Technological Change and its Labor Impact in Five Industries

Apparel/Footwear/Motor vehicles
Railroads/Retail trade

U.S. Department of Labor
Bureau of Labor Statistics
1977

Bulletin 1961

Library of Congress Cataloging in Publication Data

United States. Bureau of Labor Statistics.
Technological change and its labor impact in five industries.

(Bulletin - Bureau of Labor Statistics ; 1961)
"Third of a series which will update and expand BLS Bulletin 1474, Technological trends in major American industries, published in 1966."
Bibliography: p.
Supt. of Docs. no.: L 2.3:1961
1. Machinery in industry--United States--Case studies. 2. Technological innovations--United States--Case studies. I. United States. Bureau of Labor Statistics. Technological trends in major American industries. II. Title. III. Series: United States. Bureau of Labor Statistics. Bulletin ; 1961.
HD6331.2.U5U54 1977 338'.0973 77-89407

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U.S. Department of Labor
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Bureau of Labor Statistics
Julius Shiskin, Commissioner
1977

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For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Stock No. 029-001-02037-6

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: Apparel (SIC 23), footwear (SIC 314), motor vehicles (SIC 371), railroads (SIC 401), and retail trade (SIC's 52-59).

This publication is the third of a series which updates and expands 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 two preceding bulletins in this series were BLS Bulletin 1817, *Technological Change and Manpower Trends in Six Industries* (textile mill products, lumber and wood products, tires and tubes, aluminum, banking, and health services) and BLS Bulletin 1856, *Technological Change and Manpower Trends in Five Industries* (pulp and paper, hydraulic cement, steel, aircraft and missiles, and wholesale trade).

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 Rose N. Zeisel and Richard W. Riche. The authors were: Apparel, David H. Miller; footwear, Rose N. Zeisel; motor vehicles, Robert V. Critchlow; railroads, Morton Levine; and retail trade, Mary Vickery.

The Bureau wishes to thank the following companies for providing the photographs used in this study: Bobbin Publications, Inc.; Brown Shoe Company, Inc.; Hitchcock Publishing Co.; R. G. Tourneau, Inc.; and International Business Machines Corporation.

Contents

Introductory Note

The following discussions of technological change in five industries are accompanied by projections of levels and rates of change of employment through 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. The projections are not forecasts but rather estimates of what the economy might be like under certain assumptions about unemployment, labor productivity, and government taxes and spending. Summarized below are the important elements of the underlying set of projections used in this study:

1. The labor force is projected to grow at a rate of 1.6 percent a year from 1973 to 1985, compared with 1.9 percent a year from 1960 to 1973.
2. Labor productivity in the private economy (1963 dollars) is assumed to grow at a rate of 2.5 percent annually from 1973 to 1985, compared with a rate of 3.0 percent from 1960 to 1973.
3. Real gross national product (in 1963 dollars) is projected to increase at an average rate of 3.6 percent during the 1973-85 period, compared with a rate of 4.2 percent in the 1960-73 period.
4. The unemployment rate is assumed to decline to 4.7 percent in 1980 and to 4 percent by 1985, compared with 4.9 percent in 1973.
5. Efforts to solve major domestic problems, such as pollution, may consume more productive resources but will not have more than a marginal effect on long-term growth.

For further information about these and alternative assumptions and projections, see the *Monthly Labor Review*, March 1976, pp. 3-21, and November 1976, pp. 3-22.

Chapter 1. Apparel

Summary

The production of apparel items involves a series of labor-intensive steps as cloth is transported through cutting, sewing, and other production operations. The technology involved is not complex – the sewing machine is the basic item of production equipment. Productivity gains are expected from advances in cutting and sewing technology, the more extensive use of computers, and improved workflow. Technologies involving large capital outlays, such as laser cutting and die cutting, will continue to be adopted primarily by large firms. Techniques to improve the utilization of labor will be of primary importance. The introduction of automatic devices on sewing machines, for example, increases productivity and reduces training time for machine operators.

Expenditures for new plant and equipment in current dollars (data from Bureau of the Census) totaled $390.5 million in 1974, over four times the $83.5 million outlay in 1960. (In real terms, however, the increase was less because prices of plant and equipment rose over this period.) In spite of continuing increases in capital expenditures, the industry is expected to remain highly labor intensive.

Because of limitations of available data, a productivity index for apparel (SIC 23) is not published by the Bureau of Labor Statistics. Trends in output and employment, however, suggest improvement in productivity during the past decade.

Apparel employment is expected to rise, with a work force of 1.5 million persons projected by the BLS for 1985. (For assumptions underlying projections, see introductory note.) Shifts in the location of apparel plants from the North to the South, and more recently to the West, have taken place as apparel firms have sought lower wage costs and other benefits. The industry is a large employer of minority workers and the largest employer of women among all manufacturing industries, both as a percent of the work force and in absolute numbers.

Technology in the 1970's

Technological changes underway in the apparel industry involve refinements to traditional cutting and sewing machinery, the limited application of new technologies such as lasers, computers, and ultrasonics, and the more widespread application of improved management methods. Although capital expenditures have been rising, improvements in apparel technology are not expected to result in displacement of workers nor involve extensive skill changes. Mechanization in the apparel industry will continue to be hindered by nonstandardized production and the large number of small firms with generally little capital available for modernization.

Mechanization

Although innovations are being introduced, as indicated in table 1, the apparel industry is expected to remain among the least mechanized of all manufacturing industries. The production process involves a series of discrete, labor-intensive operations related to the design, assembly, sewing, and pressing of completed apparel items. Extensive application of automatic, laborsaving technology to production operations thus continues to be difficult and in some cases uneconomical. A factor in the historically low level of mechanization is the nature of the apparel production process, which involves short, nonstandard production runs to accommodate seasonal lines and frequent style changes. Another factor hindering the introduction of mechanized equipment is the lack of institutions of higher learning to train apparel engineers, such as those which exist in Germany and elsewhere in Europe.

The extent of mechanization in the industry depends largely on the type of item produced. The production of standardized, less fashion-oriented types of clothing, such as shirts and pants, involves extensive mechanization because long production runs make it economically feasible; production facilities for women's sportswear, where style changes are frequent, are less mechanized because production runs are shorter.

New technology has had an impact on skill requirements for some positions. In sewing operations, for example, automatic contour seamers, profile stitching machines, and numerically controlled sewing machines increase output per worker and enable less skilled workers to perform duties of more highly skilled operators. The advantages of the new machinery are that it reduces training time (thereby reducing expenses) and enables management to draw from a larger labor pool.

Table 1. **Major technology changes in the apparel industry**

Technology	Description	Labor implications	Diffusion
Automatic contour seamers, profile stitching machines, and numerically controlled sewing machines	Equipment which transports cloth through sewing operations automatically.	Job duties of sewing machine operators, a major segment of the work force, have been modified. Material is guided through sewing operations automatically with operators in some instances able to tend more than one machine. Skill and training requirements for operators have been lowered. Mechanics, however, may need retraining to carry out more complex maintenance.	Limited to the larger plants. More widespread use is expected with the anticipated growing use of PROMS (Programmable Read Only Memory Units)—mini-memory units which greatly increase equipment flexibility.
Laser cutting	Computer guided laser cutting systems cut fabric at high speeds with high accuracy, reducing material losses and insuring uniformity.	Impact on cutters and associated occupations uncertain, but expected to be minimal because diffusion expected to be limited. Potential exists to achieve unit labor savings—because of high speed—but improved accuracy is the major advantage. In contrast to sewing room occupations, most cutting room jobs are held by men.	Used to a very limited degree in cutting men's suits. High capital costs will limit its use to the largest firms.
Numerically controlled cutting devices	Numerical control equipment directs devices through their operations with improved product quality and higher cutting speeds.	Impact on cutters and associated occupations uncertain, but some labor savings are anticipated. As in laser cutting, material savings are an important benefit.	Used to a limited degree in larger apparel plants. High capital cost will limit diffusion.
Ultrasonic sewing	High frequency sound waves (ultrasonics) are used to create a frictional bond between layers of thermoplastic cloth. The bond acts as and simulates stitching, though no thread is used. Similar to fusing, except that no adhesive is required.	Sewing machine operator duties modified but impact not widespread.	Use limited to materials with a high synthetic content unless a thermoplastic bonding layer is used. Limited growth is expected.
Electronic computers	Computers are being used by management for sales analysis and forecasting, process inventory, and workflow management. In the production process they are being used in conjunction with numerical control equipment and marker preparation.	Computer-related positions of data processing manager, systems analyst, and programmer among new occupations associated with diffusion of computers. Unit labor savings primarily in management and office data processing functions, with limited computer applications in production operations.	More widespread use of computers expected. In 1974, 297 computer installations were reported. The use of computers in pattern grading and marker preparation is expected to continue to grow rapidly.

Advances in cutting technology

Innovative approaches to fabric cutting such as the use of lasers, numerical control, water jet cutting, refined die cutting methods, and new pattern grading equipment are being introduced on a limited basis in larger firms. The occupations of marker and cutter will be most affected by further diffusion of these innovations.

Computer-guided laser fabric cutting systems are being used to a limited degree for men's suits. The high capital costs of laser systems prevent all but the largest firms from using them. The preciseness of the cut reduces material loss and insures uniformity. Although laser cutting systems presently cut only one layer of cloth at a time, advantages include improved cutting speed and accuracy, less fabric wastage, and reduced inventory requirements. One company using laser cutting for men's ready-to-wear suits reduced cutting time significantly. Another firm using a computer-guided laser system to prepare patterns for made-to-measure suits (cutting is then done by conventional methods) sharply reduced the time between order and delivery. Numerically controlled cutting systems also are in limited use, with more widespread application expected. These systems are fast and accurate, and have the capability to achieve savings in material. The extent to which laser and numerically controlled cutting systems reduce unit labor requirements for markers and cutters is uncertain. Water jet cutting, a technology proven for leather cutting in the footwear industry, is now being applied to cloth cutting.

