel products.

Continuous casting

Continuous casting, with considerable potential for increasing productivity, is gradually being incorporated into the steelmaking system. In this process, the steel is tapped from the furnace and poured directly into the continuous caster, from which it emerges a solid semifinished slab, billet, or bloom. In the traditional method, steel is poured into ingot molds; cooling, stripping, and reheating are required before the ingots can be rolled into a semifinished form. Originally installed only in minimills to produce small structural shapes and bars, continuous casting for larger shapes, plates, and sheets has now been installed in many mills.

Manpower requirements have been estimated to be roughly 10-15 percent less with continuous casting than with the ingot system for the same production. Unskilled and semiskilled workers, such as strippers and moulders, are not required. Nevertheless, it has not been very widely adopted because technical and operating problems have plagued the process; in 1973, less than 10 percent of steel was made by continuous casting.[4] Many of the problems, however, are now being solved and it is expected that by 1985 the proportion of steel made by continuous casting will be considerably greater, perhaps as large as one-half.[5]



Continuous casting process converts molten steel into solid slabs which are cut by remote control.

Rolling and finishing operations

The rolling and finishing processes which change the shape of the semifinished slab or bloom into a sheet, bar, or other structure are becoming more automated and continuous. The hot strip mills built in the 1960's incorporated very substantial technological improvements. These included sophisticated electronic controls, considerably greater speed, larger slab furnaces, automatic roll changing, and other such developments.

Computers

Computer use is increasing for both processing data and controlling operations. Nevertheless, a survey by *Iron Age* in 1973 showed that less than 10 percent of all steel operations of the respondent companies were computer controlled.[6] Rolling mills accounted for the largest number of computer installations. Minicomputers are widely used to control discrete functions or as satellites to a larger system. Although large computers will continue to grow in number, smaller controls such as minicomputers and programmable controllers will become increasingly important.

Hot strip mills are well suited for computer control because their operations are so complex. One of the newest hot strip mills, computer controlled from start to finish, requires only 32 workers on each shift compared to about 80 in older facilities. Automatic controls however, are prerequisites to computer control and are largely responsible for the reduction in manpower requirements.

Production and Productivity Outlook

Output

A record of more than 150 million tons of raw steel was produced in 1973, and shipments of steel mill products peaked at 111 million tons.[7] A slight decline occurred in 1974 as the economic slump affected the industry. The larger companies are vertically integrated from raw material to finished mill product, and may own and operate iron ore, coal, and limestone mines, coke ovens, iron and steelmaking furnaces, rolling and finishing mills, and large transportation facilities.

Output of steel rose almost steadily and sharply from 1960 to 1966, at an average annual rate of 6.2 percent (measured in tons, adjusted for product mix).[8] In contrast, the succeeding 7-year period was severely affected by economic slowdowns, production bottlenecks, and rapidly growing imports. Output fluctuated in those 7 years and increased an average of less than 1.0 percent annually. (See chart 6.) However, in the last year of the period, 1973, output registered more than a 13-percent increase, even as some steel products were in short supply. Over the entire period of 1960-73, steel production rose an average of 2.5 percent a year. As the economy slowed down in 1974, output dropped about 3 percent below 1973.

While the output growth rate was relatively low in the last decade, imports of steel mill products increased more than 5 times from 3½ million tons in 1960 to a peak of over 18 million tons in 1971. As a percent of apparent domestic supply (net tons), imports rose from 5 percent in 1960 to about 18 percent in 1971.[9] This upward trend in steel imports was associated with rapid increases in foreign steel capacity and slack demand abroad, foreign cost and exchange advantages, and technological problems in domestic production (see productivity section). However, by 1973, imports had declined to 15 million tons and 12½ percent of apparent domestic supply, as booming world demand reduced the availability of foreign steel and currency revaluations reduced its price advantage.

Some industry officials believe that demand may grow as much as 25-30 million tons to a total of about 180 million tons by 1980.[10] This would mean an output growth rate in the next 7 years slightly above the 1960-73 average and about 3 times greater than in the last 7 years. This outlook assumes greater domestic demand, lower imports, and adequate capacity.

Productivity

Productivity gains[11] were only moderate in the 13 years from 1960 to 1973 and were concentrated largely in the first half of the period. Output per man-hour of all employees in the basic steel sector increased at an average annual rate of 2.4 percent from 1960 to 1973, but reflected very diverse movements over the 13-year period. While the average annual gain was 4.1 percent from 1960 to 1966, it declined to 0.5 percent annually in the next 5 years. In 1972 and 1973, however, productivity jumped 5.8 and 10.8 percent respectively as many of the conditions associated with the late 1960's changed.

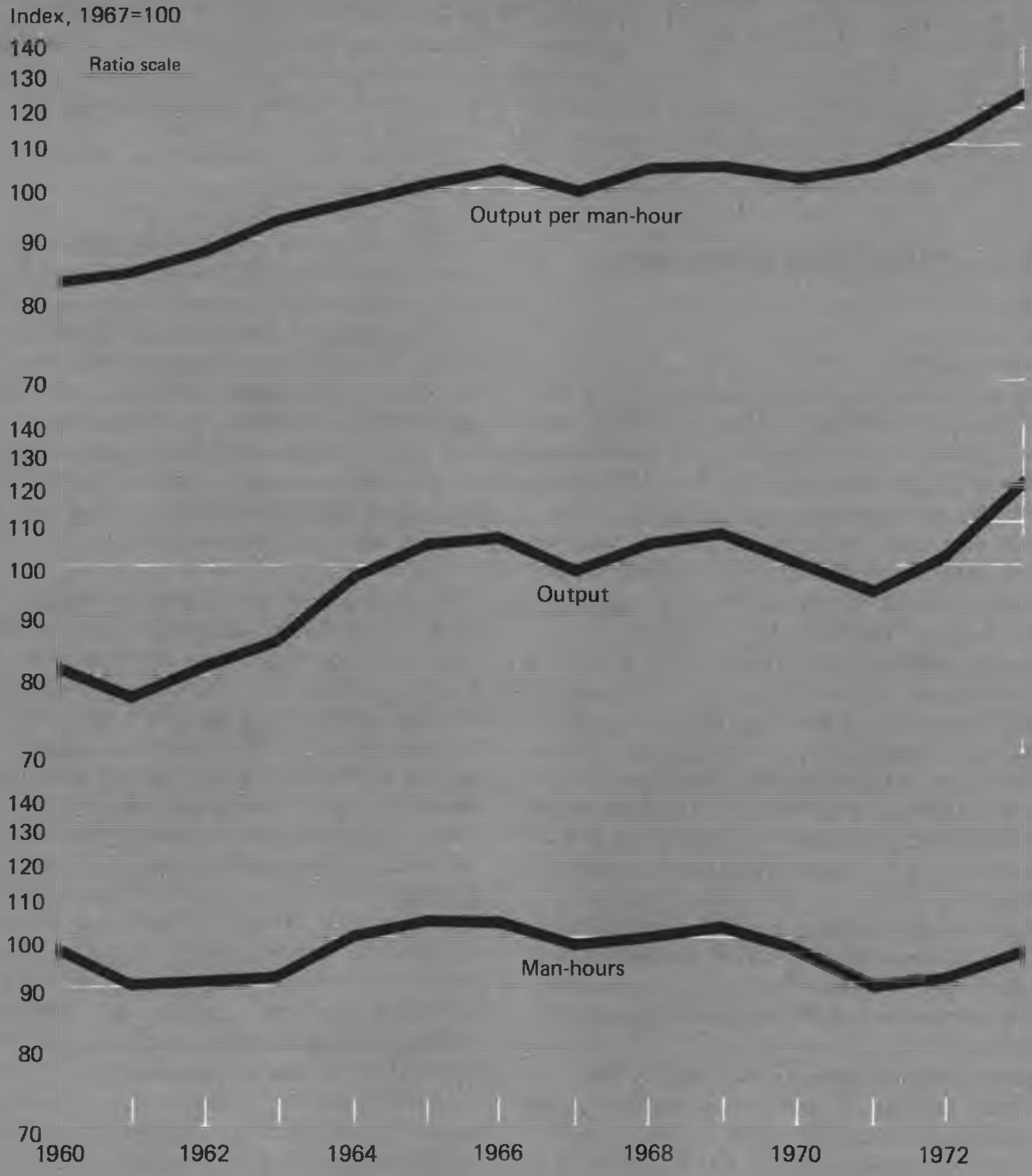
The low rate of productivity growth in the last 5 years of the decade occurred in spite of significant technological changes. Several reasons probably account for this, including the relatively low volume of output discussed earlier, which resulted in less than optimum capacity usage. In addition, however, the highly complex machinery installed in recent years has required a longer break-in period than had usually been necessary. While 5 years is generally considered the normal span between the initial capital expenditure and full-scale operation, many new facilities have involved more extensive delays in construction, startup, and debugging. For some new technologies, such as continuous casting, operational problems continued to limit potential productivity gains for years after installation. At the same time, the problem of integrating new and larger capacity machinery resulted in an imbalance in output.

In 1972 and 1973, many of these problems were overcome. The corner was turned on the optimum use of the equipment installed in the 1960's; demand strengthened and imports fell off; and the financial picture improved. In addition, the new labor-management agreement assured uninterrupted production.

In the last half of the 1970's, several factors will probably continue to affect productivity growth favor-

Chart 6

Output per man-hour, output, and man-hours in the steel industry, 1960-73



Source: Bureau of Labor Statistics.

ably, assuming relatively stable economic conditions: greater capital expenditures to round out modernization programs and thereby increase capacity, stronger demand, and more consistent and efficient operation of newly installed machinery.

Best plant practice

While no general conclusion can be drawn from one year's data, some indication of the potential productivity level for an industry sector is suggested by the difference between the productivity levels of the "most efficient" plants and the average plant in that sector.[12] Comparative data for 1967 are presented in table 7 on average value added per production worker man-hour. (Although the measure 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 two industry sectors for which 1967 data are available, average value added per man-hour in the "most efficient" mills was about 3 times larger than the average of the "least efficient" mills. Compared to the average mill, average value added per man-hour in the "most efficient" plants was about 1½ times greater.

The wide range in productivity levels within an industry sector may reflect differences in management, labor, capital expenditures, basic raw materials, and other factors. Unfortunately, data are not adequate to determine the relative importance of these factors.

Table 7. Value added per production worker man-hour in the steel industry[1]: Ratios of "most efficient" to "least efficient" plants and to average plant, 1967

Industry sector	"Most efficient" to "least efficient" plant	"Most efficient" to average plant
	(Ratios)	
Blast furnaces and steel mills	2.96	1.41
Steel pipe and tubes	2.89	1.58

[1] Data available only for the 4-digit sectors shown.

NOTE: Establishments in each sector were ranked by 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 data from the Bureau of the Census prepared for the National Commission on Productivity and Work Quality.

Investment

Capital investment in the steel sector was very heavy in the second half of the 1960's. Expenditures for new plant and equipment rose to a peak of almost $2 billion by 1968 (Census data), but then dropped back steadily to somewhat over $1 billion in 1971 and 1972 and only rose slightly in 1973.[13] From 1964 to 1970, expenditures averaged $1.6 billion and then fell sharply to an average of $1.2 billion in the succeeding 3-year period. Capital expenditures per production worker dropped at an annual rate of 6.3 percent in 1966-72, compared to a rise of 7.6 percent for 1960-66 (table 8). However, although prices of steel plant and equipment are not available, the very sharp rise in general machinery and equipment prices over this period suggests that real capital outlays in the steel industry increased considerably less than is shown by the current-dollar data and that the decline in recent years has been greater.

The sharp drop in investment in the last several years can be attributed in large part to unfavorable economic conditions. As mentioned earlier, imports have expanded sharply while domestic output and return on investment have fallen off.[14] This has reduced the incentive to continue the earlier high rate of investment. To some extent, the problem is a matter of investment timing. Some new technologies (for example, the oxygen furnace) became widely accepted in the United States only several years after they were already well established overseas,[15] and in the same time span between investment and effective operation, imports expanded. For example, in 1960, 3 percent of U.S. steel and about 12 percent of Japanese steel were produced by the basic oxygen process. By 1965, the BOP accounted for 17 percent of U.S. production but it constituted more than half of Japan's production. In 1971, the first year that the BOP accounted for more than 50 percent of U.S. output, the Japanese proportion produced by the BOP was 80 percent.

Table 8. Indicators of change in the steel industry, 1960-72

Indicator	Average annual percent change[1]		
	1960-72	1960-66	1966-72
Payroll per unit of value added	0.1	-2.5	2.1
Capital expenditures per production worker	3.6	7.6	-6.3

[1] Linear least squares trends method.

SOURCE: Bureau of the Census.

Recently, however the industry's financial position has improved and the pressure to invest is increasing. Capital expenditures in the next few years will aim to fulfill the estimated demand requirements for 1980 (25-30 million tons above 1973). How much additional capacity—and expenditures—this would require, however, is not clear. Estimates of raw steel capacity in 1973 vary, ranging from 155 million tons[16] to 180 million tons.[17] There appears to be more general agreement on the need for additional capacity "downstream", that is, in semifinishing and finishing operations, which would generally break bottlenecks in existing plants. This effort, known as "rounding out," could increase capacity substantially. By mid-1974, plans for capacity growth, primarily from rounding out and balancing, ranged up to 15 million tons.[18]

In addition, the industry must finance heavy expenditures for pollution control related to almost every process in production. Although annual outlays for pollution control averaged roughly 10 percent of capital outlays in the years 1969 through 1973, the problem continues to be serious.[19] The estimate of annual expenditures projected by the industry for the next several years is considerably greater than in those 5 years.[20]

Expenditures necessary to control pollution on older equipment may not be economically feasible. For example, some engineers believe it can cost a million dollars or more to equip a single open-hearth furnace with air-cleaning equipment, and many shops have 10-15 furnaces. The industry has the alternative of closing down the older marginal equipment rather than installing controls.

The outlook, therefore, is for larger capital outlays for rounding out and balancing production, for replacing obsolete equipment, for pollution control, and for expansion. Some specialists believe that to meet expected demand in 1980 the industry would have to more than double the annual outlays of the 1960's for the rest of this decade.[21]

Employment and Manpower

Employment trends

Steel mills employed 607,800 workers in 1974 (BLS data), only slightly more than in 1973 but substantially above (6.2 percent) 1972 when employment was at the lowest point in the post-World War II period. Overall, from 1960 to 1974, the average annual rate of employment change was –0.3 percent. (See chart 7.) While employment rose slowly (0.9 percent a year) from 1960 to 1966, it dropped by an average of almost 1½ percent annually from 1966 to 1974.

The general trend for production workers differed from that for nonproduction workers. Employment of production workers hit a peak in 1965 and then declined almost steadily till 1972, while nonproduction workers moved up steadily from 1964 to 1969 and then dropped sharply. In the period 1966-74, production worker employment fell almost twice as rapidly as did nonproduction worker employment. For the entire period 1960-74, production workers showed a small annual decline (–0.4 percent) while nonproduction workers rose slightly (0.3 percent).

According to projections by BLS for 1980 and 1985[22] (for assumptions underlying these projections, see the introductory note) steel employment would not change significantly from 1974 to 1980. Employment would decline from 1980 to 1985 (under the assumptions of these projections) by an average of about 0.5 percent annually.

Occupational trends

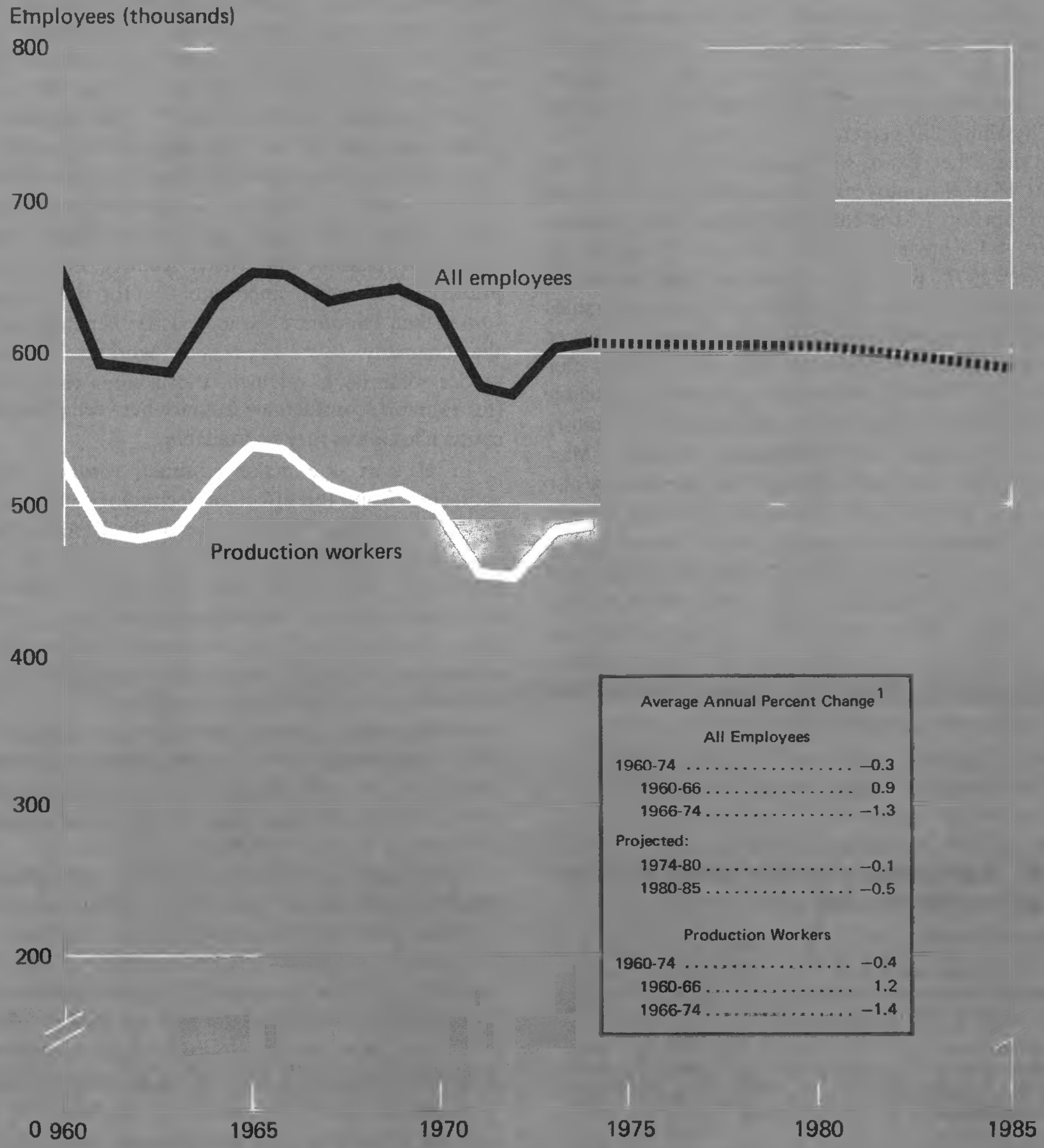
Job content and occupational requirements are being affected by changes in technology. Blue-collar workers (craft and kindred workers, operatives, and laborers) who constituted slightly more than three-quarters of all steelworkers in 1970, are expected to decline in number and as a proportion of the total industry work force by 1980. Of this group, craft and kindred workers, about a third of all steelworkers in 1970, are expected to remain the same in number but increase proportionately by 1980. More complex machinery and instruments tend to require craft and maintenance workers who are more highly skilled and trained, but not necessarily a greater number of workers.

On the other hand, the relative importance of operatives in the steel mill is slowly declining as machine speed, capacity, and automaticity increase. The more advanced oxygen furnace, for example, now takes one-fifth as much labor to process a heat as is required by the open-hearth process. It is expected that this trend will continue to reduce the proportion of operators—now less than 30 percent of all steelworkers.

The manpower implications of computer process control in blast furnaces, steelworks, and rolling mills were studied by BLS in 1969.[23] The major impact, according to this study, was a change in job duties rather than a change in the number employed. Job changes among operators generally consisted of a shift from manual to automatic control of dials, levers, and other control devices. Some operators were also trained to operate computer equipment. Among nonoperating workers, supervisors gained responsibility for computer

Chart 7

Employment in the steel industry, 1960-74 and projected for 1980 and 1985



Average Annual Percent Change[1]

All Employees	
1960-74	–0.3
1960-66	0.9
1966-74	–1.3
Projected:	
1974-80	–0.1
1980-85	–0.5
Production Workers	
1960-74	–0.4
1960-66	1.2
1966-74	–1.4

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

Source: Bureau of Labor Statistics.

equipment, recording clerks shifted to automatic data logging techniques, and electronic maintenance workers were trained to repair and maintain computer systems.

Unskilled jobs are being eliminated wherever possible as laborsaving devices are adopted. For example, more efficient blast furnaces using processed ores eliminate many unskilled jobs. This also applies to the use of the basic oxygen and electric furnaces in place of open-hearth furnaces. It is expected that continuous casting and other relatively new, more efficient operations will continue the pattern of reducing demand for unskilled labor. Service workers—only 3 percent of the industry work force—may also decline substantially from 1970 to 1980, by almost 30 percent.

On the other hand, white-collar workers, about 20 percent of steel employees, are increasing in number and as a proportion of the total. Professional and technical workers, who are expected to increase 10 percent by 1980 over 1970, will also constitute a larger proportion of the total. In general, the need for technically trained personnel is increasing with the use of more advanced instrumentation, computer controls, and pollution control devices. Growing technical occupations include process control engineers, programmers, laboratory testers, and research and development specialists. Managers, officials, and proprietors, and salesworkers are also expected to increase very substantially over the decade.

These changes are summarized in table 9 and chart 8, which show the Bureau of Labor Statistics projections of employment by occupation for 1980. While occupational changes reflect technological advances, they also reflect other industry and labor factors such as shifts in the importance of subindustries, changes in management organization, and the availability of labor.

Table 9. Employment in the steel industry by occupational group, 1970 and 1980[1]

(Percent distribution)

Occupational group	1970	1980
All occupations	100.0	100.0
White-collar workers	20.2	22.3
Blue-collar workers	79.8	77.7
Craft and kindred workers	33.3	35.0
Operatives	29.3	27.8
Laborers	14.1	12.6
Service workers	3.1	2.3

[1] Data are for blast furnaces and steel mills (SIC 3312) and the electrometallurgical products industry (SIC 3313).

SOURCE: Bureau of Labor Statistics.

Adjustment of workers to technological change

Over 95 percent of steelworkers are in plants covered by bargaining agreements with the United Steelworkers of America (USWA) and other unions. Many provisions for easing the workers' adjustment to technological changes are included in these contracts, although reference to "technological change" may not be made specifically. Basically, the major form of protection to the worker is the concept of seniority rights associated with layoff, recall, and transfer. Of particular importance is the interplant job opportunity program which gives laid-off workers the right, on the basis of seniority, to job openings in other plants.[24] The provision in a major agreement states: "An employee of a steel plant continuously on layoff for 60 days or more who had 2 or more years of company continuous service on the date of his layoff and who is not eligible for an immediate pension and social security shall be given priority over other applicants . . . for job vacancies (other than temporary vacancies) at other steel plants of the company . . ."[25] For such workers, continuous service seniority is retained, and in some circumstances (for example, considerable distance between plants) relocation allowances may be available.

In at least one major contract, earnings may be protected from the effect of technology changes. The agreement states: "The purpose of the Earnings Protection Plan is to protect a level of earnings for hours worked by employees, with particular emphasis on employees displaced in technological change . . ."[26] For those eligible under this protection plan, earnings are maintained at a certain percentage of the wages received in the base period preceding the change.

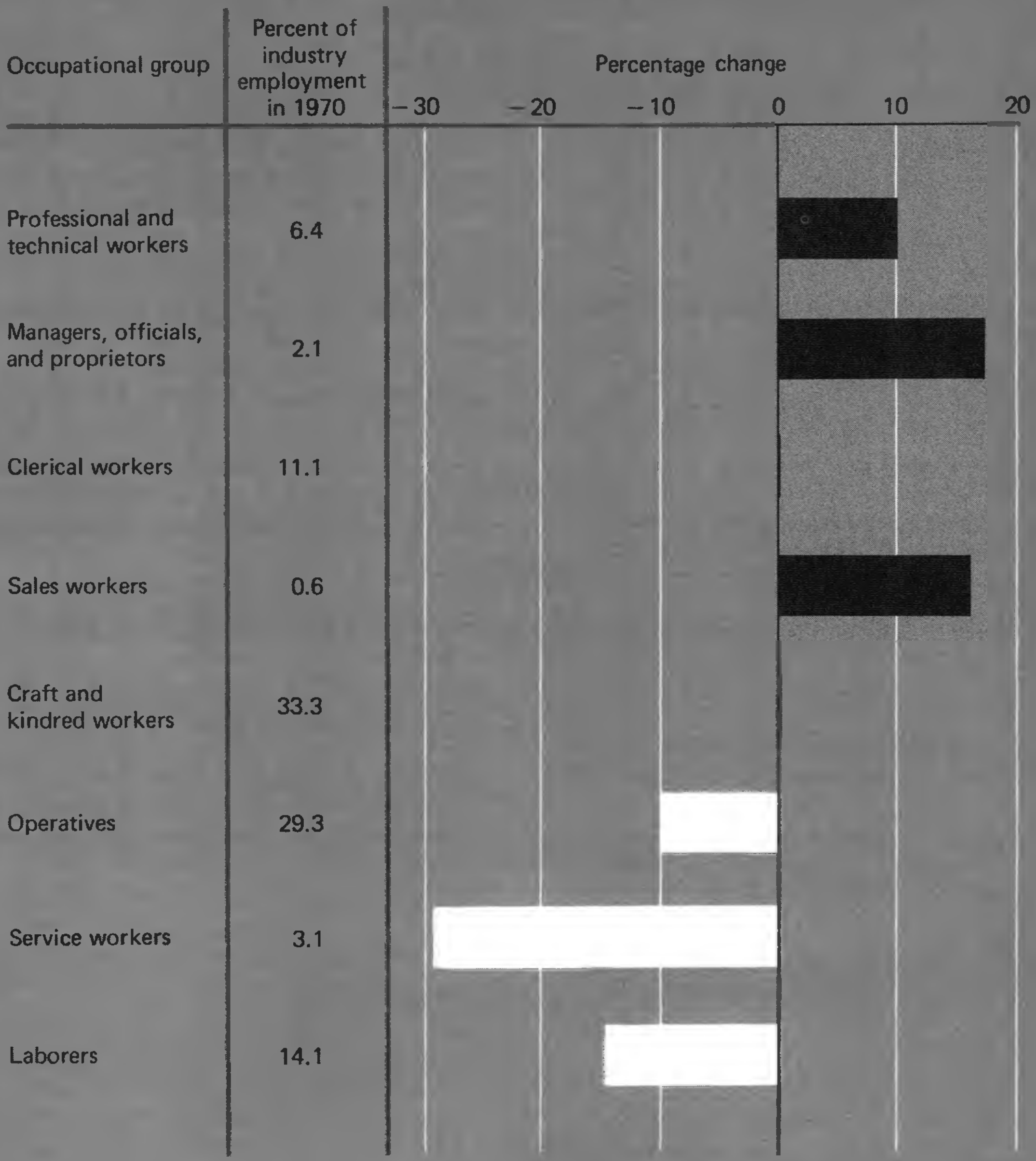
Worksharing is also used to protect the employee who might otherwise be laid off. In this system, under certain conditions, the total amount of work available is divided among all eligible employees to give them an average minimum of 32 hours per week.

In the event of layoff, supplementary unemployment benefits cover about nine-tenths of the production workers. These weekly benefits, for workers laid off or on a short workweek, were increased in the 1974 contract. In cases of permanent layoff or termination because of the introduction of new equipment or closing of a department or plant, provisions for severance pay cover more than four-fifths of the production workers.

Significant provisions exist in the area of early retirement available to persons who lose their jobs because of layoff or plant closings, known as the "70/80" pension provisions. With certain conditions, such workers may retire if age plus years of service total 70 or more for those retiring at age 55 or later, or total 80 for those who retire prior to age 55. Under this plan,

Chart 8

Projected changes in employment in the steel industry by occupational group, 1970 to 1980



Source: Bureau of Labor Statistics.

the worker receives a special payment in addition to the amount of the regular pension as an incentive to retire. Other early retirement provisions are also available.

Provisions to help ease the worker's adjustment may also include advance notice of changes. In 36 contracts covering 1,000 workers or more (involving 354,000 workers overall), only 3, covering fewer than 10,000 workers, have provisions requiring advance notice of technological changes. However, 17 contracts (covering 135,000 workers) require advance notice for shutdown and relocation or for layoff.

An unusual aspect of the 1971 and 1974 USWA agreements was the formation of joint advisory committees at the local level to improve productivity "and to meet the challenge posed by principal foreign competitors in recent years."[27] This pioneering effort by labor and management is concerned with furthering understanding of the need for productivity growth "so as to provide employment security and assure continued company growth."[28]

—*FOOTNOTES*—

[1] American Iron and Steel Institute, *Annual Statistical Report 1973*, p. 53.

[2] Ibid.

[3] *Iron and Steel Engineer*, June 1971, p. 81.

[4] American Iron and Steel Institute, *Blast Furnace and Raw Steel Production*, AIS-7, Yearend 1973.

[5] *Iron Age*, April 1, 1974, p. 53.

[6] "Steel Takes Many Mini Steps in Control," *Iron Age*, April 5, 1973, pp. 63-68.

[7] AISI, *Annual*, p. 8.

[8] *Indexes of Output Per Man-Hour, Selected Industries, 1973 Edition*, Bull. 1780 (Bureau of Labor Statistics, 1973), p. 61.

[9] AISI, *Annual*, p. 8.