Improved die cutting methods are another major innovation achieving improved accuracy and other advantages in cutting operations. Large-scale cutting is needed, however, to offset the high capital costs of the processes and therefore diffusion is limited to larger plants.

New pattern grading equipment which has the capability to produce copies of a master pattern in a number of differ-

Apparel worker operating a cutting machine ent sizes is increasing productivity. New pattern marking systems which use photographs of a miniaturized pattern to preplan the marking of full-size patterns also are being used increasingly. Computerized pattern marking and grading are being used experimentally by some plants. Improvements in pattern marking and grading maximize cloth utilization and minimize preparation time and cost.

Advances in sewing technology

In sewing operations, gains in productivity are being achieved by work handling aids, machine attachments, parts stackers, and increased machine speeds. Since sewing machine operators may spend only 20 percent of their time actually sewing, machines that reduce the time required to position, adjust, and stack fabric can yield time savings.[1] Thread cutters (trimmers), parts stackers, needle positioners, and button feeders contribute to worker productivity gains. While individual savings are small, their cumulative effect may be substantial.

The installation of automated button sewing systems featuring sequential indexing and automatic button feeding increases output and reduces unit labor requirements. In one plant visited by the BLS, for example, prior to the introduction of an automated button sewing system, an operator sewing buttons on shirts could do 2,300 pieces per day. On the new system, the operator is able to tend two machines, increasing output to 4,000 pieces per day.

The linking of sewing machines and numerically controlled equipment to perform a series of programmed operations has increased output, improved quality, and lowered unit labor costs in some plants. When the numerically controlled sewing machine is programmed to sew a specific operation, the control guidance function of the operator is removed, resulting in job simplification and greater quality consistency. The operator becomes more of a loader and positioner. While the machine is going through its programmed cycle, the operator can operate additional machines or tend to other operations. Training time for new operators is less on a numerically controlled sewing machine.

In an example of the productivity potential of new sewing machine technology, a tape-controlled machine being used for inside sewing of shirt collars reportedly can turn out the same output as the former method with 64 percent fewer workers. Moreover, operator training time is less than half that required on the former system. Numerical control is expected to see increased use, though principally in the larger plants. The more widespread use of mini-memory units called PROMS (Programmable Read Only Memory Units) is expected to increase the diffusion of automated sewing equipment.

Job duties also are being modified by the introduction of machine-controlled sewing machines such as the automatic contour seamer and the profile stitching machine. These units are guided through sewing operations automatically by photoelectric sensors, cams, templates, and PROM units. Skill requirements are changed since operators no longer perform these functions manually. These systems are relatively new and are in limited use in some of the larger apparel plants. More widespread introduction is expected.

Sewing without thread, or sonic sewing, is an innovation being introduced on a limited basis in the United States. Instead of a needle and thread, the sonic sewing device has a wheel or "horn" which vibrates the fabrics to be sewn at such high speeds that they fuse together. The cloth being sewn must have a high percentage of synthetic content or have a fusable bonding layer. The process is similar to the older methods of fusing or bonding except that sonic sewing requires no adhesive. A shared advantage of the new and older methods of fusing is the absence of a thread inventory. The fusing and bonding process is used widely on parts of garments, generally on linings, labels, and short seams. One of its greatest potentials is in quilting where it can make decorative stitching.

Computers

Computers are being used on a limited though increasing scale in the apparel industry; in 1974, 297 computer installations were reported.[2] Declines in computer purchase and rental costs have increased the feasibility of computer usage. Generally located in the larger plants, computers are used most widely for accounting purposes, though they are being applied increasingly to sales analysis and forecasting, process inventory, and workflow management. In the production process, computers are being used more extensively in pattern grading and marking, and as part of numerical systems for machine guidance directing cutting tools and sewing heads. Computers also have made their entry in the area of work-in-process control on the manufacturing floor.

Centralized production and assembly

By centralizing production and assembly and introducing new equipment, larger companies are achieving economies of scale. One shirt plant in Georgia visited by the BLS, for example, performs cutting operations for five plants and assembly of shirt fronts for three plants. Also an increasing practice is the shipment of cut parts to low-wage plants in foreign countries where they are assembled and shipped back to the United States for marketing.

Improved management methods

In recent years, increased emphasis has been placed on raising productivity through improved management techniques. Work flow studies for determining plant layout and time and motion studies to optimize the arrangement of machines and operators are being applied more widely in apparel plants. Improved quality control methods are reducing material and product losses and improved scheduling techniques are making possible more efficient utilization of labor. The electronic computer also is being used by management in a few plants to carry out inventory management and sales forecasting and analysis more effectively.

The separation of work processes into a number of simple operations performed separately by operators (the section system) increases worker productivity and utilizes less highly skilled labor. The single-hand tailor system, where most sewing operations are performed by a single highly skilled individual, is used for a few men's garments and for some of the more expensive women's garments.

Output and Productivity Outlook

Output

Output in the apparel industry rose at an average annual rate of 2.2 percent (Federal Reserve Board data) from 1960 to 1975. (The FRB index has limitations and therefore should be considered only as a rough indicator of output movement.) This rate was lower than the 2.6-percent average annual rate for 1950 to 1960. The rate of growth in output was greater in the early 1960's, averaging 3.4 percent for 1960-67 in contrast to an average annual rate of increase of 1.5 percent for 1967 to 1975. During 1967-71, output increased at an annual rate of 0.8 percent as the economy slowed in the late 1960's and imports of cotton, wool, and manmade fiber apparel items rose by 139 percent. From 1971 to 1973, apparel production averaged a 5.8-percent annual increase as consumer spending on apparel increased and imports leveled off. Between 1973 and 1975, however, output declined by 4.2 percent.

Productivity

Because of limitations of available data, reliable measures of productivity for the industry are not available. Productivity measures are difficult to compute because of the lack of product standardization in the industry. However, some improvement in output per production-worker-hour is suggested by comparing trends in data on output from the Federal Reserve Board and production worker hours from the Bureau of the Census. (See chart 1.) Between 1960 and 1974, output increased at an average annual rate of 2.5 percent, substantially higher than the 0.6-percent average annual increase in production worker hours.

Investment

Capital expenditures

Expenditures for plant and equipment in current dollars (data from Bureau of the Census) rose from $83.5 million in 1960 to $390.5 million in 1974, an average annual increase of 13.3 percent. (In real terms, however, the increase was less because prices of plant and equipment rose over this period.) More than 50 percent of total spending for new plant and equipment during 1960-74 took place during the last 5 years of the period (1970 through 1974). In spite of substantial increases in capital expenditures, the industry remains one of the most labor intensive of all manufacturing industries. Payroll costs accounted for 51 percent of industry value added in 1974 (Census data) compared to 42 percent for all manufacturing. Capital expenditures per production worker in the apparel industry increased at an average annual rate of 12.5 percent from 1960 to 1974. (See table 2).

Table 2. Indicators of change in the apparel industry, 1960-74

Indicator	Average annual rate of change[1]		
	1960-74	1960-67	1967-74
Payroll per unit of value added	-0.9	-0.6	-1.1
Capital expenditures per production worker	12.5	14.2	8.8

[1] Linear least squares trends method.

SOURCE: Bureau of the Census.

Employment and Occupational Trends

Employment

The apparel industry is one of the Nation's largest manufacturing industries, employing over 1.2 million workers in 1975 (BLS data), or about 7 percent of the manufacturing work force. The industry is characterized by a large number of small plants, with approximately one-half of the industry's 24,134 establishments (Census data) employing fewer than 20 employees. The trend is toward fewer, but larger, plants. Average employment in 1972 was 56 employees per establishment, in contrast to 40 employees per establishment in 1958.

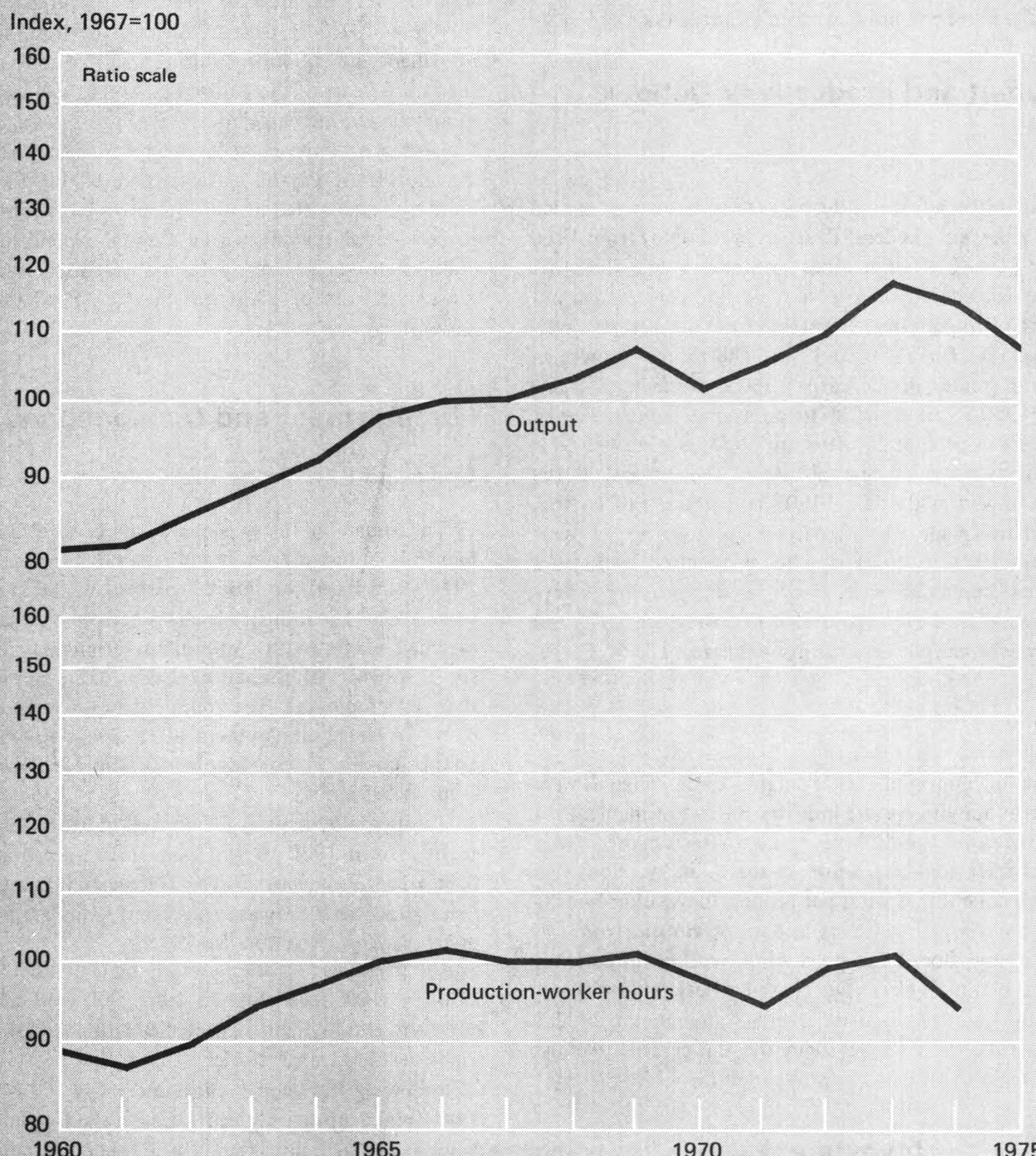
Total employment in the apparel industry increased only slightly from 1960 to 1975—at an average annual rate of 0.5 percent (see chart 2). The average annual rate of growth from 1960 to 1967 was 2.2 percent, compared to a decline of 1.0 percent from 1967 to 1975.