[10] "The Smiles on the Faces of U.S. Steelmakers," *Business Week*, Sept. 14, 1974, p. 152.

[11] *Indexes of Output*, p. 60.

[12] Based on unpublished data prepared by the Bureau of the Census for the National Commission on Productivity and Work Quality.

[13] Data for 1960-72, Bureau of the Census; 1973 estimated by BLS. The Census data are for establishments. Expenditure data by the American Iron and Steel Institute are for companies.

[14] AISI, *Annual*, p. 13.

[15] American Iron and Steel Institute, Japan Iron and Steel Federation, and International Iron and Steel Institute.

[16] Edwin H. Gott, Chairman of the Board of the U.S. Steel Corporation, in a paper given at the Regional Technical Meeting of the Iron and Steel Institute, Nov. 9, 1972.

[17] Institute for Iron and Steel Studies, *Commentary*, December 1972, p. 4.

[18] "The Smiles on the Faces of U.S. Steelmakers," *Business Week*, Sept. 14, 1974, p. 152.

[19] American Iron and Steel Institute, *Steel Industry Economics and Federal Income Tax Policy*, Feb. 1974, table 14.

[20] American Iron and Steel Institute, *AISI News*, April 11, 1974.

[21] Thomas A. Schick, "Will There Be Enough Steel in 1980?" *Steel Facts*, Feb. 19, 1974.

[22] Based on projections in *The U.S. Economy in 1985: A Summary of BLS Projections*, Bull. 1809 (Bureau of Labor Statistics, 1974), table C-4.

[23] *Outlook for Computer Process Control*, Bull. 1658 (Bureau of Labor Statistics, 1970).

[24] Provisions noted are from the 1974 contracts with the United Steelworkers of America.

[25] *Agreement between United States Steel Corporation and the United Steelworkers of America*, Aug. 1, 1974, p. 108.

[26] *Agreement*, p. 66.

[27] *Agreement*, p. 203.

[28] *Agreement*, p. 204.

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Aircraft and Missiles

Summary

The introduction of new materials, equipment, and manufacturing processes may act to reduce labor requirements for clerical workers and laborers as well as improve the quality of the products of the aerospace industry (aircraft and parts, SIC 372, and missiles and space vehicles, SIC 1925). New materials such as structural composites are continually being developed and introduced into the industry to be used in the manufacture of aircraft, missiles, and space vehicles, resulting in improved product quality and changing manpower requirements. Further development of lasers should accompany the discovery of new applications for this technology. Simulation through the use of computerized models should continue to grow in importance while continued advances in forming and joining techniques can be expected.

Because of limitations in available data, definitive measurements of productivity in the aircraft and missiles and space vehicles industries are not available. However, Federal Reserve Board data for the aircraft component of the industry indicate that there was a steady upward rise in output during the 1960 to 1968 period. Man-hours also increased during this period but at a much slower rate. After 1968, both output and man-hours declined but the rate of decrease of man-hours exceeded that of output. For the 12-year period 1960-72 as a whole, output rose at a faster rate than man-hours. The trends in output and man-hours would thus seem to suggest that productivity in the aircraft industry has been improving both in periods of contraction and expansion, and that productivity should continue to improve in the 1970's.

Output of the missiles and space vehicles industry (Census data) reached a peak in 1966, declined to 1971, and turned upward slightly in 1972. The average annual rate of increase in output between 1960 and 1966 was considerably greater than the rate of increase in man-hours. Both output and man-hours decreased between 1966 and 1972 but man-hours decreased at a higher average annual rate. Thus, productivity in this component of the industry also appears to have increased during periods of both expanding and declining output.

Capital expenditures rose during the 1960 decade in the aircraft and parts industry. Expenditures grew rapidly from 1960 to 1967 but entered a period of decline after 1967. In the missiles and space vehicles industry, expenditures for plant and equipment reached a peak in 1968. As in the past, the future direction of capital expenditures will be heavily influenced by Federal Government decisions on spending for defense and space programs, since much of the industry's work is done on Federal Government contract.

Employment in the aircraft and missiles and space vehicles industries initially increased during the 1960-74 period but declined somewhat in the latter part of this period because of cutbacks in Federal spending. BLS projections for the aircraft industry (see introductory note for assumptions) indicate that employment may increase slightly between 1974 and 1980 and continue to increase to 1985. These increases merely represent a gradual recovery in employment, however, since even the projected employment figure for 1985 is well below the peak levels of the 1960-70 decade.

BLS employment projections for the missiles and space vehicles industry also indicate higher rates of increase between 1974 and 1985 than in the aircraft industry. But for this segment of the industry, too, the projected 1985 employment figure is below the peak employment levels of the 1960-70 decade.

Technology in the 1970's

The adoption of new technology in the aerospace industry may lead to further reductions in manpower requirements for laborers and for service and clerical workers. Technological developments will also continue to result in increasing the skill requirements for workers in the industry.

The aerospace industry is one in which technological changes in both products and manufacturing processes take place especially rapidly. Among the many new technologies recently introduced in the industry which should gain widespread usage are the development of new materials, new techniques of assembly and fabrication, the use of direct numerical control of machine tools, and the use of lasers for trimming resistors and for welding. (See table 10.) However, because the products of the aerospace industry are essentially custom-built and require limited quantities of many different parts, advanced equipment introduced must be flexible and capable of producing small quantities of items economically.

Materials

A major innovation is the development of advanced filamentary structural composites, materials which should become much more widely used. Many firms in the industry are now working in composites, developing fabrication techniques and learning more about approaches to design.

Cost per pound of the composites has been high

Table 10. Major technology changes in the aircraft and missiles industry

Technology	Description	Diffusion
Advanced filamentary structural composites	These new materials permit very large structural elements to be made in single pieces. Composites can be molded to exact dimensions, avoiding the high cost of machine tools required for machining metals. Their use also greatly reduces or eliminates the material wasted in scrap and can lower the weight of aircraft.	Recently introduced; use continues to expand.
Glass-reinforced plastic rotors for helicopters	These new rotors permit higher gross weights, altitudes, and airspeeds. Cost per pound should be comparable to metal rotors using automated production processes.	This is a new product and it has not yet had any impact on the industry.
Explosive bonding	In this process the clad metal is placed parallel to and a slight distance above the backer metal. The clad is propelled across the standoff space by detonating an overlayer of explosive. A plastic flow of the metal surfaces slightly ahead of the collision point and causes a jet to form. This removes surface films which can spoil the bond. Also, explosive bonding can eliminate the problem of brittle compound formation.	Already being used in the industry but the equipment is expensive and is only feasible for large production runs. The high cost is likely to hinder its rate of diffusion.
Bulge forming technique	This technique can cut manufacturing costs by 80 percent. It involves placing a cylindrical piece of annealed tubing in a die of the desired shape and then filling it with liquid or polyurethane. Advantages include elimination of joint strength problems and the need for welding.	Not in widespread use but its advantages may make it more popular.
Electrochemical machining	Electrochemical machining is a quick way to manufacture large jet parts. Metal is removed from a workpiece by means of a formed electrode. It makes deep cuts quickly and eliminates the need for many basic operations.	Use should continue to expand.
Numerical control	This process involves the automatic operation and control of machine tools by means of a system of electronic devices, servomechanisms, and coded tape instructions. It reduces errors and machining time and can cut unit labor costs.	Already widely used in the industry.
Adaptive control	A refinement of numerical control which allows a continuous automatic adjustment of the cutting process to compensate for such factors as vibration and temperature change. It increases machine productivity.	Adaptive control should become more widely diffused because of its advantages over numerical control.
Direct numerical control	This process uses a central processing unit to run the various machine tools. It has a number of advantages over numerical and adaptive control and users of these two may eventually switch to direct numerical control.	Direct numerical control equipment is already being used; usage is likely to expand in the future.
Lasers	Laser technology has continued to expand and lasers are now being used for such things as trimming resistors, balancing gyros, and welding.	Lasers are already widely used and their usage should continue to grow.
Computers for simulation	Computers are being used to create models which permit the study of dynamic systems. These models can be used in evaluating situations which could arise under actual conditions.	The use of computers for simulation could expand as techniques are further developed.

relative to other aerospace metals and will probably continue to be so.[1] There are offsetting factors, however, which have generated great interest in composites despite their high cost. Studies by a number of manufacturers have indicated that, on balance, costs are lower because making parts with graphite filaments eliminates the need for the expensive metalworking machine tools (and their operators) required by high performance metals.[2] Another advantage of the composites is that they greatly reduce or eliminate the material wasted in scrap.[3] For example, using graphite tape (composites normally appear in two forms—either as tape or in combination with metal in structural shapes) very large structural elements can be made in single pieces.[4] Little or no machining is necessary since composite structures can be directly fabricated to the final configuration.

Also, use of composites lowers the weight of aircraft.[5] Studies indicate that a wing employing composites would weigh 25 percent less than one made completely of light alloys. A fuselage containing 56 percent composites could be 20 percent lighter.

Glass-reinforced plastic rotors have been developed for helicopters which permit higher gross weights, altitudes, and airspeeds.[6] Initial production cost of the blades was high because they were handmade. However, automatic machining in certain processes could lower labor costs and, possibly, make the cost per pound of glass blades comparable to that of metal ones.

Explosive bonding, a technique which has already been proven commercially, is increasingly being applied to the joining of dissimilar metals in aerospace fabrication.[7] Presently used bonding techniques such as welding, brazing, and diffusion bonding can lead to difficulties with brittle compound formation—a problem that can be avoided with explosive bonding. The equipment used in explosive bonding is very expensive, however, and is only feasible for large production runs—a fact that may hinder its rate of introduction.

Assembly and fabrication

A new bulge forming technique led to an 80-percent reduction in manufacturing costs when it was employed by a manufacturer of jet aircraft.[8] These savings were realized in the process of making ducting of complex shapes. The process involves placing a cylindrical piece of annealed tubing in a die of the desired shape and then filling it with liquid or polyurethane. The liquid or polyurethane is then compressed, causing the tubing to be forced into contours of the die cavity so that it takes the required shape. After removing the shaped part from the die, trimming is all that remains to be done; no welding is needed. Also, problems with joint strength are eliminated. There are other advantages such as increased control over ducting thickness, smoother sections, and elimination of the need for pressure sizing after forming.

Electrochemical machining

Electrochemical machining is proving to be a quick way to manufacture large jet parts from refractory alloys and at the same time save on labor costs by eliminating the need for toolmakers.[9] For example, a certain steel fitting which normally needs a minimum of 3 hours of machining time can be made in 15 minutes with electrochemical machining. Likewise, a screw gear housing which previously required 6 hours of machine work can be fabricated in 90 minutes. With the electrochemical machining facility, metal is removed from a workpiece by a formed electrode. Deep cuts can be made quickly and to close tolerances. Use of electrochemical machining obviates the need for basic machining operations and their operators. These include shaping, planing, drilling, milling, boring, turning, and grinding. Supplemental processing such as stress relieving and deburring can also be eliminated. The use of electrochemical machining should continue to increase throughout the 1970's.

Numerical control of machine tools

Numerical control has gained widespread acceptance in the aerospace industry.[10] The highest penetration of numerical control (NC) machines has been in the aircraft industry. According to a private survey, in 1973, 4.3 percent of all machine tools in the aircraft industry were NC, up from 1.1 percent in 1968. About 2.2 percent of the machine tools in the aircraft engines and parts industry were NC, an increase from 1.6 percent in 1968.

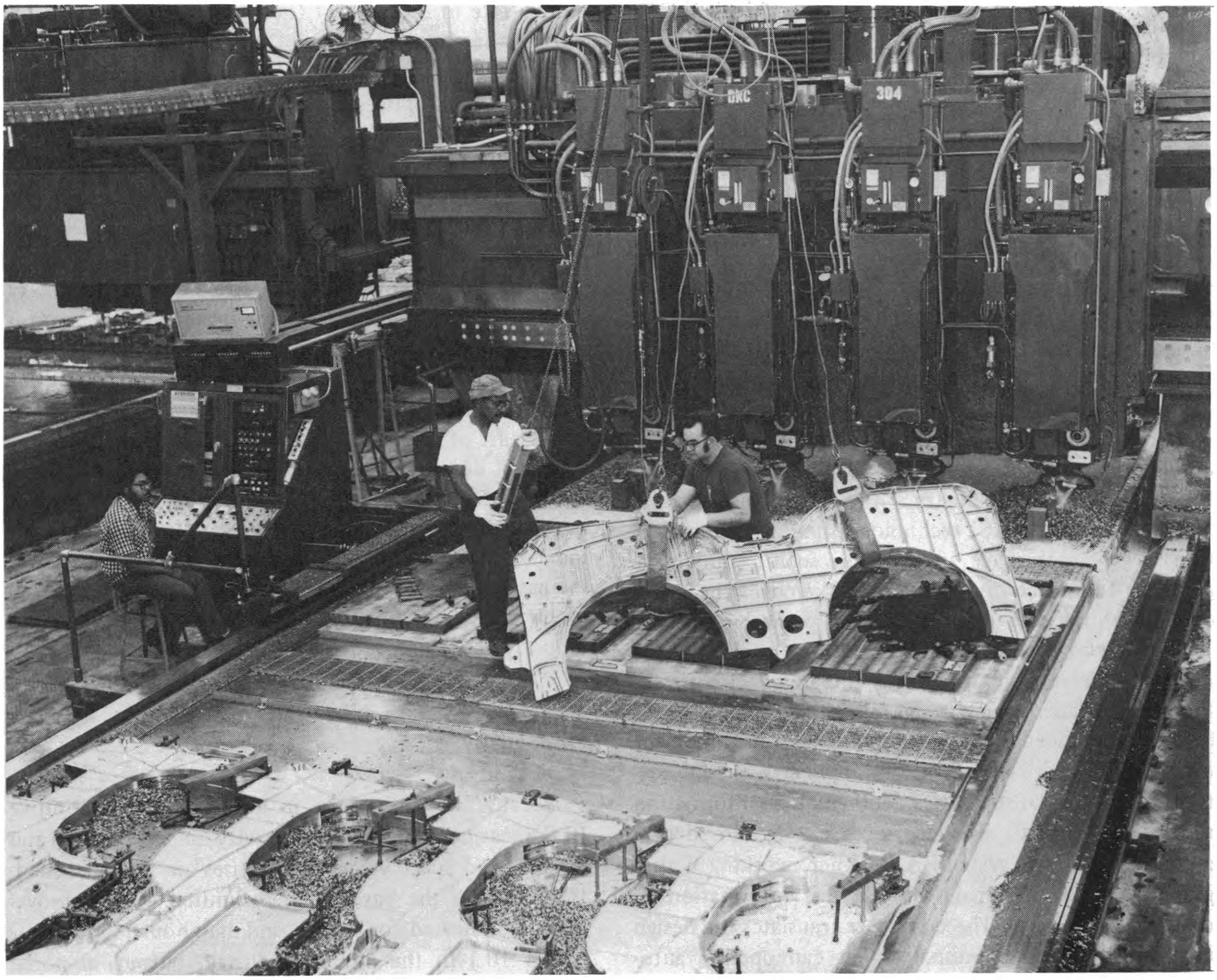
The NC process involves the automatic operation and control of machine tools by means of a system of electronic devices, servomechanisms, and coded tape instructions. Numerical control can reportedly reduce tooling and fixture costs by 70 to 80 percent in comparison with conventional machines. Machining time can be reduced by roughly the same proportion, and the number of errors can be cut in half. Machine utilization can also be increased, by as much as 200 percent, and savings of 25 to 80 percent in unit labor costs are possible.[11]

The numerical control process itself is being improved by the introduction of "adaptive control." This refinement allows a continuous automatic adjustment of the cutting process to compensate for such factors as vibration and changes in temperature. Adaptive control performs the function previously performed by the programmer or operator and has the advantage of increasing machine productivity.

Direct numerical or computer control, the use of a central processing unit to run the various machine tools, is becoming increasingly accepted. One advantage of direct numerical control is improved restart capability. When synchronization is lost between machine and control systems, the practice on machine tool numerical control systems is that the machine returns to a set point which has been inserted on the numerical control tape at intervals of 10-20 minutes. With direct numerical control, on the other hand, a reference point can be inserted by the computer in every data block representing a machine slide command. The machine tool can then return to this reference point, which may be a matter of minutes back from the break point instead of hours. As a result, more machine time is spent in cutting metal and less in traversing air.

Direct numerical control has the additional advantage of having a disk for data storage instead of the tape normally used for input to a numerically controlled machine. Disk storage eliminates the cost of tape, saves the time needed to make up a tape, and eliminates the need for a tape reader.

Also, direct numerical control greatly reduces the amount of electronic hardware needed, thus lowering the initial capital investment required for new machines and maintenance costs.[12] With direct numerical control, the tape reader and input logic and interpolation sections, which would be involved with numerical control, are transferred to the computer. The downtime which could be caused by a failure in any of these functions is reduced or eliminated so that machine utilization is improved. The computer also handles data much more rapidly than the control units on numerically controlled machines, resulting in better machine performance.



Direct numerical control of machine-tool cutting operations.

Laser technology

Lasers are gradually supplanting other methods used to trim resistors.[13] Resistors often have to be trimmed to size after they are superimposed on the circuit substrate. The laser has several advantages over the more commonly used trimming methods such as the diamond scribe, sandblasting, or electric arc. When lasers are used for trimming, the properties of the resistor remain largely unchanged. The laser is easy to operate and operators can be trained to perform accurate trimming in less than an hour.

Developments have been taking place in the use of lasers for welding. Lasers will weld metals such as stainless steel and titanium with less distortion than that produced by the currently used electron beam processes in materials up to 0.1 inch in thickness. Successful welding, without distortion, of such nonferrous metals as aluminum and beryllium copper has been done on thicknesses up to .05 inch.[14] Another advantage of laser welding is that it involves fewer variables than other welding processes, resulting in greater uniformity in the product. Also, skill requirements are lower with the laser welding system than with the electron beam process.[15]

Computers

Use of computers for simulation—the use of models to aid in studying dynamic systems—is very important in the aerospace industry for design, development, and evaluation. This makes possible optimization of systems and subsystems to certain criteria before building any hardware.[16]

Large-scale integration (LSI) represents an important development in electronics which may prove significant for the aerospace industry. Already in use in the computer industry, LSI technology should find application in the aerospace industry in such products as guidance computers for missiles. LSI removes the inherent limitations of a two-dimensional plane by stacking electronic component elements on top of each other. It increases the complexity of the integrated circuit and thus increases performance and reliability.[17]

Computer-aided design techniques are an important innovation which can be broadly applied to the fabrication of all types of structures. Mathematical information representing aircraft body surfaces can be stored in a computer memory system. A designer, working with a graphic display terminal, can use this information to design aircraft parts. The computer translates the design into mathematical coordinates that can operate automatic drafting machines and numerically controlled machine tools. It is especially useful for predicting the behavior of composite materials in complex stress applications. These techniques could affect manpower requirements and productivity in composites by decreasing the amount of hand labor and the number of rejected parts. While this innovation should result in increasing the need for computer programmers, it should reduce the need for engineers, drafters, tool and die makers, and machinists. The application of nondestructive testing techniques such as laser holography, acoustic emission, and advanced ultrasonic and infrared imaging could also reduce labor requirements and increase productivity.

Production and Productivity Outlook

Output

Output in the aircraft industry increased at an average annual rate of 3.2 percent (Federal Reserve Board data) during the 1960-73 period. The rise was not steady, however. From 1960 to 1968 output increased at an average annual rate of 10.9 percent. This contrasted sharply with the 1968-73 period during which output decreased at an average annual rate of 9.4 percent. The 3.2 percent average annual rate of increase for the 1960-73 period was still above that for the preceding 1954-60 period when output actually decreased.

Output in the missiles and space vehicles industry increased at an average annual rate of 1.7 percent (Census data) during the 1960-72 period. Output peaked in 1966, however, so the increase in output over the 1960-72 period was not steady.

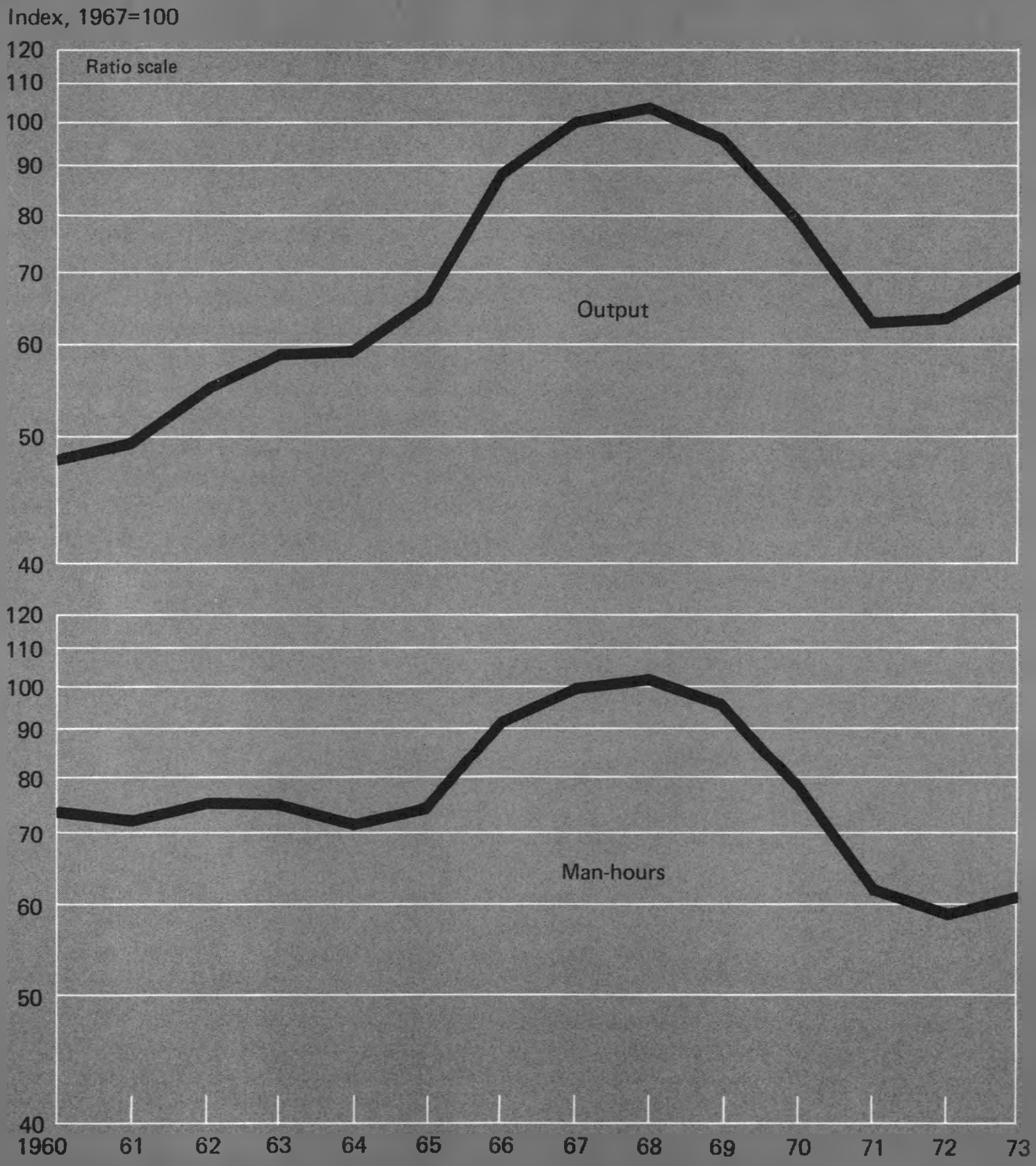
As part of its general set of economic projections, the BLS has developed estimates of growth in output to 1980. These are projections of what the economy might be like under certain conditions. These projections indicate that the output of the aircraft industry will increase at a rate of roughly 7.6 percent per year from 1973 to 1980, and that of the missiles and space vehicles industry at 3.8 percent per year.

Productivity

Because of limitations in available data, definitive BLS measurements of productivity in the aircraft and missiles and space vehicles industries are not published. However, on the basis of these limited data, improvement is indicated for output and man-hours. (See charts 9 and 10.) In the aircraft industry, output, as noted earlier, rose at an average annual rate of 3.2 percent from 1960 to 1973 (Federal Reserve Board data) while

Chart 9

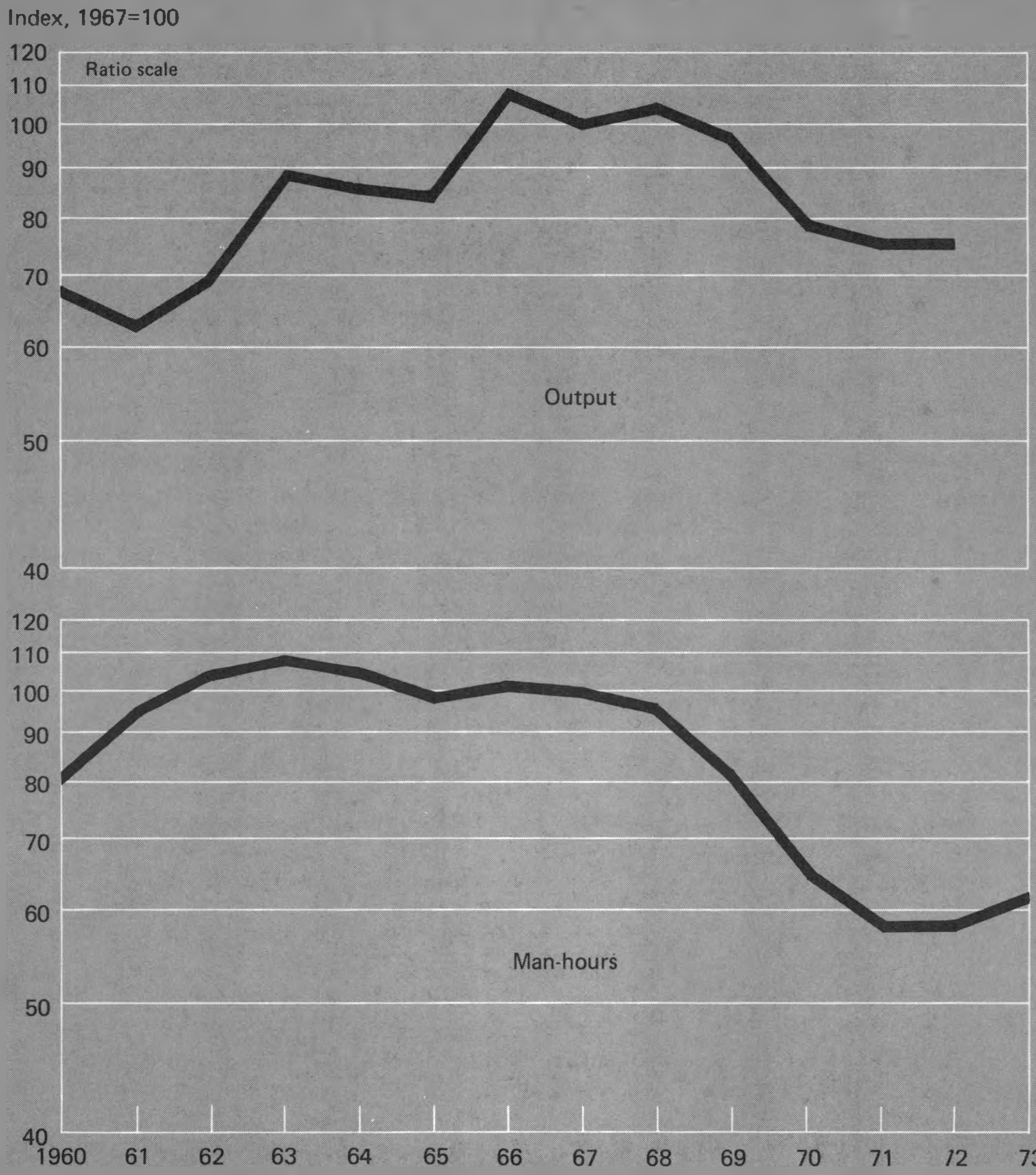
Output and man-hours in the aircraft and parts industry, 1960-73



Sources: Board of Governors of the Federal Reserve System and Bureau of Labor Statistics.

Chart 10

Output and man-hours in the missiles and space vehicles industry, 1960-73



Source: Bureau of the Census and Bureau of Labor Statistics.

man-hours decreased at an average annual rate of 0.8 percent from 1960 to 1973. Similarly, output in the missiles and space vehicles industry rose at an average annual rate of 1.7 percent between 1960 and 1972 while man-hours decreased at an average annual rate of 4.2 percent.

Best plant practice

Some idea of the potential productivity level for each subindustry can be gained by finding the difference between the productivity levels of the most efficient plants and the average for the subindustry group. Data on value added per production worker man-hour in 1967 for the "most efficient" and "least efficient" plants in three subsectors of the aircraft industry are presented in table 11. The productivity indicator used here is value added per man-hour. "Most efficient" plants are defined as those which fall into the highest quartile of plants when ranked by 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 4½ to a little over 3½ times greater than in the "least efficient" plants. This represents a considerable increase in the ratios over those which existed in 1958 (for the two industry subgroups for which data were available). In 1958, value added per production worker man-hour in the "most efficient" plants varied from 2 to a little less than 3 times greater than in the "least efficient" plants.

The 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 11 shows that the "most efficient" plants in nearly every case spent more on plant and equipment per employee in 1967 than either the "least efficient" plants or the average plant in every sector shown.

Investment

Capital expenditures

Expenditures for plant and equipment in the aircraft industry (Census data) rose from $179.2 million in 1960 to $236.9 million in 1971, at an average annual rate of increase of 8.0 percent. The growth in capital expenditures was not steady, however. Over the 1960-67 period, these expenditures grew rapidly, increasing at an average annual rate of 21.1 percent. After peaking in 1967 at $798.9 million, capital expenditures decreased, thus lowering the average annual rate of increase for the 11-year period to 1971.