The peak year for total employment was 1969, when the industry work force totaled 1,409,000 workers. By 1975, however, employment had declined to 1,235,000 workers, the lowest level since 1961.

Following the steep cyclical decline of 1974-75, employment turned up sharply in 1976, and the long-term outlook is for continued increases. The 0.6-percent annual rate of growth projected by BLS for 1973-85 is about the same as the industry's rate of employment growth during 1960-75, but is considerably below the 1.9-percent rate projected for the total private nonfarm economy. (See introductory note for assumptions related to projections.)

Chart 1

Output and production-worker hours in the apparel industry, 1960-75[1]

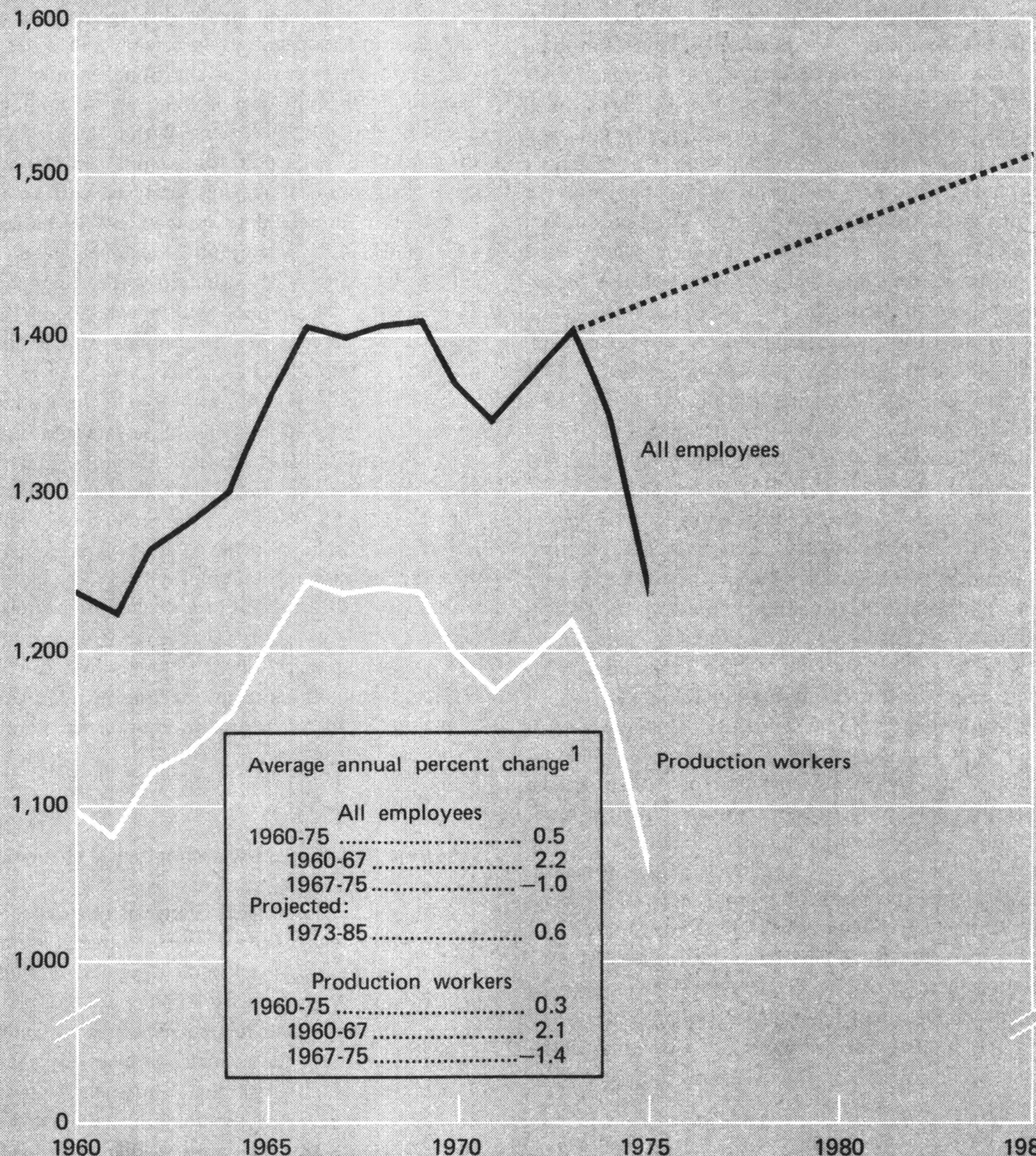


[1] 1974 data are the latest available for production-worker hours.

Source: Output, Board of Governors of the Federal Reserve System; production-worker hours, Bureau of the Census.

Chart 2

Employment in the apparel industry, 1960-75, and projection, 1973-85



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

Source: Bureau of Labor Statistics.

Apparel plants traditionally have located in the metropolitan areas in the North because of their proximity to markets. Since World War II, however, there has been a movement away from the Northern cities to the urban and rural South, and more recently to the Southwest. The establishment and relocation of plants in the South and West have been a result primarily of the industry continuing to seek a lower wage structure and other benefits. Although apparel plants are widely dispersed throughout the country, about 80 percent of the industry work force is concentrated in 15 States. New York and Pennsylvania rank first and second in apparel industry employment; other leading States include California, North Carolina, New Jersey, Georgia, Texas, Tennessee, Massachusetts, South Carolina, Alabama, Mississippi, Virginia, Missouri, and Illinois.[3]

Earnings of apparel workers are among the lowest in all manufacturing industries. In 1975, the apparel production worker earned an average of $3.19 per hour or $111.97 per week, compared to an average of $4.81 per hour or $189.51 per week for all manufacturing. Most production workers are paid on a piece-rate system in which total earnings depend upon speed and skill. The industry experiences high turnover rates. In 1975, the separation rate (monthly average) for the apparel industry was 6.1 per 100 employees, substantially above the separation rate of 4.2 per 100 employees in all manufacturing. According to a recent national survey of several hundred apparel plants, 77 percent claimed to be unable to meet expansion objectives for lack of labor.

Within the apparel industry, employment trends varied during 1960-75. The greatest gains were in men's and boys' furnishings and miscellaneous fabricated textile products—employment in both industry components rose by 17 percent. The greatest decline was in the industry component with the lowest total employment—hats, caps, and millinery—where employment fell sharply, by 55 percent.

Women accounted for 81 percent of the apparel industry work force in 1975, up from 78 percent in 1960. The apparel industry has a higher proportion of women in the work force than any other manufacturing industry. In all manufacturing, women averaged only 29 percent of the work force in 1975. Women are employed primarily as nontransport operatives (mainly sewers and stitchers), occupying nearly 90 percent of these jobs (1970 Census data), and to a lesser degree in clerical positions, staffing slightly over 70 percent of these positions. Women staff fewer than 20 percent of the management, administrative, and sales occupations in the industry and less than 50 percent of the professional, technical, and craft worker positions.

Occupations

Technological and other changes will continue to alter the structure of occupations in apparel plants. The proportion of production workers to the total work force fell during 1960-75 (BLS data); this trend is expected to continue. The apparel industry has a higher than average proportion of production workers, 86 percent compared to 71 percent for manufacturing as a whole in 1975.

According to BLS projections for the apparel industry, employment increases are expected over the period 1970-85 in most occupational groups: Professional, technical, and kindred workers; managers, officials, and proprietors; sales workers; clerical and kindred workers; craft and kindred workers; and operatives. (See chart 3.) However, fewer service workers (janitors, cleaners, guards, attendants, etc.) and laborers will be employed in 1985.

The introduction of new apparel technology is not expected to bring about major displacement of workers, although unit labor savings in sewing and other production operations are expected as additional manual functions are eliminated. In some occupations, new technology will bring about increased employment. Within the professional, technical, and kindred group, for example, employment of computer programmers, systems analysts, and other computer specialists is projected to increase by 19 percent between 1970 and 1985, as computer systems are diffused more widely. In the craft and kindred worker category, new and more complex technology will be a factor in the projected gain of 18 percent in the number of mechanics, repair workers, and installers.

New technology is not expected to have a major impact on the level of employment of sewers and stitchers, who make up about 50 percent of the total apparel industry work force and constitute more than two-thirds of the operatives category. However, the increase in employment of sewers and stitchers during 1970-85 is projected to be less than the increase in total employment. The extent to which technology will bring about a decline in the relative importance of this key occupational group is uncertain. One readily apparent impact of new technology on sewing and stitching occupations is the decline in relative importance of manual skills as automatic equipment increasingly performs production tasks.