Capital expenditures data for the missiles and space vehicles industry are available only for the period 1963-69; however, these data reveal a trend in capital expenditures similar to that in the aircraft industry. Expenditures increased from $48.8 million in 1963 to a high of $117.1 million in 1968. In 1969, these expenditures dropped to $88.8 million.

The increasing importance of capital relative to labor is reflected in the changing ratio of payroll to value added. (See table 12.) In the aircraft industry, this ratio declined from 1960 to 1971 at an average annual rate of 1.8 percent. In the missiles and space vehicles industry,

Table 11. Value added and capital expenditures in the aircraft and parts 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)			
Aircraft	4.54	1.28	([1])	1.20
Aircraft engines and engine parts	4.05	1.58	1.06	.97
Aircraft equipment not elsewhere classified	3.57	1.65	1.44	1.04

[1] Not available.

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 data from the Bureau of the Census prepared for the National Commission on Productivity and Work Quality.

Table 12. Indicators of change in the aircraft and missiles industry, 1960-71

Indicator	Average annual percent change[1]		
	1960-71	1960-66	1966-71
Payroll per unit of value added:			
Aircraft and parts	–1.8	–1.7	–1.8
Missiles and space vehicles	(2)	(2)	–0.3
Capital expenditures per production worker:			
Aircraft and parts	8.8	17.3	–10.6
Missiles and space vehicles	(2)	(2)	–7.1
Research and development expenditures as a percent of net sales[3]	–4.2	1.9	–6.5

[1] Linear least squares trends method.

[2] Not available.

[3] For companies in the combined aircraft and missiles and space vehicles industries which have research and development programs. Separate figures for each industry were not available.

SOURCES: Department of Commerce and National Science Foundation.

the ratio declined from 1966 to 1971 at an average annual rate of 0.3 percent. (Data were not available for the entire 1960-71 period.)

Funds for research and development

Research and development (R&D) is especially important in the aircraft and missiles and space vehicles industries. (Data on R&D expenditures are available only for these industries combined.) According to the National Science Foundation, outlays for R&D increased from $3.5 billion in 1960 to $5.9 billion in 1969 before dropping to $4.9 billion in 1971. The average annual rate of increase over the 1960-71 period was 3.8 percent. Comparable R&D data for the entire 1950-60 period are not available, but from 1956 to 1960 R&D expenditures increased steadily from $2.1 billion to $3.5 billion.

Federal Government spending plays an important role in the research and development activities of the aerospace industries. According to the National Science Foundation, Federal Government spending for research and development in 1972 in the aerospace industries was more than 4 times as great as company outlays.

Employment and Manpower

Employment trends

Employment in the aircraft and missiles and space vehicles industries declined in the overall 1960-74 period. As can be seen in charts 11 and 12, the decline was not steady. In the aircraft industry, total employment increased from 627,900 in 1960 to a peak of 852,000 in 1968 before dropping off to 532,100 in 1974. The average annual rate of decrease of total employment in this industry was 1.0 percent for the 1960-74 period.

In the missiles and space vehicles industry, total employment declined from 128,200 in 1960 to 91,000 in 1974. The average annual rate of decline for this period was 4.9 percent. Total employment reached a total of 172,600 in 1963 before starting a relatively steady decline which bottomed out in 1972 at 84,600.

The average annual rate of decline in production worker employment in each industry was greater than the rate of decline in total employment. In the aircraft industry, the number of production workers declined at an average annual rate of 1.5 percent, from 369,600 in 1960 to 290,500 in 1974, compared with a 1.0 percent decline for all employees. Employment of production workers in the missiles and space vehicles industry fell from 48,500 in 1960 to 24,300 in 1974, an average annual rate of decline of 6.8 percent. The corresponding rate of decrease for all employees in this industry was 4.9 percent.

BLS projections (see introductory note for assumptions) indicate that employment in the aircraft industry may increase between 1974 and 1980 at an average annual rate of 1.0 percent, reaching 565,000 in 1980. The projections for the missiles and space vehicles industry indicate a considerably faster rate of growth between 1974 and 1980, at an average annual rate of 4.7 percent, to 120,000 in 1980. Projections to 1985 indicate continuing growth, with employment reaching 600,000 in the aircraft industry and 143,000 in the missiles and space vehicles industry.

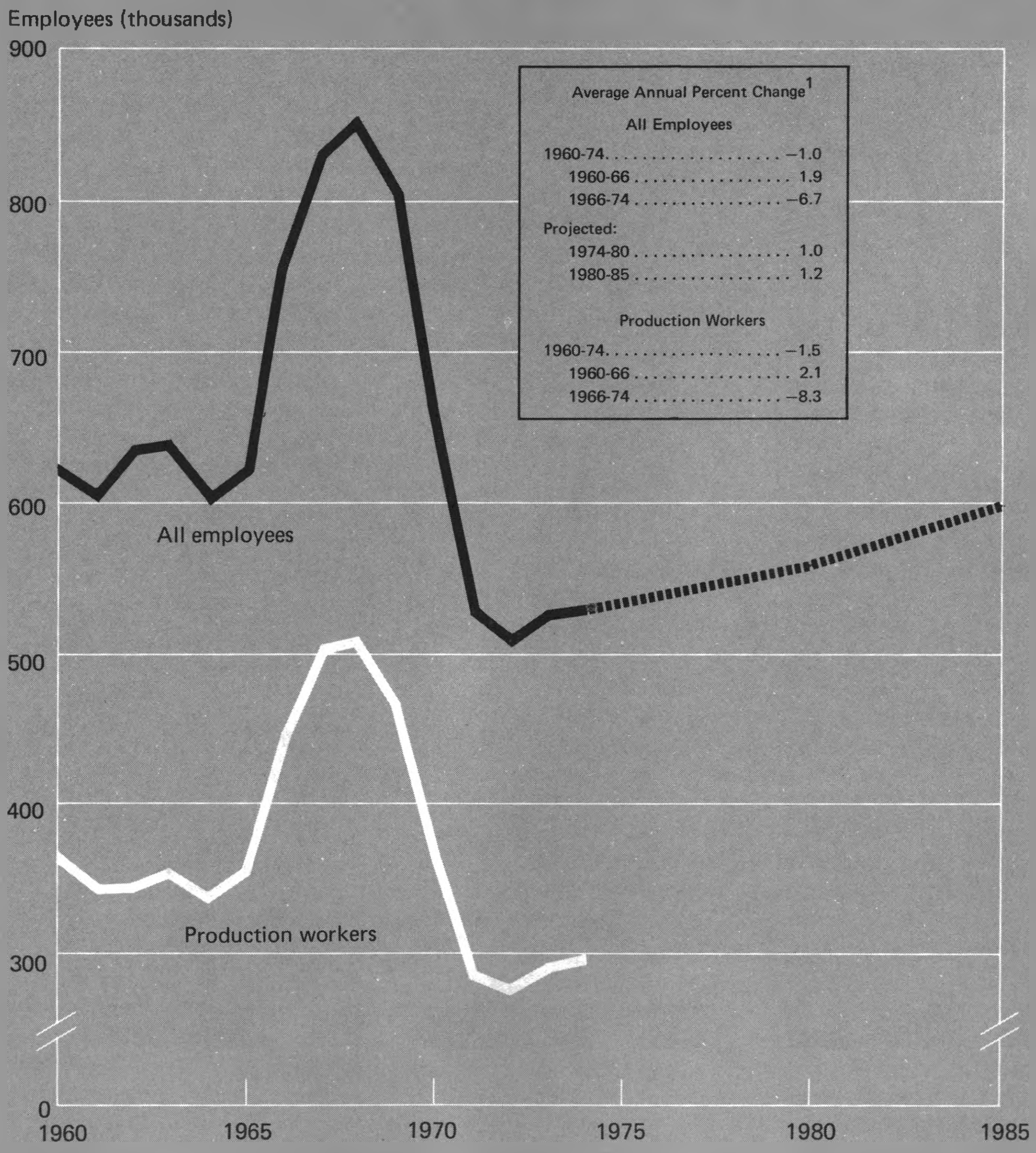
Occupational trends

Skill requirements have changed for the workers using numerically controlled (N/C) machine tools. For example, the programmers for this equipment require a strong background in mathematics and a good grasp of the principles of cutting and tooling. For N/C machine tool operators, however, less knowledge is now needed as judgments and decisionmaking concerning such things as speeds, feeds, and width and depth of cut are being made by the programmer and are transferred to the tapes which actuate the N/C tools.

The continuing expansion of knowledge in the industry should lead to more specialization for engineers, scientists, and technicians. Because of the extent

Chart 11

Employment in the aircraft and parts industry, 1960-74 and projected for 1980 and 1985



Average Annual Percent Change[1]

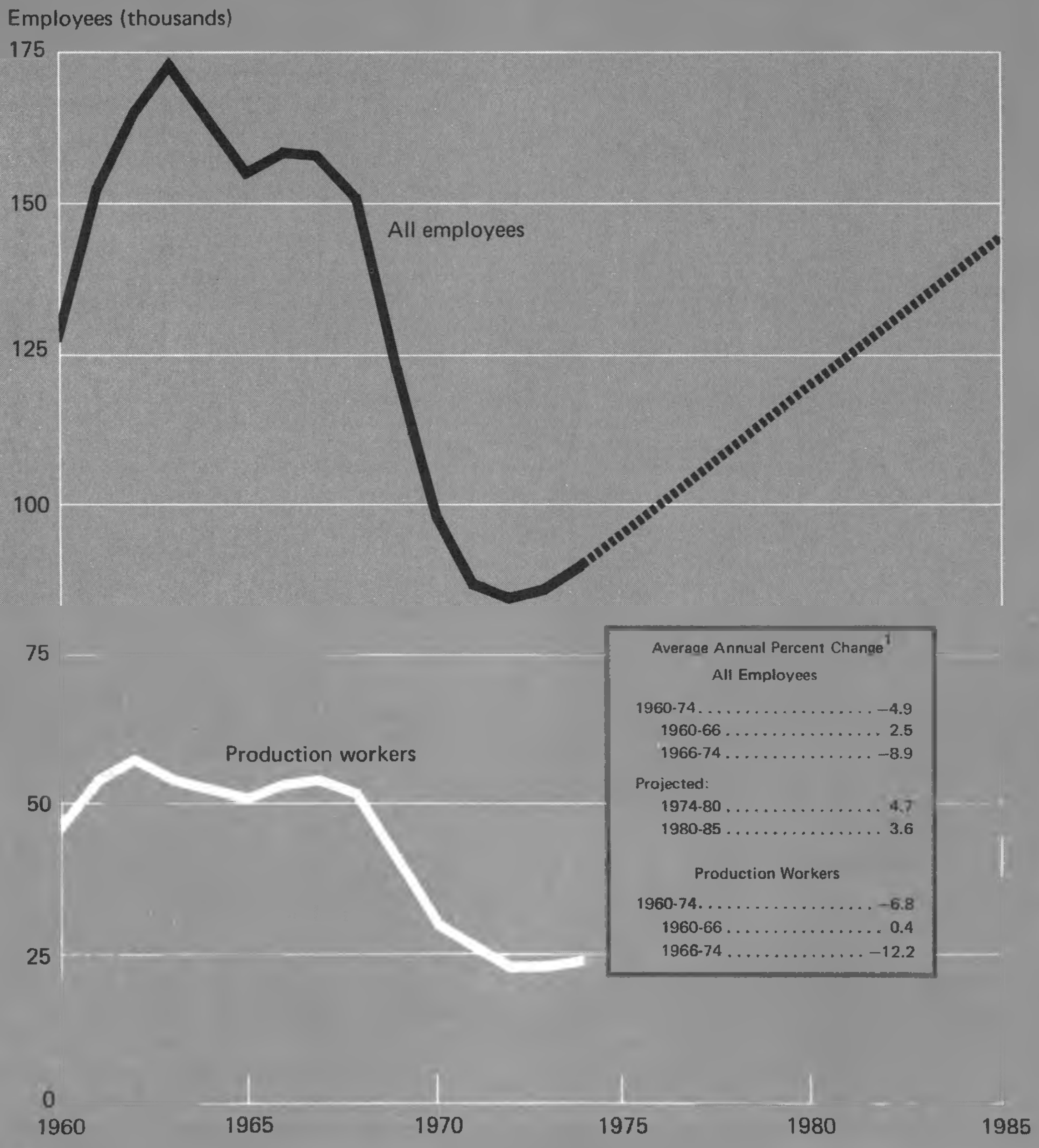
All Employees	
1960-74	−1.0
1960-66	1.9
1966-74	−6.7
Projected:	
1974-80	1.0
1980-85	1.2
Production Workers	
1960-74	−1.5
1960-66	2.1
1966-74	−8.3

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

Source: Bureau of Labor Statistics.

Chart 12

Employment in the missiles and space vehicles industry, 1960-74 and projected for 1980 and 1985



Average Annual Percent Change[1]

All Employees	
1960-74	–4.9
1960-66	2.5
1966-74	–8.9
Projected:	
1974-80	4.7
1980-85	3.6
Production Workers	
1960-74	–6.8
1960-66	0.4
1966-74	–12.2

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

Source: Bureau of Labor Statistics.

of research and development activities, the proportion of workers in scientific and technical occupations is much greater than in most other manufacturing industries. In 1970, for example, almost one-fourth of all employees in the aerospace industries were engineers, scientists, or technicians.

The BLS has made projections of the occupational distribution for 1980 which take into account the impact of technological changes underway in the aircraft industry, as well as other factors influencing occupational trends. It is likely that by 1980 blue-collar workers will represent a slightly smaller proportion of total employment in the aircraft industry, about 46 percent in 1980 compared to 52 percent in 1970. Among white-collar workers, the greatest increase in relative importance between 1970 and 1980 will be for sales workers, followed by professional and technical workers, and managerial and administrative personnel. Technical personnel often supervise and direct research and development activities or manage sales, purchasing, accounting, and industrial relations departments. Among blue-collar workers, laborers and service workers (cleaning service workers, janitors, and guards, for example) will show the greatest relative decline and craft workers the least. Chart 13 shows the changes expected among these occupations between 1970 and 1980. Similar information for the missiles and space vehicles industry is not available.

Computer-related occupations are growing in importance. The 1970 Census of Population recorded 5,048 computer programmers, 2,683 systems analysts, 2,449 peripheral equipment operators, 4,130 keypunch operators, and 280 data processing machine repairers employed in the aircraft and parts industry. By 1980, computer-related occupations are expected to be a larger proportion of the industry work force.

Adjustment of workers to technological change

Provisions relating to technological change only occasionally appear in union agreements in the aerospace industry. One such clause in an agreement reads: "It is recognized that in the field of data processing, improved and advanced equipment will be introduced from time to time. When the advent of such new equipment results in a drastic change, the company agrees to meet with the union to discuss the problem of consideration of other work for qualified displaced employees."

Where no specific provision is made for ways to adjust to technological change, the contract provisions which deal with seniority, retirement, and supplementary unemployment benefits undoubtedly apply. The agreements often provide for layoff procedures to take place in accordance with standing based on seniority. Seniority also commonly governs in rehiring laid-off employees.

–FOOTNOTES–

[1] John F. Judge, "Aerospace Use of Graphite Composites Expands," *Aerospace Technology*, May 6, 1968, pp. 38-40.

[2] Ibid., p. 40.

[3] John F. Judge, "Composite Materials: The Coming Revolution," *Airline Management and Marketing*, September 1969, pp. 85-91.

[4] Ross L. Goble, "Composites Lighter and Cheaper," *Astronautics and Aeronautics*, August 1972, pp. 44-49.

[5] Ibid.

[6] Warren C. Westmore, "Vertol Testing Glass Fiber Rotor Blades," *Aviation Week and Space Technology*, Aug. 11, 1969, pp. 80-83.

[7] John F. Judge, "Explosive Bonding Aids in Joining of Dissimilar Metals," *Aerospace Technology*, June 17, 1968, pp. 44-45.

[8] *American Machinist*, Jan. 12, 1970, p. 33.

[9] *Aerospace Technology*, April 1971, p. 49.

[10] Michael L. Yafee, "McDonnell Douglas Modernizes Machining," *Aviation Week and Space Technology*, July 28, 1969, pp. 98-107.

[11] "Technology and Manpower in Nonelectrical Machinery," *Monthly Labor Review*, June 1971, pp. 56-62.

[12] Yafee, op. cit., p. 106.

[13] Joel A. Strasser, "Laser-Assisted Optical Tooling Making Big Gains in Aerospace Industry," *Aerospace Technology*, April 8, 1968, pp. 24-27.

[14] Ken Miller, "Distortion and the Laser: Best Weld Yet in Sight," *Industrial News*, March 20, 1967.

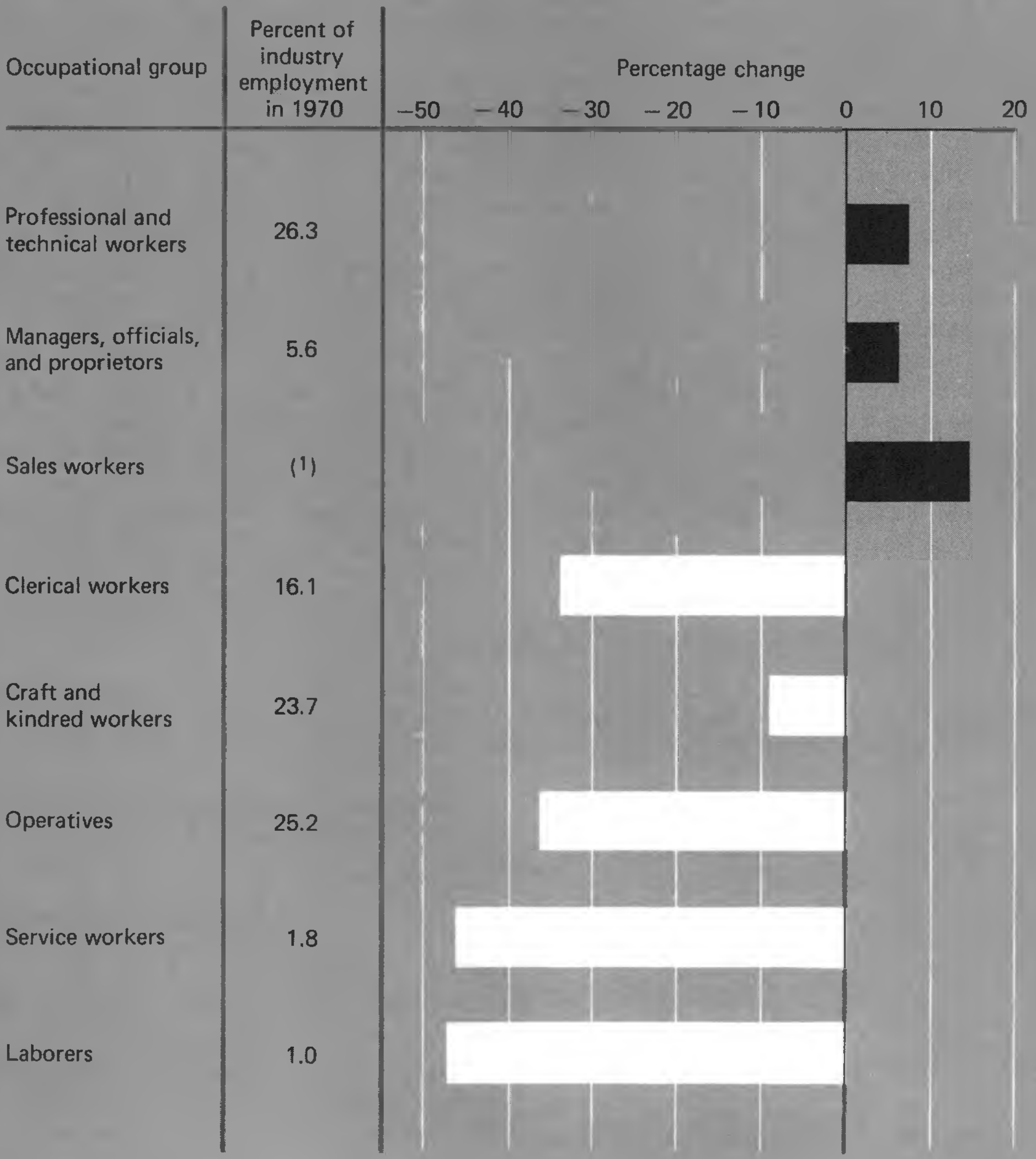
[15] Ken Miller, "Laser Welds: Cost and Quality Control," *Southern California Industrial News*, April 10, 1967, pp. 11 and 19.

[16] John Seiley and Tony Fredrickson, "Simulation in the Aerospace Industry," *Computer Sciences Corporation Report*, pp. 13-18.

[17] "New Dimension in Aerospace Electronics," *Aerospace Technology*, Jan. 29, 1968, pp. 24-46.

Chart 13

Projected changes in employment in the aircraft and parts industry by occupational group, 1970 to 1980



[1] Less than .05 percent.

Source: Bureau of Labor Statistics.

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Prasow, Paul, and Massarik, Fred. *A Longitudinal Study of Automated and Nonautomated Job Patterns in the Southern California Aerospace Industry.* Institute of Industrial Relations, University of California, Los Angeles, April 1969.

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Wholesale Trade

Summary

Further adoption of recent technological changes in coding, computerizing, warehousing, and customer services is likely to increase productivity and alter the occupational distribution of employment in wholesale trade (SIC 50). Although the industry as a whole is undergoing significant changes, these changes are being implemented more rapidly and extensively in some subdivisions than in others. The grocery and drug industries appear to be in the forefront.

Comprehensive reports are being generated which expedite shipments, streamline preparation of invoices and billings, and increase inventory turnover through more sophisticated computer manipulation of routine data. Warehouse operations are becoming more efficient because of improvements in product packaging, increased use of coding on shipping containers, new methods of assembling orders, and more extensive use of computerized conveyor systems. As the network of highways alters traffic patterns, changes are being made in some warehouse locations to improve their serviceability as distribution centers. Moreover, materials handling equipment installed in new single-level as well as high-rise warehouses is being more fully automated as stacker-retriever systems are integrated with conveyor systems. Also, customer services have grown to include third-party billing, catalogs, franchised operations, automated inventory control records, and store design and layout.

Gross national product originating in wholesale trade is expected to continue to grow more rapidly throughout the 1970's than the output of the total private economy. The rate of growth in employment will probably slow down to somewhat less than the overall national rate; productivity may rise to the rate projected for the economy as a whole. (See introductory note for assumptions underlying these projections.) Shifts in employment among occupational groups are expected to continue as an increasing number of sales personnel are engaged in providing services to retailers and as relatively fewer employees are required in the movement of goods to the stores.

Technology in the 1970's

Refinements in the existing technologies found in wholesale trade[1] are enhancing productivity performance and changing the distribution of employment among occupations. As services are enlarged to strengthen customer operations and expand wholesale sales, the need for sales representatives increases. Also, as new information services are implemented and innovative services are offered to customers, computers are used both more extensively and more intensively. Consequently, relatively more managers and clerical workers are hired and these occupations represent a larger share of wholesale employment. In contrast, as warehouses are relocated to adapt to changing transportation facilities and their materials handling methods are streamlined, and as more fully automated single-story and high-rise structures are built, the need for operatives, laborers, and service and craft workers decreases and their proportionate share of wholesale employment declines. (See table 13 for a brief overview of the major technological changes in wholesale trade and their expected diffusion.)

Coding

While product coding is a traditional tool of trade, new plans for using a code to move a product continuously by a unique identification from point of production to point of consumption or use have been developed by private and public agencies. Distribution Codes Incorporated (DCI) is implementing a coding system for identifying manufacturers and their products and has issued nonduplicate numbers directly to manufacturers in, for example, the electrical, heating and air-conditioning, and automotive supply industries. The coding system developed independently for the grocery industry is known as the Universal Product Code (UPC). A third and fourth code, the National Drug Code (NDC) and the National Health Related Items Code (NHRIC), both developed by the Federal Drug Administration, cover pharmaceuticals and health products. The four codes are being adapted for compatibility. The total

Table 13. Major technology changes in wholesale trade

Technology	Description	Diffusion
Coding	Numeric codes which can uniquely identify all types of manufactured products are being put into use to permit speedier communication between retailer, wholesaler, and manufacturer.	Universal Product Code (UPC) for consumer products in grocery outlets covered about 50 percent of the items sold in 1974 and will cover 75 percent by the 1975 year-end. Code marking is underway in electrical, electronic, wholesale stationery, heating and air-conditioning, and automotive supply industries. Companies selling drug and health-related products are also using UPC symbols on their packages.[1]
Computers	Direct placement of customer orders to wholesaler's computer reduces paperwork; inventory adjustments through computerized instructions to manufacturers for replacements improve reordering accuracy and lower inventory requirements; single detailed printout of customer's account for aggregated daily shipments consolidates all invoices and billing.	For accounting functions and inventory control, expanded by 1972 to nearly two-fifths of wholesale firms; more advanced uses limited to larger innovative firms.[2] According to one estimate, nearly 1,400 central processing units were installed by mid-1971.[3]
Warehousing	New structures are situated on beltways to service regional and national markets, supplemented by mini-warehouses for local needs. Standardized case measurements, shrink wrap pallets, plastic containers, and specialized conveyor systems facilitate handling, and sequentially listed computerized order printouts speed order picking. Automated warehousing with console-controlled, interfaced conveyor and stacker/retriever systems reduces space and labor requirements for storage and removal.	Gradually being introduced as old warehouses are replaced;[4] handling techniques generally applicable industrywide; automated warehousing restricted primarily to new structures designed to handle a high volume of uniform products such as dry groceries and frozen foods.[5]
Customer services	Computerized billing for accounts payable to retail customers, catalogs, and managerial expertise strengthen customer operations and expand wholesaler sales.	Limited but gradually being expanded by firms with growth potential.[6]

[1] "Universal Product Coding Paves the Way," *Automation*, November 1973, p. 12.

[2] Donald F. Martin, "A Look Ahead—1973" (Washington, National Association of Wholesaler-Distributors, 1973), p. 1.

[3] Based on data compiled by the International Data Corporation.

[4] "Howard Brothers Doubles Warehouse Capacity," *Discount Store News*, Aug. 12, 1974, p. 31.

[5] Frank A. Tully, "Build High for Storage Savings," *Automation*, March 1973, pp. 44-47.

[6] "Wholesalers: Your Secondary Inventory," *Special Report to the Office Products Industry* (Washington, National Office Products Association, 1972), pp. 3-6.

system is considered adequate to identify by code present and future manufactured products until at least the year 2000.[2]

Coded orders as received from customers may be communicated by the merchant wholesaler to the manufacturer by computer as well as by more conventional methods. Reordering using automated information reduces paperwork, chance of error, and response time throughout the distributive process. As a result of the speedier flow of supplies, inventory controls may be improved by the manufacturer, merchant wholesaler, and retailer. Additional clerks may be needed to prepare data for the computers but fewer stock clerks are likely to be used for pricing merchandise for retail sale. Also, smaller inventories will reduce required warehouse space and may lessen the demand for stock handlers.

Computers

Computerization of in-house accounting and inventory control tasks, introduced in the early 1960's, was extended by 1972 to nearly two-fifths of wholesale firms and probably to one-half by 1974.[3] Purchasing and billing methods are consequently now more efficient. Automatic links with customers and manufacturers for inventory needs and also for market analysis, however, are limited to the larger innovative firms. Some customers are placing orders directly with the wholesaler's computer which prepares a consolidated shipping ticket for all items going to that customer, prints the customer's invoice, posts accounts receivable, and automatically adjusts inventories by instructing the manufacturer to ship more goods to the warehouse.[4]

The proliferation of products stocked by the distribution system has also led to the need for innovations in invoicing procedures.[5] Some wholesalers, after making agreements with industrial customers to a selling price based on a percentage markup from cost, fill the customer's daily orders and forward a single computer run of the customer's account with coded information (including the different markups by item) rather than thousands of invoices for the multiple shipments. Also, the inventory control of some wholesalers has been improved, as shown by higher rates of inventory turnover, as a result of the integration of their customers' inventories with their own. Computer-generated reports point out both out-of-stock items and dead inventory. Accuracy of reordering has been improved through analysis of customer orders and projected needs. As more complex data manipulation becomes necessary to generate additional reports used primarily by managerial level personnel, the number and capability of the computer personnel increase.

Warehousing

With the growth of the interstate highway system through the 1960's, some new warehouses were located on thruways and beltways to serve as distribution centers.[6] The new structures, with the exception of cold-storage warehouses, are typically single-storied with a newly designed roof which requires fewer supports and results in more available floor space, easier maneuverability of merchandise, and heavier floor loading.

Some wholesalers, as in the automotive service, hardware, and plumbing equipment industries, continue to locate in urban centers and also are operating in suburban shopping areas. Although certain traditional market areas may remain discrete, intercity highway systems have connected many distributors with customers previously considered inaccessible. Some central warehouses have been supplemented by subsidiary warehouses stocked for local markets; mini-warehouses with limited, fast-moving inventories may be added during the 1970's in areas of high demand. These changes tend to permit the more efficient scheduling of pickup trucks for intracity shipments and of intercity trucking through the use, for example, of a single tractor to haul two trailers. The number of miles of transportation required is reduced, and the need for delivery and route drivers, mechanics, and repairers declines.

Product packaging is contributing to distribution efficiencies.[7] Increasingly the dimensions of case packs of products received at the warehouse are designed for safe, easy, and efficient palletizing and to fit an assigned channel space on the order picking line. Shrink wrap pallets (both the pallet and its content are wrapped in plastic) accommodate some irregularly shaped shipments. The use of plastic as containers reduces weight and breakage in some warehouses. Packaging designs with pricing areas already marked off simplify warehouse work of item pricing; lift-out tabs in shelf cartons expedite order-picking and reduce damage to items.