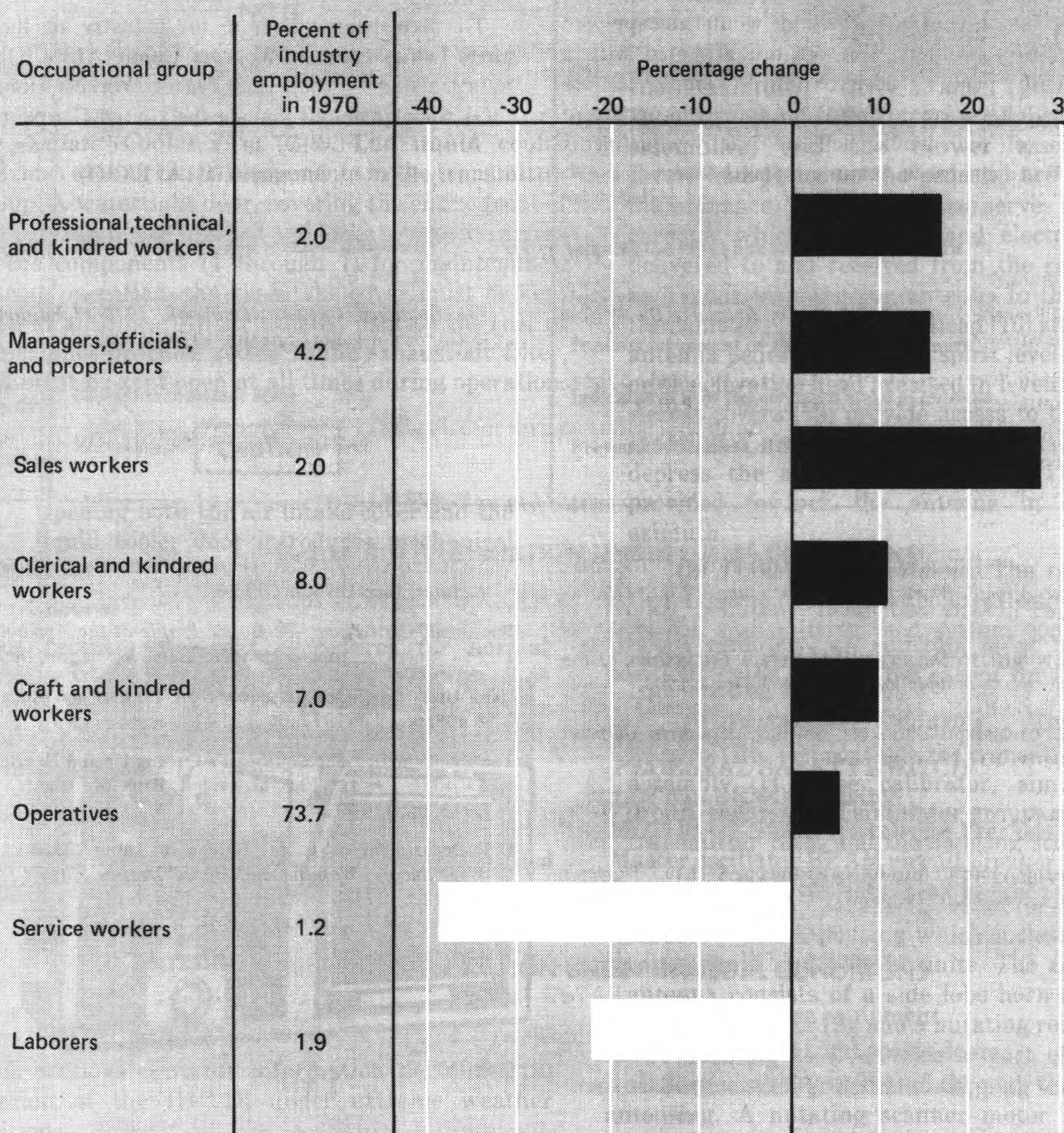
Adjustment of workers to technological change

Although technological change is not expected to bring about widespread displacement or downgrading of apparel workers, some labor-management agreements now in effect in the industry provide for advance notice, planning of labor requirements, and related measures to facilitate adjustments should they be needed. A review by the BLS of 48 major collective bargaining agreements covering 1,000 workers or more in the apparel industry located eight agreements covering 149,700 workers that contained provisions requiring advance notice of technological change. For example, one agreement covering approximately 60,000 workers contained the following clause:

> "The Administrative Board shall adopt rules and regulations in connection with the introduction of new ma-

Chart 3

Projected changes in employment in the apparel industry, by occupational group, 1970-85



Source: Bureau of Labor Statistics.

chinery in the industry in order that workers shall not suffer any undue hardships."

Another agreement, covering more than 100,000 workers stated:

"If, however, in the event that the introduction of any such new machinery, changes in manufacturing techniques and technological improvement would not, in the opinion of either party, be consistent with the maintenance of the aforesaid basic conditions, then the Association and the Amalgamated Clothing Workers of America shall each appoint a committee which jointly shall study and seek to resolve the problems attendant upon such change."

Although union contract provisions would not apply to apparel industry workers who are not affiliated with a union, extensive planning, advance notice to employees, use of attrition to lower employment, and training programs to provide new job skills would facilitate orderly adjustments to technological changes in nonunion plants.

Additional training for mechanics and maintenance workers may be required as new production technology incorporating complex electronic, pneumatic, and hydraulic control systems is introduced more widely.

The degree of unionization varies with the type of apparel item produced and region of the country. Unionization tends to be very strong in the men's coats and suits and expensive women's wear sectors of the industry, and weak in work clothing, less expensive women's wear, and men's wear other than coats and suits. Union membership is highest in metropolitan areas, particularly in the northeastern States.

The two major unions in the industry are the International Ladies' Garment Workers' Union (ALF-CIO), and the Amalgamated Clothing and Textile Workers Union (AFL-CIO). Smaller unions include the United Garment Workers of America (AFL-CIO) and the United Hatter's, Cap, and Millinery Workers International (AFL-CIO).

FOOTNOTES

[1] Apparel Research Foundation, Inc., *The Journal of the Apparel Research Foundation, Inc.*, Vol. 3, No. 2, p. 2.

[2] Ed Burnett, "Computers in Use: Analyzed by Standard Industrial Classification: 1974 Compared with 1968 – Part 2," *Computers and People*, June 1975, p. 28.

[3] *Occupational Outlook Handbook, 1976-77 Edition*, Bulletin 1875 (Bureau of Labor Statistics, 1976), p. 607.

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Chapter 2. Footwear

Summary

Technological changes have been very moderate in the footwear industry in the last 20 years. It is still essentially a piecework, cut-and-assembly industry and the changes in skill and labor requirements over this period have been minimal. The outlook for modernization is somewhat more favorable as new technologies are developed, including flow molding, new lasting machinery, and computer-controlled cutting and stitching. However, their use is limited and the rate of diffusion will probably continue to be quite slow.

Output of shoes and slippers (except rubber) declined at an average rate of 2.2 percent annually from 1960 to 1975. In 1975, output was the lowest in the post-World War II period. Imports have made significant inroads in industry markets; they constituted 44 percent of apparent consumption[1] in 1975 (in quantity), compared with 13 percent in 1966. In 1976, imports again rose very sharply, and there is no indication of a significant reversal of this trend.

Productivity growth was relatively slow in the 1960-75 period (0.4 percent annually) and was associated with a sharp decline in output and a somewhat steeper drop in employee hours. Among the 58 industries for which BLS data are available, the footwear industry experienced the lowest productivity gain. Moreover, its productivity is not expected to increase substantially in the second half of the decade.

Outlays for machinery, whether purchased or rented, have been relatively low. Combined outlays for rental and purchase of plant and equipment per production worker in 1971 were only one-fourth as large as the average for all manufacturing. Rental outlays, however, are high in this industry compared to other industries, often exceeding capital expenditures. The outlook is perhaps more promising, but the structure of the industry, e.g. many small firms, and unfavorable economic conditions, including high imports, continue to act as deterrents to investment.

Employment is at the lowest point in at least 35 years. From 1967 to 1975, the rate of decline averaged 4.3 percent annually and was associated with sharp decreases in output. Employment recovered noticeably in 1976 as the economy improved, but the long-term outlook is for continued slow decline.

Structural changes are occurring in the industry. The vertical integration of larger companies (principally by acquisition of retail outlets) is altering investment and marketing patterns. Another change taking place is the geographic relocation to more rural areas in the South and West. This study, however, does not cover these subjects but concentrates primarily on technological changes and their labor implications.

Technology in the 1970's

Shoemaking is still in large measure a piecework industry—technology has not changed significantly in the last 20 years. Perhaps the most important change is the increased use of synthetic materials. Most technological changes have consisted of the merging or elimination of a number of single small operations, rather than the introduction of automated machinery. Depending on the type of shoe made, from 50 to 100 operations may still be required. Although a few technologies of the last decade, such as injection molding and computer-controlled cutting and stitching, have altered traditional methods in some lines of production, their use is very limited and their effect on labor requirements has been minimal. (See table 3.)

There are significant obstacles to the introduction of automatic machinery. One of the most important is that the industry as a whole is not using a uniform last-grading system that would allow the introduction of standardized equipment. Another factor is that many of the new technologies are not economically feasible with the short-run production patterns common in the shoe industry because of the high capital outlays required. It is, moreover, difficult to design automatic equipment which can be adapted quickly to the frequent style changes. Even the materials handling problems have not been successfully worked out in the smaller plants. The use of leather which is not uniform is itself a limiting factor in the use of highly mechanized or automated equipment.

Nonleather materials

Strong productivity growth, in the long run, may depend on the use of synthetic materials. Because they are more uniform, nonleather materials may be cut several layers at a time, for example. But perhaps of greater importance is the fact that synthetic materials with thermoplastic properties are necessary for many of the new, more productive technologies. Flow molding and injection molding, discussed below, are two such examples.

Table 3. Major technology changes in the footwear industry

Technology	Description	Labor implications	Diffusion
Laser cutting	Computer-controlled laser for pattern cutting; considerably faster than conventional methods.	Unit labor requirements for pattern cutters greatly reduced.	Used by approximately six to seven shoe companies plus several suppliers; not expected to increase substantially.
Flow molding	Automatically molds designs in thermoplastic uppers resembling stitching, pinking, perforations, etc. Permits rapid fashion changes.	Reduces labor requirements for uppers by 20 percent, eliminating stitching and other operations, but requires skilled technicians to prepare molds.	Introduced about 5 years ago, now used for less than 10 percent of vinyl shoes. Growth depends on material and labor savings.
Computer-tape stitching	Numerically controlled sewing system; permits rapid style changes, but is only economically feasible with long production runs.	Greatly reduces unit labor of skilled sewing operators.	Available commercially only 1 to 2 years, used primarily by boot makers. Now finding other applications.
New lasting machinery	String lasting requires sewing a string around the upper which is pulled to shape around the last. Also improvements in flat lasting machinery reduce number of operations.	String lasting eliminates need for skilled lasting operator. Generally reduces unit labor needs for lasting.	About 7 percent of nonrubber shoes are string lasted. Newest flat lasting very widely used.
Injection molding	Automatically molds thermoplastic bottoms to either synthetic or leather uppers.	Requires little or no hand skill; eliminates many operations in most plants requiring skilled workers, including edge trimmers, sole attachers, shankers, etc. One operator may replace six for conventional cement soles.	Introduced in the 1960's, now applied to about 7 percent of nonrubber shoes; growth may be affected by rapid diffusion of premolded unit bottoms.
Unit bottoms	Molded unit bottoms purchased by shoe factory.	Eliminates highly skilled operators required in conventional bottoming.	Diffusion very rapid.

Although synthetics are very common for other parts of the shoe, less than two-fifths of the shoes manufactured use synthetics for the upper part. These are almost entirely vinyls or urethanes and most are in the lower priced lines. The more expensive poromeric materials, which reportedly breathe and absorb moisture, have been successful primarily in specialty shoes. Currently, new synthetic materials are being tested which may be used successfully for better shoes. Also, considerable work has been done in trying to develop a reconstituted leather which would have some of the advantages of synthetics.

New cutting procedures

Cutting of shoe uppers and linings, the first major machine operation, continues to be a highly skilled occupation for men and women. Some cutters are the highest paid workers in the plant, although labor costs for cutting account for only 5 to 8 percent of total labor costs. In general, the cutting process for linings and materials, both leather and synthetic, remains basically unchanged in almost all plants.

One new technology, a computer-programmed water jet process for cutting manmade shoe material for insole and outsole shapes, is just becoming available commercially. Although it is not significantly faster than a skilled cutter using a die, the water jet process offers the potential for more efficient material utilization. However, because material savings are difficult to measure and labor savings are small, manufacturers find it difficult to justify the investment.

Another relatively new technique is the computer-controlled laser cutter for pattern cutting. But it is used by only 6 or 7 of the largest shoe companies, and by several specialized pattern-making plants that supply the industry. It is four or five times faster than the older conventional process, but will continue to be limited because of the expense.

New sewing methods

The fitting room, which may encompass as much as 40 percent of the factory's labor requirements, is most likely to see many technological changes in the next decade.[2] Fitting, or preparing the uppers, requires assembling and sewing or otherwise attaching sections of the uppers together, and perhaps sewing a design on top. The changes which are being most widely adopted are modifications to the sewing machine which require fewer manual skills and less handling and therefore less time per operation. Since fancy stitchers are often the largest occupational group in the shoe plant, this could lead to significant reductions in unit labor costs.

Automatic tape-controlled stitching machine forms a design on the shoe upper

Some of the technological advances on the newer machines include mechanized thread cutting and automatic needle positioning. According to an industry specialist, this type of machine can increase output per worker-hour by about 40 percent over machines requiring manual operations. However, maintenance costs may be increased. Currently, only a small proportion of the industry has adopted these changes.

Flow molding. Since sewing is a relatively expensive process in shoe manufacture, a new method called flow molding, which closely resembles stitching but can only be used with thermoplastic materials, may be one of the more important developments in shoe manufacture.[3] In this process, a high-frequency radio wave system is used to emboss a pattern of stitches or designs or other detail onto a thermoplastic upper from a mold generally made from an identical leather component. It can also attach different pieces of thermoplastic to form a particular design. In the conventional system, highly skilled operators would perform stitching, printing, or perforating jobs to complete the same design.

Flow molding may save as much as 20 percent of the labor conventionally used in preparing the upper parts of some shoes, but requires skilled technicians to prepare the mold and to make the original pattern. Consequently, this process may be most economical for long runs which conventionally would require considerable sewing, perforating, or other decorative work. Also, the vinyls currently in use have not been fully satisfactory for the flow molding process. The development of new and better materials could result in the greater use of this process. Available commercially for about 5 years, flow molding is currently used in less than 10 percent[4] of vinyl shoes made. Whether this process becomes more important will depend on the price and availability of thermoplastic materials, the availability of skilled technicians, and the cost of substituting flow molding for conventional methods.

Computer stitching. A relatively new development in the fitting room is computer stitching. Computer stitching is faster and may be more accurate for decorative stitching than traditional methods but it is not economically feasible, except for long runs. This numerical control system utilizes a computer tape to control stitching and thereby reduces the required employee-hours and skill level of the operator. For example, cowboy boot designs sewn with conventional methods may take a highly skilled operator about 10 minutes; with computer-tape stitching, a relatively unskilled operator would require only 2-3 minutes.[5] Since this system is not economical for many operations, newer systems to reduce the cost of automated stitching are being adapted to shoe manufacture. It is expected, for example, that they will make feasible the automatic join-and-sew operations such as closing of seams and conventional bar tacking operations.

New lasting methods

Lasting operations, which may account for about 25 percent of the labor requirements of the shoe factory,[6] shape the shoe on a form—called a last—made to size and style specifications. This step in shoe manufacture involves five basic operations and some preparatory operations which can be combined in alternative ways and on various machines. Lasting is undergoing many changes but progress varies considerably depending on the shoe style and material.

In general, the lasting method requires many steps including tacking and cementing to fasten the shaped material to the insole. Thermolasting, the most common method, molds and fastens a synthetic or leather upper by using electronically activated cement, eliminating the jobs of tacking and precementing. Although thermolasting has been very widely accepted, some older plants still have not adopted it. An important advance of the last 5 years is the one-station process of pull-toe lasting which combines the separate operations of pulling-over and toe lasting. This combination of operations saves time, reduces labor, and lowers the required skill level. In some cases, the pulling and lasting operation can now be done on two machines in place of six.

Another change in lasting methods in the past decade is the application of string lasting to vinyl-upper footwear. A string is sewn around the upper part of the shoe and when the shoe is ready for lasting (shaping), the string is pulled tight around the last. In contrast, thermolasting requires a highly skilled operator who can shape the upper properly and cement it carefully without damaging the material. Currently, about 7 percent of nonrubber shoes are made with string lasting.[7] Although the string method can be used with leather, it requires special equipment and is not in general use. Many of the problems involved are being solved, however, and the use of string lasting for leather shoes may increase.

In welted construction, the lasting operation may include as many as nine steps, requiring several skilled and semiskilled operators. About 15 percent of nonrubber shoes and almost 50 percent of men's shoes are made in this way.[8] In this process, relatively little technological change has occurred, although modifications to existing machinery have been developed. New machines have recently become available which combine many operations; their use makes possible three-machine lasting with savings in operators' labor. Many operators in welted construction are toe and side lasters and pullover machine operators.[9]

Last grading

The more rapid adoption of a standard system of grading shoe lasts—geometrically rather than arithmetically—could significantly increase productivity. It is based on the concept of changing all last (shoe form) dimensions proportionately by the same percentage factor with each size change. The arithmetic grading system, in general use since 1887, is based on adding fixed increments to length, width, and girth for each size change. Unlike the arithmetic grading system, geometric grading does not require manual labor for adjusting and positioning in shoemaking operations. While geometric lasts are being adopted by the larger companies, in general the changeover to geometric grading has been very gradual because of the costs associated with replacing old lasts. A research program recently funded by the industry and the Federal Government is investigating several aspects of standardization. One of its objectives is to educate the industry to the advantages of standardization.

Bottoming processes

The injection molding process of attaching the bottom to the shoe substantially reduces the labor required for conventional shoe production, but is used for only about 7 percent of nonrubber shoes.[10] The conventional method of cementing the shoe bottom onto the upper is a difficult, highly skilled operation which may involve a dozen steps. In this newer bottoming operation, the injection molding machine automatically molds a shoe bottom from thermoplastic or polyurethane material to the upper part of the shoe. Little or no hand skill is required in this operation, which replaces several cutting, trimming, and finishing jobs. One operator may replace as many as six operators in the conventional cement-sole operation.

In spite of these apparent advantages, injection molding has not been readily adopted. The high cost of molds is a limiting factor. Another major reason is the success of "unit bottoms," discussed below. The unit bottoms which are purchased by the plant provide the advantages of injection molding without the high capital investment and mold development costs.

For shoes which include a welt around the sole, relatively little change has occurred in the highly skilled bottoming process currently in use. The welt is a strip of leather or other material which is sewn to the insole rib—only one of many processes necessary for preparing and bottoming a Goodyear-welt shoe. The process of sole-attaching is done on a lockstitch machine which fastens the sole to the welt. Some of the newer machines combine operations but no important technological changes have occurred, with the one exception of cement toe lasting in place of wire. In general, the plants which produce higher priced men's shoes use many highly skilled workers for bottoming, some of whom, like the inseamers, are among the higher paid workers in the plant.