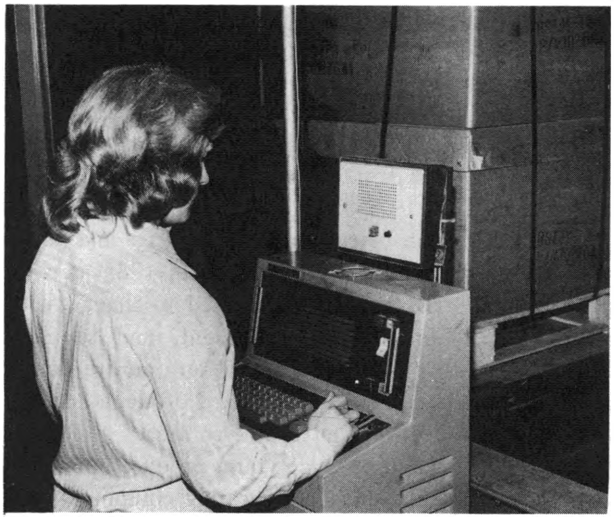
Conveyor systems expedite truckloading, floor to floor handling, and assembly. Roller or slider bed belt conveyors and trolley systems may be operated mechanically or may be automated, using computerized control.

A new, computerized order entry system is enabling pickers to assemble orders with less effort in two-thirds the time in some drug warehouses. The computer sorts the items ordered by the customer according to the location of the merchandise along the assembly line, and the pickers select the items in the sequence listed on the new computer printout forms. Also, items with high turnover as revealed by computer records are shelved near the conveyor belt to minimize selection time.

Automated warehousing. A completely automated high-rise cold-storage warehouse, such as is used for frozen food products in the grocery and farm products industry, requires less than one-half the number of square feet to store the same number of pallets as a conventional forklift truck-operated warehouse.[8] Pallets are stored in multipallet-deep, push-in flow racks located on either side of a stacker/retriever crane. Full random storage requires aisles only inches wider than the crane. Both storage and order pickup are controlled automatically by a computer from a console station on the shipping dock. The computer performs information functions and is capable of identifying the types and quantities of items needed for replenishment, locating items in the system, determining destinations and the required frequency of shipment, and directing preventive maintenance.

The computer also directs the sequence of operations of the material handling equipment. Order selection may be accomplished either by placing a man aboard the stacker or by bringing the load to a picker and returning the load to storage via the stacker crane. The computer verifies the accuracy and completeness of each operation and notes and reports suspected machine malfunctions.

A high-rise storage system is capable of handling different types of loads with one control computer. Hard-to-handle shapes may be moved by overhead trolley conveyors and pallet loads, when necessary, on a two-level conveyor belt network. Split loads may be



Operator entering data into a warehouse computer terminal.

stored and retrieved manually by an operator from a cab in which is mounted a data terminal for communication between the operator and the computer.

In some high-rise warehouses typically exceeding 100,000 square feet in floor space, towlines replace forklifts for ground-level transportation, eliminating both truck and battery maintenance. Carts equipped with a roller bed interface with a conveyor. Unitized loads of cartons are lowered automatically onto the positioned carts by fitting the multiple forks of the loader to the special baffle-type surface of the carts.

An automated storage system operates with less damage to products, buildings, racks, and equipment, and almost without pilferage. In cold-storage applications, a remotely controlled high-rise system functions more efficiently than humans, and the cost to maintain the environment is less. Storage system control equipment may be upgraded from an initial installation of automatic control of each stacker at the head of an aisle to remote control capacity for multiple stackers and finally to on-line computer control. With improved warehousing efficiencies, fewer man-hours of employment per unit of output are required of stock handlers and stock clerks.

Customer services

Traditional services are being maintained, with adjustments for changing conditions, and new services are being added as merchant wholesalers' capabilities grow and customers' needs shift.[9] The wholesale function continues to encompass such services as product information, credit, delivery, real estate and store planning, and service centers for repair and replacement of appliances. These basic aids to retailers are being supplemented by recent innovations which include third-party billings, catalogs, and franchised operations.

Both local and regional wholesalers review and adjust their product mix to serve the needs of specialized markets. The total number of products has been multiplying and each new product requires an investment in warehouse space, market analysis, and sales training. As products are introduced or changed, wholesalers receive continuous training from manufacturers and relay their product information to their retailing customers.

Extension of credit and charging of interest to customers with outstanding balances are financial services provided by some wholesalers in routine business transactions. Wholesalers also frequently make deliveries more expeditiously than manufacturers. Retailers are further assisted by real estate and store planning as wholesalers analyze store locations for market potential and cooperate in arranging store planning services for layouts by product line and decor. Repair of appliances and replacement of damaged products for the customer are transferred to the service center of the wholesaler supplying the merchandise.

Some additional services are being rendered by wholesalers such as third-party billing, i.e. charge-account customers of the wholesaler's customer. Wholesaler catalogs both with and without prices are a source document on available merchandise used by retailers to promote sales. Wholesalers have initiated franchised operations of retail outlets for which they may design the physical layout, select sites, loan part of the capital, determine operating procedures, and provide national advertising. These services may increase the wholesale trade demand for such workers as sales engineers, engineering technicians, computer clerks, and sales managers.

Production and Productivity Outlook

Output

Output, measured by the value (in constant dollars) wholesale trade adds to gross national product, grew at an annual rate of 5.3 percent in the 1960-73 period. A 5.9-percent growth rate from 1960 through 1966 slackened to a 4.4-percent rate from 1966 through 1973. The growth rate projected for 1973-80 (see introductory note for assumptions) is 5.3 percent per year, and for 1980-85, 2.9 percent.

The Bureau of Domestic Commerce of the U.S. Department of Commerce forecasts a decline for 1980 as compared to 1973 in the share of total wholesale sales of the merchant wholesalers engaged in the different major industrial subdivisions, shown in the following distribution of total industry sales:

	Percent of total sales	
Industry	*1973*	*Projected 1980*
All wholesale trade	100.0	100.0
Groceries	18.7	16.5
Machinery, equipment, and supplies	11.5	9.6
Motor vehicles and equipment	8.5	7.0
Electrical goods	6.2	5.1
Lumber and other construction materials	5.2	5.1
Beer, wines, and spirits	4.3	3.6
Hardware and plumbing equipment	4.3	3.5
Dry goods and apparel	3.8	2.9
Paper and paper products	2.6	2.2
Drugs and proprietaries	2.0	1.7
Furniture and furnishings	1.9	1.3
Miscellaneous	31.0	41.5

Productivity

Productivity measures for the industry have not been developed by the Bureau of Labor Statistics but some indication of trends can be obtained by examining the relationship between output and man-hours. (See chart 14.) The rate of increase in output in the 1960-73 period exceeded the rate of increase in man-hours expended in its production, thus indicating a productivity gain for this period. The outlook for annual productivity gains for the 1973-85 period as a whole is for a gain in line with that in the total private economy.

Employment and Manpower

Employment trends

The total number of persons engaged in wholesale trade reached 4.4 million in 1973, over 36 percent above the 1960 level. (See chart 15.) The total man-hours of employment grew less rapidly, by about 32 percent, reflecting the increasing use of part-time employees. The growth rate for 1960-66 was 2.2 percent for total persons engaged and also for total man-hours; the 1967-73 growth rate for total persons rose to 2.5 percent while the growth rate for man-hours dropped significantly to 2.0 percent.

The distribution of total employment changed somewhat between 1960 and 1973; the proportion of wage and salary workers increased from 92 to 93 percent and the proportion of self-employed declined from 8 to 7 percent. Also, the ratio of salary to wage workers rose from slightly less than 1 in 7 in 1960 to nearly 1 in 6 in 1973. A slackening off in the annual growth rate in total employment from 2.5 percent for the 1960-73 period to 1.2 percent for 1973-85 is projected by the Bureau of Labor Statistics; for wage and salary workers an annual decline in the growth rate from 2.6 percent for 1960-73 to 1.4 percent for 1973-85 is expected.

The distribution of employment of wage and salary workers among industry subdivisions in 1985 as compared to 1973 (BLS data) is expected to change, with wholesalers of machinery, equipment, and supplies; electrical goods; motor vehicles and automotive equipment; and drugs, chemicals, and allied products increasing their distributive shares. In contrast, dealers in groceries and related products, farm product raw materials, hardware, plumbing and heating equipment, dry goods and apparel, and miscellaneous wholesalers are expected to decline relatively as a source of industry employment.

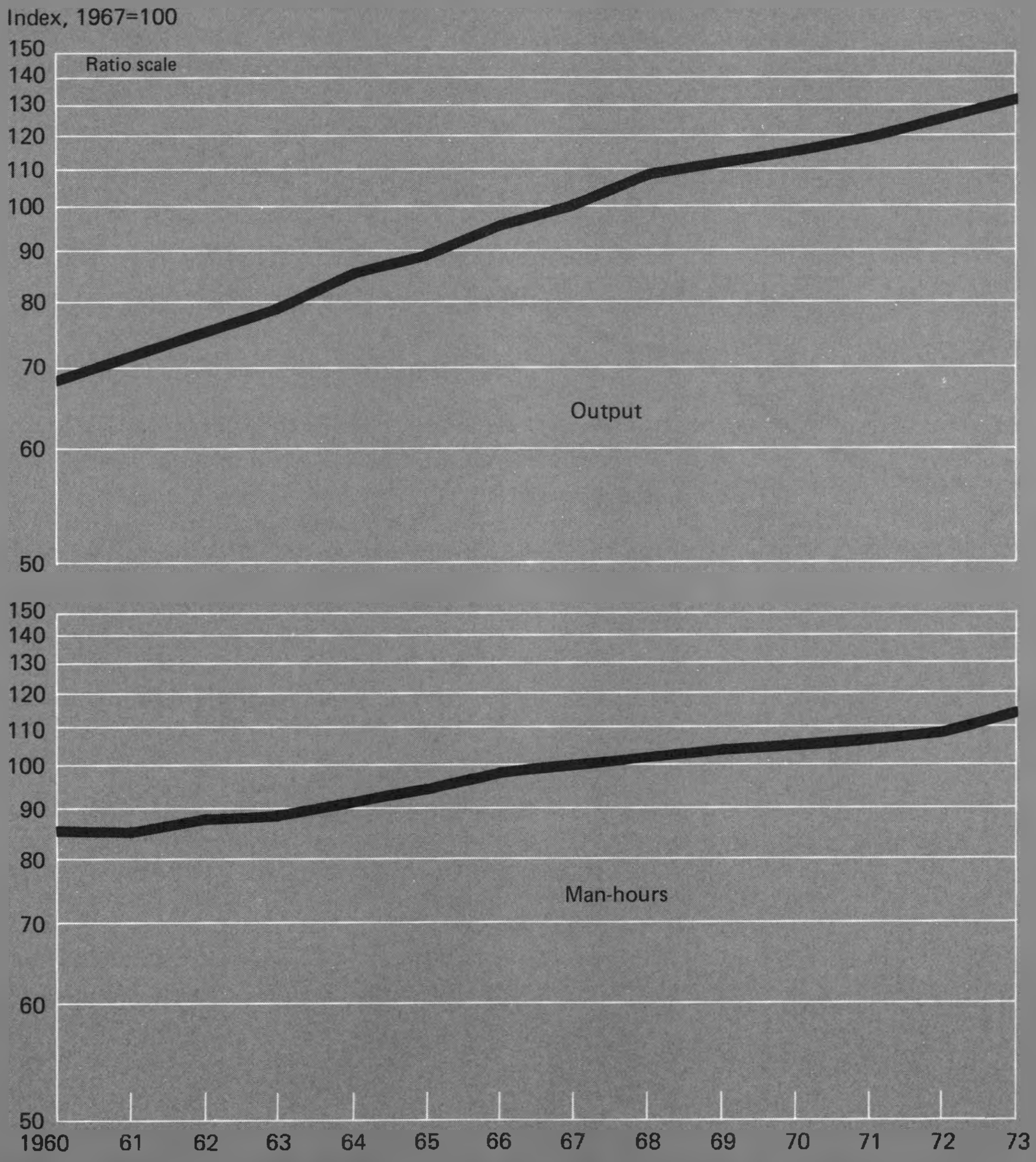
Women have consistently amounted to about 23 percent of the total industry work force. The proportion of black workers increased from 6.5 percent in 1966 to 8.2 percent in 1970. Black women rose as a proportion of black workers from 21 percent in 1966 to 24 percent in 1970, substantially the same as the proportion of all women in the industry.[10] In the occupational categories, men primarily fill the occupations of buyers, sales workers, delivery drivers, truckdrivers, warehouse workers, and laborers, while women workers usually perform the office functions of bookkeeping and secretarial work. Women also frequently work in warehouses as pickers, packers, and checkers of items of limited bulk and weight and also in warehouse offices as order takers.