Molded unit bottoms

The process of bottoming, i.e. attaching the bottom to the upper part of the shoe, has been greatly simplified in recent years for some styles of shoes by the purchase of molded unit bottoms by the shoe factories. The purchased units are cemented to the uppers, thus eliminating the more skilled, exacting operations of bottoming and the associated labor which would be required in the shoe factory. While some of the larger companies make their own molded bottoms, most companies purchase them from specialty shops. The diffusion of this practice has been very rapid and is being used for men's and women's shoes, whether high- or low-heeled, leather or synthetic.

Output and Productivity Outlook

Output

Output of shoes and slippers (except rubber) declined at an average annual rate of 2.2 percent from 1960 to 1975. In 1975, after 7 consecutive years of decline, the annual output was the lowest in the post-World War II period.[11] Production rose very slowly from 1960 to 1967 (average increase of 0.1 percent annually), but dropped sharply (average of 4.2 percent annually) from 1967 to 1975 (chart 4). The sharp decline since the mid-1960's, when output hit peak levels, was largely a function of the reduced output of women's shoes. Production of women's shoes fell over 40 percent from 1966 to 1975, while men's shoe production declined about 18 percent over these years.

The contraction in footwear production is largely associated with lower price, higher style imports which started to increase in the mid-1960's. Low labor cost in exporting countries has been the key factor. In the period 1966-75, the quantity of imported shoes more than tripled, to 319 million pairs, while domestic shoe production fell 36 percent. In 1975, imports constituted 44 percent of apparent consumption (quantity) compared with 13 percent in 1966. In terms of value, imports made up 27 percent of consumption in 1975 compared with 5 percent in 1966.[12]

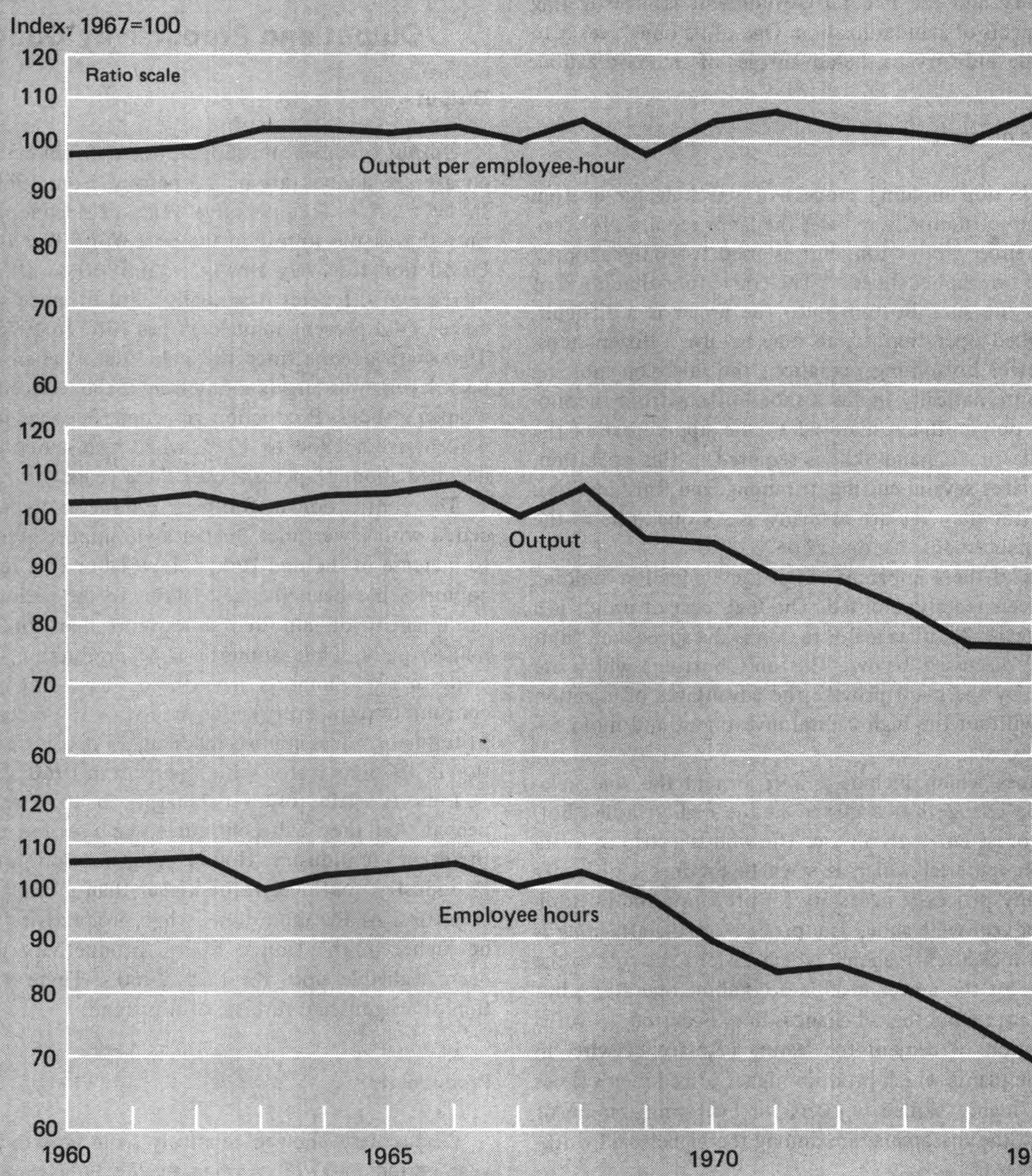
Imports again rose very sharply in 1976 and it is expected that they will continue to be a serious problem to the domestic industry. Hourly compensation in the domestic industry continues to be higher than in most exporting countries. At the same time, while productivity levels may be higher in the United States, productivity growth has been negligible since the early 1960's. There is no indication of a significant reversal of this trend.

Productivity

Productivity showed relatively little growth in the 15-year period 1960-75. Among the 58 industries for which BLS data are available, the footwear industry experienced the lowest productivity gain.[13] Output per employee-hour increased only 0.4 percent annually during 1960-75, compared with 2.1 percent in the decade of the 1950's. The low productivity growth is associated with the very sharp de-

Chart 4

Output per employee-hour, output, and employee hours in the footwear industry, 1960-75



Note: 1975 data are preliminary.
Source: Bureau of Labor Statistics.

cline in production, as discussed above, and a somewhat steeper drop in employee hours over the period. As can be seen on chart 4, the rate of productivity gain has been relatively stable but small since 1960.

In 1975, however, productivity showed an unusually high increase of 7.4 percent as output declined relatively little (1.5 percent) and employee-hours fell very steeply (8.2 percent). In anticipation of a severe and long-lasting recession, employees were laid off during late 1974 and early 1975. Although demand picked up sharply later in 1975, workers were recalled only slowly. A similar pattern of production and hours had occurred in 1970, the only other year since 1950 in which the productivity gain was high.

The very slow growth in footwear productivity is associated, in large part, with methods of production which have not changed significantly in recent years. Moreover, continued emphasis on fashion changes, even for men's shoes, necessitates short-run production schedules in which productivity is relatively lower. The following tabulation shows the difference in productivity between "hi-style" and volume production in one manufacturing plant visited:

Type of shoe	*Output per production worker (pairs per 8 hours)*	
	Hi-style	*Volume*
Welts	4 – 5	8 – 10
Cements:		
Novelties	6 – 8	9 – 12
Flatties	12 – 15	15 – 20
Injection molded:		
Stringlast	–	40

Productivity is not likely to increase substantially in this decade. As shown earlier, current technological changes are only slowly affecting unit labor requirements, and expected capital expenditures are not likely to change this significantly in the next several years. The industry's problems are currently compounded by the uncertain economic outlook coupled with strong imports.

Nevertheless, some changes are occurring which may strengthen the industry. One of these is the increase in vertical integration by the larger firms, principally by the acquisition of retail outlets. While greater concentration of production has not occurred in the industry, the larger companies are becoming stronger and more effective in dealing with marketing problems and perhaps with capital investment.

Best plant practice

Although the average productivity of an industry is the common measure, the range of distribution of productivity among establishments in an industry with a high degree of specialization such as the shoe industry can be significant as a measure of potential growth or simply for greater understanding of productivity differences. In a study of 1967 Census data[14], shoe plants were ranked by value added per production-worker-hour, which permits a rough indication of the range of distribution of productivity. In this industry, average value added per production-worker-hour in the highest quartile was 2½ times larger than in the lowest quartile, and 1½ times larger than the average. (See table 4.) This may reflect differences in product mix, size, management, labor utilization, capital outlays, and other factors. Unfortunately more detailed data are not available.

Table 4. Value added in the shoe (except rubber) industry: Ratios of "highest quartile" to "lowest quartile" plants[1] and to average plant, 1967

Ratio	Value added per production-worker-hour
Highest quartile to lowest quartile	2.5
Highest quartile to average	1.5

[1] Establishments were ranked by the ratio of value added per production-worker-hour. Data cover nonrubber shoes only and do not include slippers.

SOURCE: Based on unpublished Census data prepared for the National Center for Productivity and Quality of Working Life.

Investment

An industry's capital outlay for equipment is generally considered an indicator of technological change. This is not the case in footwear, however, because the practice of leasing machinery is so extensive.[15] Most firms still lease some machinery, and some firms lease all their machinery. Although the smaller companies tend to lease more because of the high cost to them of capital (or the problems of availability), even the largest companies may lease as much as 25 percent of their machinery. Census data for 1973 indicate that about half the outlay by footwear companies for plant and equipment was for rental payments. In manufacturing as a whole, rental payments accounted for only 16 percent of total outlays in 1973.

Taken together, outlays for plant and equipment, whether purchased or rented, have been relatively low in this industry. Expenditures for new plant and equipment moved up, after several years of decline, to $44 million in 1973. But this was slightly below the peak outlay in 1968. Rental payments also increased in the last several years to $44 million, but that too was no higher than the 1968 payments.

These are current-dollar figures which reflect costs unadjusted for changes in the prices of machinery or changes in rental costs. Although prices of shoe machinery, specifically, are not available, prices of special and general purpose machinery rose very substantially over the 1968-73 period. It is, therefore, reasonable to assume that the capital expenditures which were similar in 1968 and 1973 actually represented a considerable decline in real dollar value in 1973. The assumption can also be made that a decline occurred in the real value of rental outlays between 1968 and 1973 although data are not available on rental costs.

Another measure of capital investment is its relationship to labor. Per production worker, the outlays for rented and purchased equipment in the shoe industry are very low relative to other industries. As employment dropped in the 1960's, outlays per production worker rose quite rapidly, to almost $500 in 1971. Nevertheless, that was only about one-fourth of the average outlay per production worker made by manufacturing industries that year (Census data).

Research and development funds are also very limited. Except for a few manufacturers, the industry relies on machine manufacturers and general suppliers for equipment development. Low profit rates and the structure of the industry, e.g. many small firms, have been serious deterrents to investment for research or development.

There is no expectation, at this time, of significantly higher investments by the industry. Most shoe companies and machine manufacturers are reluctant to make substantially larger capital outlays when production is declining, without anticipation of a substantial change in direction.

Employment and Occupational Trends

Employment

About 163,000 workers were employed in the footwear industry in 1975, the lowest number since 1939 (earliest comparable data; BLS). Following a relatively stable period in the 1950's and early 1960's, employment declined sharply. From 1960 to 1967, employment fell an average of 0.5 percent annually, but from 1967 to 1975 the rate of decline was considerably faster, 4.3 percent annually. (See chart 5.) This accelerated rate of decline is associated with the very sharp decrease in output which started in the late 1960's and deepened during periods of recession. Overall, from 1960 to 1975, employment in footwear manufacturing fell an average of 2.2 percent annually. Although employment recovered noticeably in 1976 as the economy improved, the long-term outlook is for continued slow decline, as shown in chart 5.

Production workers accounted for about 87 percent of all employees in the industry in 1975, and their share of the total has not changed significantly since 1960. This proportion is very high compared with other industries. In all manufacturing, production workers account for about 75 percent of all employees.

Women historically have held a large proportion of jobs in the footwear industry and in the last decade their relative position has been further strengthened by technological changes. Changes in manufacture associated with cutting, lasting, and bottoming—and especially the shift to leather substitutes—have tended to reduce unit labor requirements for jobs that were traditionally held by men. At the same time, jobs held by women—top stitching, fitting, and inspection—have been relatively stable. As a result, the number of women employees declined only 6 percent from 1960 to 1975 compared with the sharp drop of 36 percent for men. By 1975, women constituted 65 percent of footwear workers, the proportion having moved up steadily from 56 percent in 1960.

Occupations

About 6 percent of the footwear workers are skilled, compared with 20 percent in all manufacturing, but about 75 percent are semiskilled, compared with fewer than half in manufacturing. The large number of semiskilled workers reflects the nature of the work—the numerous hand or machine operations involved in assembly and finishing. Many of these semiskilled jobs, typically performed by women, are simple and repetitious and require relatively little training. Most of these are in the stitching, fitting, and inspection operations. The skilled jobs are more often performed by men and include cutting, lasting, and bottoming. However, a few highly skilled jobs are held primarily by women in stitching and fitting operations.[16]

Since technological changes are evolving slowly, they are influencing skill and labor requirements only moderately. Nevertheless, a few innovative processes with a relatively rapid rate of diffusion, such as injection molding, are altering occupational patterns in some shoe plants.

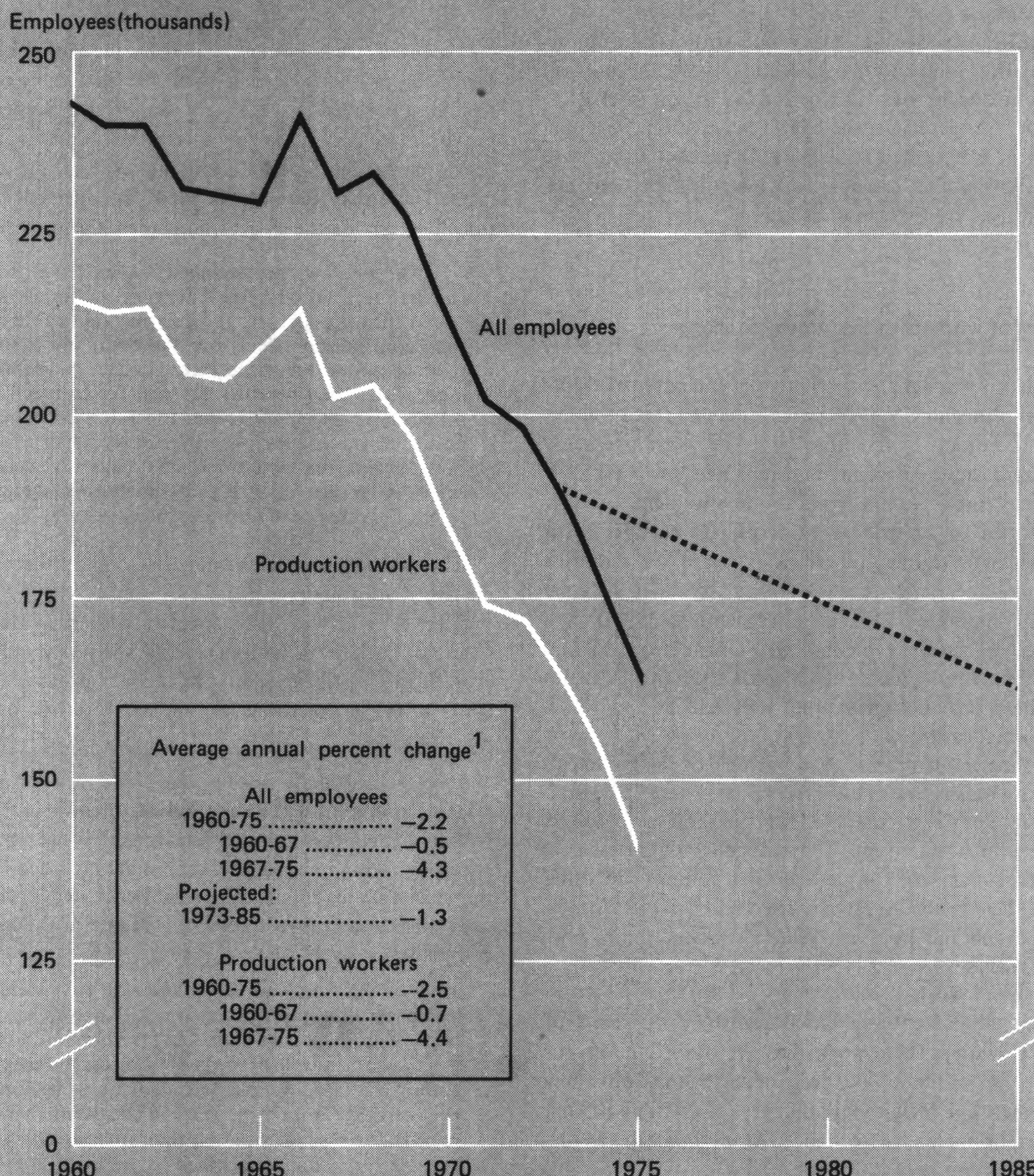
The major thrust of new technology in this industry is to simplify the jobs, or "de-skill" them, in an effort to increase productivity and reduce unit labor cost. For example, new molding techniques that simulate stitched uppers eliminate the need for skilled stitching operators. Similarly, in the computer-tape stitching innovation, an unskilled operator can do the job in one-fifth the time required for a skilled stitcher working conventionally. The use of synthetics rather than leather is another example of job simplication. Cutting uppers from hides is a slow and difficult job, requiring skill and experience, while vinyl can be cut 8-10 sheets at a time with considerably less skill. Nevertheless, while skill levels are being reduced in many operations, the level of responsibility required for the operation of a few complex machines may be greater.

To a lesser extent, certain occupations are being entirely eliminated by new technologies. For example, an injection-molded sole, unlike the conventional cement sole made in an average plant, does not require operations by the edge trimmer, the heel attacher, the sole attacher, the shanker, and others. As mentioned earlier, one operator may replace as many as six on the conventional cement-sole operation.

The effect of new technologies on labor requirements depends on the rate of diffusion, which, as discussed above, is relatively slow in this industry. Consequently, these changes are only moderately altering the occupational distribution in the industry. The BLS projections of footwear

Chart 5

Employment in the footwear industry, 1960-75, and projection, 1973-85



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

Source: Bureau of Labor Statistics.

employment by occupation[17] in 1985 (chart 6) show very little change in the distribution between 1970 and 1985. White-collar workers (professional, technical, and kindred workers; managers, officials, and proprietors; and sales and clerical workers) are expected to increase their share of total employment from 14.1 percent in 1970 to 15.1 percent in 1985. The blue-collar group of craft workers, operatives, and laborers may drop only 1 percent of their share to 83 percent of the total. The remaining group, the service workers, will continue to constitute about 2 percent of all workers in this industry.

The distribution in 1970 and in 1985 is not expected to differ significantly because every occupational group, according to this projection, is reflecting the total industry employment decline over this period, as shown in chart 6. The number of operatives, the largest occupational group in the industry, is expected to decline 27 percent from 1970 to 1985. Within this category, sewers, stitchers, and machine operatives are the largest groups.

Adjustment of workers to technological change

Programs to protect the worker from the adverse effects of changes in machinery and methods may be incorporated into union contracts or they may be informal arrangements between labor and management. Adjustments to new technologies may relate to the workers' involvement through advance notice or knowledge of workload changes, with possibilities of retraining or transfer based on seniority rights. Where severance is a possibility, seniority may be particularly important. Aid in adjustment to layoff may include various types of income maintenance such as supplementary unemployment benefits or severance pay. In general, these provisions are more prevalent and more detailed in formal contracts.

In the shoe industry, less than one-half of the industry's production workers are in establishments covered by labor-management contracts compared with an average of 60-65 percent in all manufacturing. They are generally 2-year contracts, rather than the 3-year contract common in other industries. The major unions are the United Shoe Workers of America and the Boot and Shoe Workers Union, both AFL-CIO affiliates.