Occupational trends

Shifts occurred in the decade of the 1960's in the distribution of employment among occupations and further changes are projected for the 1970's by the Bureau of Labor Statistics. (See chart 16.) Each occupational group will show an increase in employment from 1970 to 1980; the gains range from 0.5 percent for service workers to 4.5 percent for laborers, 9.9 percent for operatives, 18.4 percent for craft workers, 24.2 percent for clerical workers and 28.3 percent for professionals. Because of differences in the size of the occupational groups, the largest number of job openings over the decade will not necessarily be in the fastest growing occupations. For example, as can be seen in chart 16, clerical workers, the most sizable group in 1970, rank fourth in percentage increase. However, of the 850,000 total additional jobs anticipated by 1980, the greatest numerical increase is expected for clerical

Chart 14

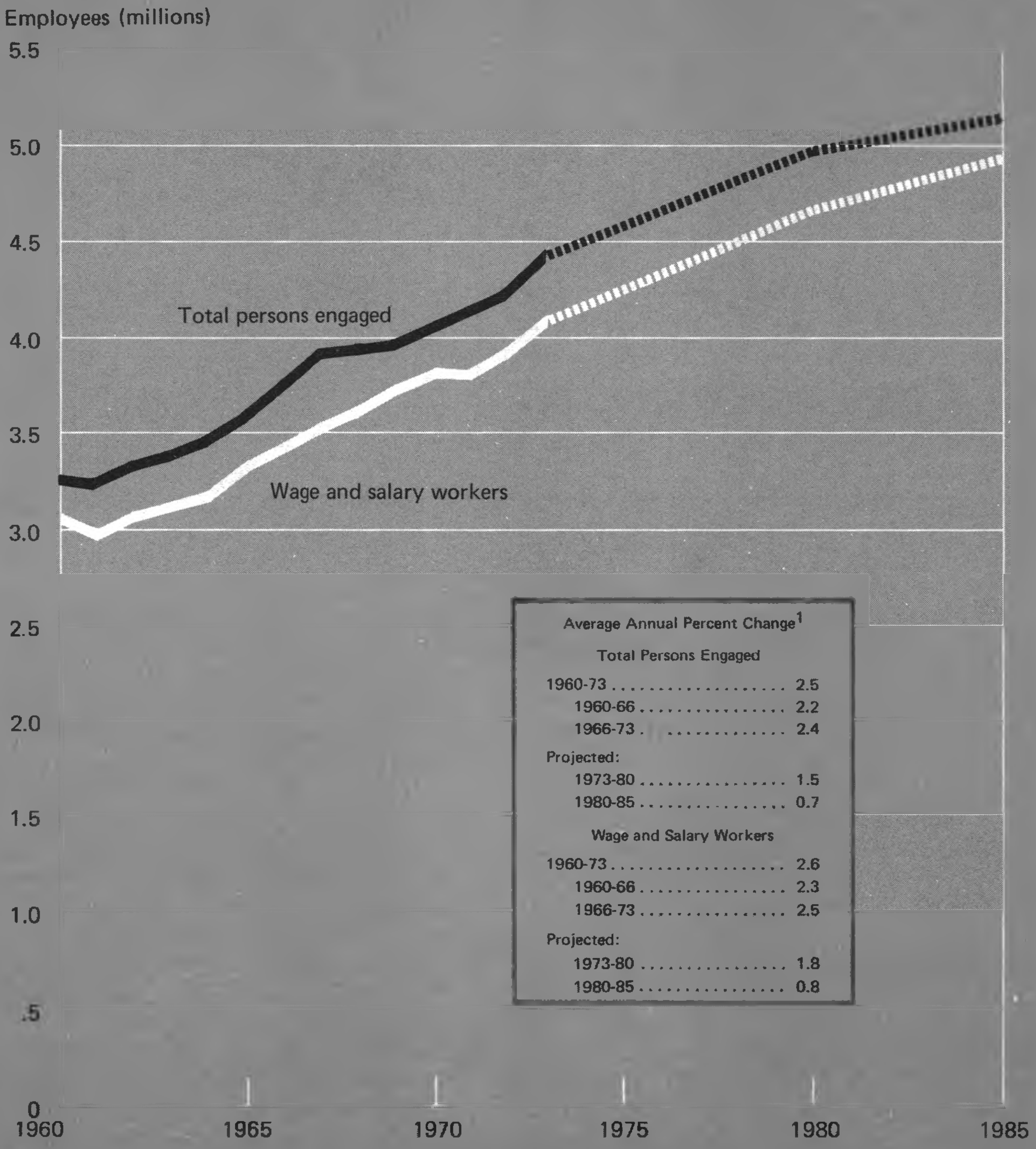
Output and man-hours in wholesale trade, 1960-73



Sources: Bureau of Economic Analysis and Bureau of Labor Statistics.

Chart 15

Employment in wholesale trade, 1960-73 and projected for 1980 and 1985



Average Annual Percent Change[1]

Total Persons Engaged	
1960-73	2.5
1960-66	2.2
1966-73	2.4
Projected:	
1973-80	1.5
1980-85	0.7

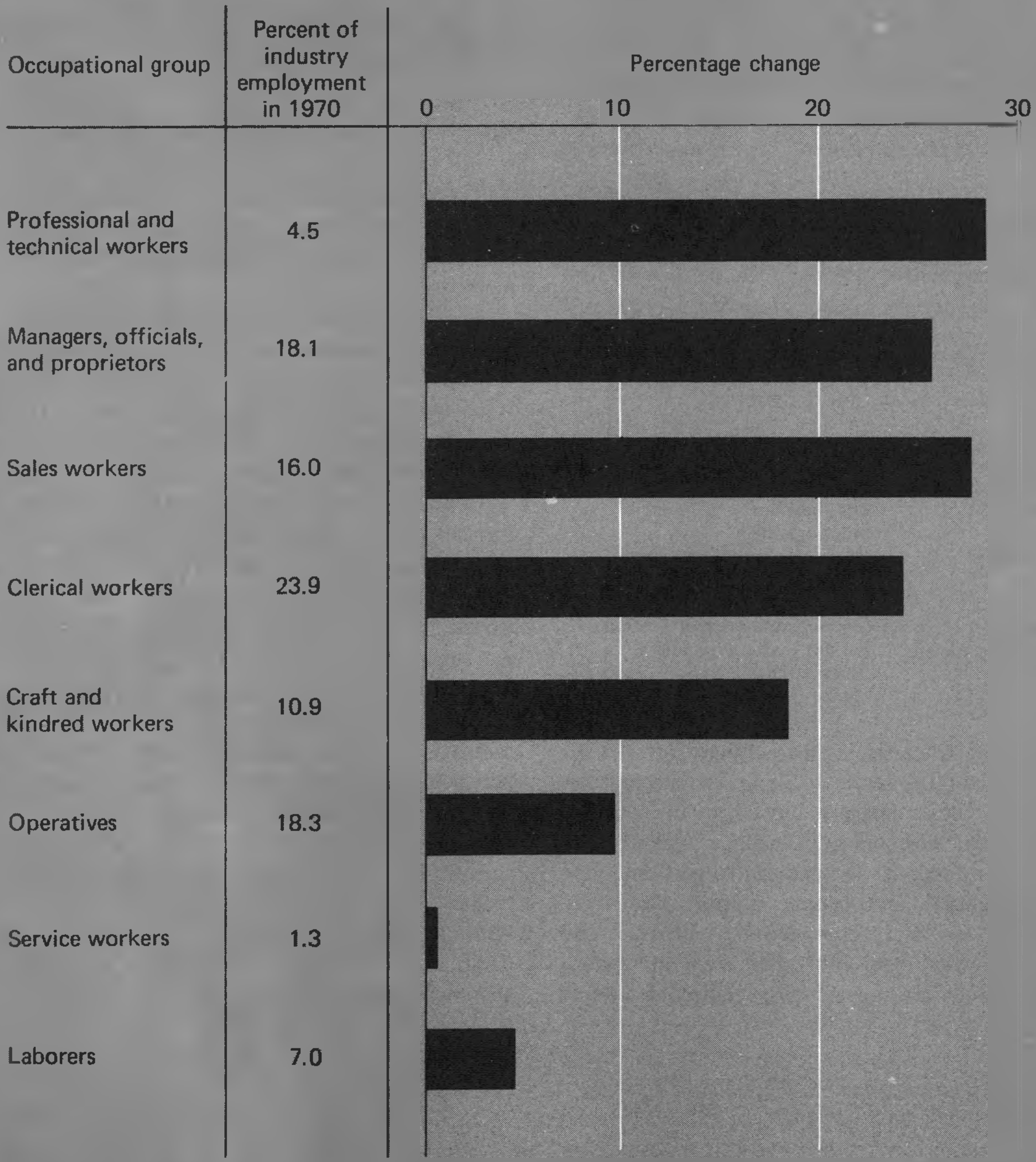
Wage and Salary Workers	
1960-73	2.6
1960-66	2.3
1966-73	2.5
Projected:	
1973-80	1.8
1980-85	0.8

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

Source: Bureau of Labor Statistics.

Chart 16

Projected changes in employment in wholesale trade by occupational group, 1970 to 1980



Source: Bureau of Labor Statistics.

workers, followed by managers, sales workers, and professional and technical personnel. Although the number of operatives, laborers, service workers, and craft workers will increase, their relative shares in industry occupational employment will decline.

A survey by the Bureau of the Census of the Department of Commerce indicates that the proportion of accountants in the professional, technical, and kindred group dropped from about 1 in 3 in 1960 to 1 in 5 in 1970, a development consistent with the introduction and diffusion of computerization for inhouse accounting functions. In the same period sales engineers increased from 2 to 3 in 10 of the professional and technical group, reflecting the growing practice of distributors of supplying customers with expertise and service.

The principal occupations expected to be affected in the 1970-80 period are listed below according to the magnitude of the relative change in the number of jobs projected by the Bureau of Labor Statistics. The greatest number of new openings is expected for sales representatives and the greatest loss in employment possibilities is anticipated for delivery and route drivers.

Increases	*Decreases*
Sales representatives	Delivery and route drivers
Secretaries	Bookkeepers
Typists	Stock handlers
Sales managers	Mechanics and repairers
Buyers	Buyers and shippers of farm produce
Office managers	
Counter clerks	Shipping and receiving clerks
Engineering technicians	Freight material handlers
Sales engineers	Stock clerks

As merchant wholesalers increasingly offer their retailer customers more services, the importance of sales representatives, sales managers, buyers, counter clerks, engineering technicians, and sales engineers grows. With an increase in professional and managerial personnel, the need for secretarial and typing support also rises. Conversely, delivery and route drivers, mechanics and repairers, and freight material handlers are relatively less important as goods are moved in specialized trucks of larger capacity whose parts are standardized to reduce maintenance requirements. Consolidated terminal facilities and the improved and expanded highway system also add to delivery efficiencies as does the increased use of automated equipment in warehouses.

In the next 10 years, according to an industry source,[11] 50 percent or more of the merchant wholesalers will computerize their inventory control, purchasing, invoicing, and shipping activities and a further deepening of applied technology is expected to reduce the need for bookkeepers, shipping and receiving clerks, stock clerks, and stock handlers.

Adjustment of workers to technological change

Trade, like nonmanufacturing industries generally, is not highly unionized. The BLS estimated that in 1972 less than 25 percent of all workers in trade were union members.

The International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers of America (Independent) is the principal union organizing in the wholesale trade industry and the National Council of Distributive Workers of America (Independent) organizes workers in the wholesale dry goods industry.

Collective bargaining agreements in the industry typically cover wage practices and supplementary benefits, job and union security, working conditions, and other employer-employee and union-management relationships. A BLS analysis of agreements covering 1,000 workers or more as of July 1, 1973 showed that advance notice of technological change was required in about 9 percent of the agreements for both nonmanufacturing industry as a whole and wholesale trade; however, 13 percent of all nonmanufacturing workers were covered by this type of provision compared to only 9 percent of workers in wholesale trade. When an agreement does not specifically refer to adjustments that are required when technological change takes place, it is likely that the seniority provisions of the contract apply. Moreover, displacements arising from technological changes may be absorbed through attrition.

–FOOTNOTES–

[1] The wholesale function may be performed by an independent agent called a merchant wholesaler or may be integrated vertically with the primary activities of the producer or the retailer. The type of wholesale operation tends to differ depending on the product line. Although the merchant wholesalers are the usual distributors of most product lines, branches of manufacturers, for example, frequently wholesale such products as electrical supplies, and farm equipment and retail food chains often operate their own warehouse systems.

This chapter deals with independent merchant wholesalers, who purchase products in volume from manufacturers and, after a title transfer, store purchased goods in their own warehouses. These wholesalers sell principally to retailers or to industrial, commercial, or professional users. They carry stock in large lots, redistribute in small quantities through sales personnel, service merchandise sold, and offer advice to the retail trade. The retailer, in turn, sells to the individual consumer.

[2] Based on Internal Revenue Service data and published by Distribution Number Bank Incorporated in *Distribution Number System* (Washington, 1972).

[3] Donald F. Martin, "A Look Ahead–1973" (Washington, National Association of Wholesaler–Distributors, 1973), p. 3.

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☆ U.S. GOVERNMENT PRINTING OFFICE : 1975 O—583-675

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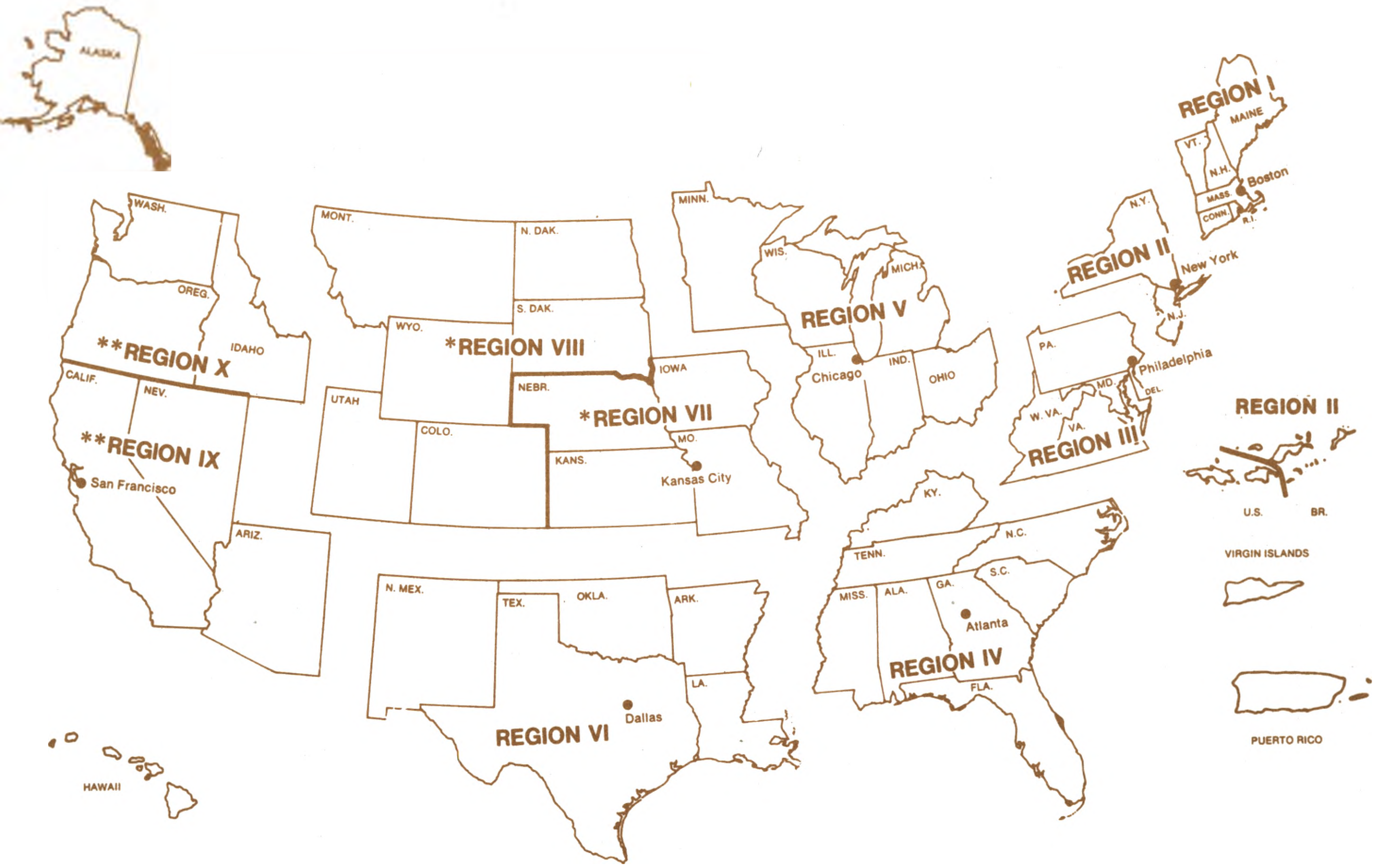

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