In the shoe industry, contract provisions to assist workers in their adjustment are based primarily on rights of seniority. However, these provisions are often limited, for example, either to the job or to the department. Only a few contracts mention technology changes, as such, and many have no arrangements for grievance. An examination by the BLS of eleven major collective bargaining agreements in effect in 1975 covering 1,000 workers or more revealed only two, accouting for 5,100 workers, which required advance notice of change in machinery or methods. Two contracts required advance notice for layoff or plant shutdown. One major contract reads:

> "When machinery substitutes for hand work, the employees of the particular operations affected shall receive the preference to operate the machinery. The union shall be notified of such contemplated changes at least five days in advance."

Since about three-fourths of the production workers are on incentive wage systems based on individual piecework, contract provisions dealing with rate structures on new or revised job schedules are very important. Some contract provisions contain wage guarantees tied to previous earnings for a determined period pending establishment of new rates. These may then be "grieved" and brought to arbitration. For one of the larger companies, the provision reads:

> "Where new or changed operations, conditions, change in method, machinery or materials are introduced into the factory, the existing applicable class wage shall continue in effect, but the company shall have the right to adjust the piece rate. If after a reasonable learning period, the operators thereon fail to reach the established level of earnings on the job, the company and union, at the request of either party, shall make a joint investigation to determine the cause of such failure, since under the foregoing circumstances, a maintenance level of earnings can normally be expected."

The matter may then be negotiated and if necessary submitted to arbitration.

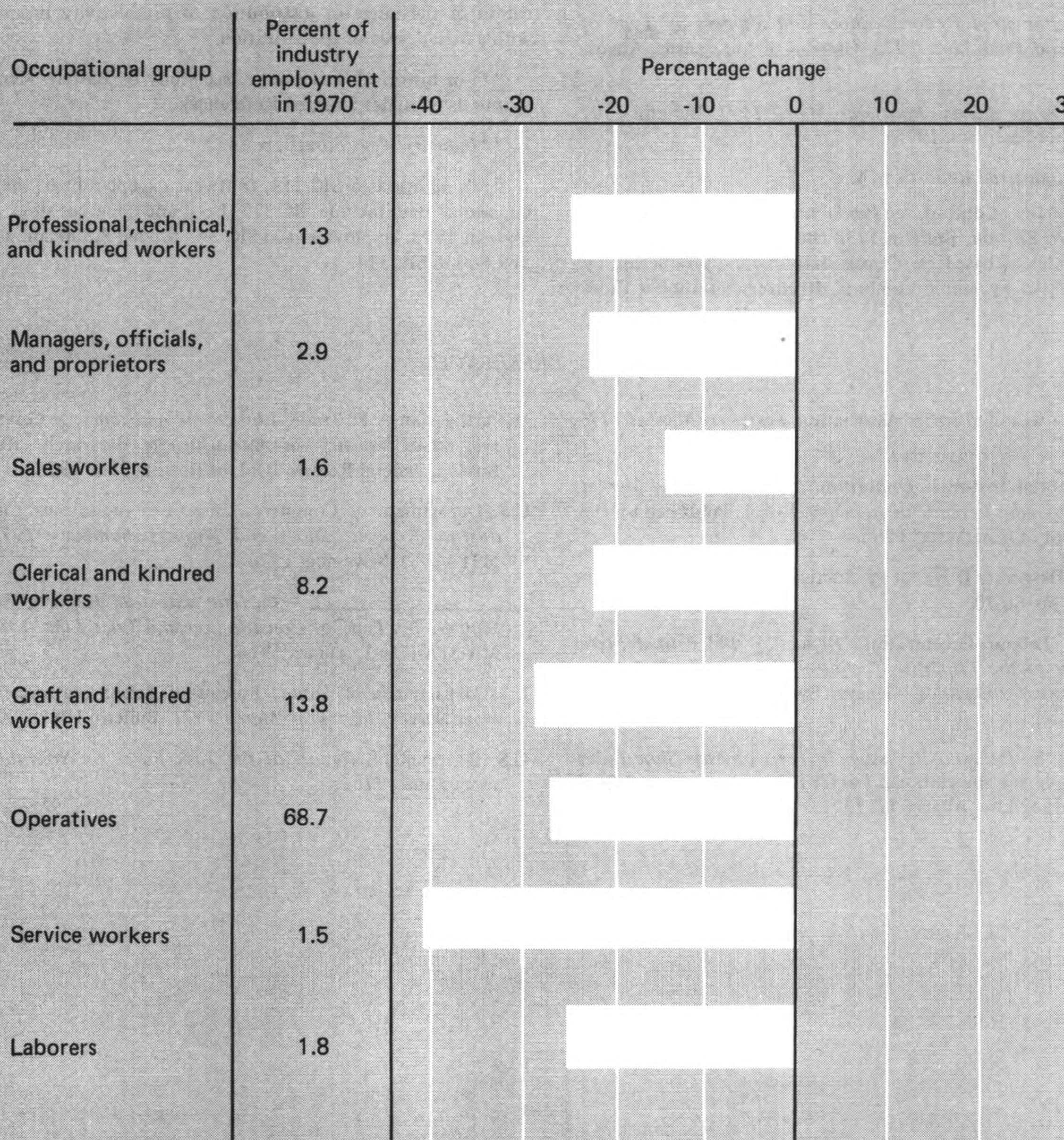
That type of wage assistance to workers in their adjustment to machine or method changes is not standard, however. Many companies do not include provisions in their contract for an interim wage rate or arbitration on the final wage rate.

Layoffs and plant closings have been and continue to be a severe problem in the shoe industry, and major contracts reflect this concern in provisions for worksharing and severance pay. Severance pay provisions are included in seven of the eleven major union contracts mentioned earlier. As for worksharing, a contract provision of one of the largest shoe companies reads as follows:

> "Layoffs shall not be made nor any employee sent home on the basis of seniority. No waiting time shall begin and no operator shall be sent home as long as there is any work ahead of any operator on the particular job. Either all or no employees shall be sent home or paid their average hourly earnings in the event there is a stoppage in the flow of work to their operation."

Chart 6

Projected changes in employment in the footwear industry[1], by occupational group, 1970-85



[1] Includes footwear cut stock and findings (SIC 313) and footwear except rubber (SIC 314).
Source: Bureau of Labor Statistics.

FOOTNOTES

[1] Apparent consumption represents new domestic supply. It is production minus exports plus imports.

[2] Unpublished data based on BLS field visits.

[3] Ibid.

[4] Ibid.

[5] Ibid.

[6] Ibid.

[7] Ibid.

[8] *Current Industrial Reports, Shoes and Slippers by Type of Construction and Price Line, 1975*, (Bureau of the Census, August 1976), p. 5.

[9] *Industry Wage Survey, Footwear, March 1971,* Bulletin 1792 (Bureau of Labor Statistics, 1973).

[10] *Current Industrial Reports*, p. 4.

[11] For the index of output, see *Productivity Indexes for Selected Industries, 1976 Edition,* Bulletin 1938 (Bureau of Labor Statistics, 1977). This index is based on Census data of shoe production by type and weighted by employee-hours. It covers nonrubber shoes and slippers. Rubber shoes are defined as shoes with soles vulcanized to fabric uppers. In 1974, production of this type of shoe totaled almost 150 million pairs, compared to 450 million pairs of nonrubber shoes and slippers.

[12] *Current Industrial Reports,* p. 4.

[13] *Productivity Indexes,* p. 7.

[14] Data exclude rubber shoes and slippers. Unpublished Census data prepared for the National Center for Productivity and Quality of Working Life. Although value-added data are not used for productivity measurement, they are nevertheless useful for a rough indication of the range of distribution of productivity in an industry with a high degree of specialization.

[15] For historical background, see study by Battelle Memorial Institute listed under Selected References.

[16] *Industry Wage Survey*, p. 14.

[17] In addition to SIC 314, footwear except rubber, the BLS occupational data include SIC 313, boot and shoe cut stock and findings. In 1973, employment in SIC 313 totaled 8,500 compared with 169,800 in SIC 314.

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Chapter 3. Motor Vehicles and Equipment

Summary

New equipment and manufacturing methods are expected to continue to be introduced in the motor vehicle and equipment industry. Specific innovations which may be applied more widely include electronic computers, improved equipment for automatic assembly, use of plastic and powdered metal materials, numerical control, and improved transfer lines. New technology in some instances is expected to improve quality and achieve productivity gains.

A total of \$2.1 billion was spent by the motor vehicle industry for new plant and equipment in 1975, and an estimated \$2.4 billion was spent in 1976. These amounts are about three times as much as the 1960 expenditure of \$790 million, although the increase would be less in real terms due to increases in plant and equipment prices over the period. The average annual rate of increase in spending was lower during 1967-75 than during the 1960-67 period. Capital expenditures are expected to increase considerably over the next several years in order to produce cars that can meet Federal Government standards for safety, exhaust pollution levels, and fuel economy.

Output per employee-hour in the motor vehicle and equipment industry (BLS data) increased at an annual rate of 3.2 percent between 1960 and 1975. The productivity growth rate in the motor vehicle industry was 3.6 percent annually during 1960-67, slightly above the 3.2-percent average annual rate achieved during 1967-75. Growth in output per employee-hour was particularly strong during 1971 and 1972 as output rose sharply from the 1970 strike-year level in response to very strong demand for cars and trucks. Further productivity growth occurred in 1975 when employment fell more rapidly than output. Productivity gains in assembly, machining, and other production operations are expected as new technology is introduced.

Industry employment rose from 724,000 in 1960 to a peak of 955,300 in 1973, then dropped during the economic downturn of late 1974-75 to 774,100 in 1975.[1] As sales and production improved in 1976, employment rose to 850,600. BLS projections indicate that employment may decline to 808,000 by 1985.

Technological and other changes will continue to alter the structure of occupations in this industry. Demand for managers, sales workers, and semiskilled operatives will increase while declines are expected in the other major occupational groups. Although new technology will reduce unit labor requirements in some operations, industry growth will result in higher long-term employment levels for computer specialists, assemblers, and others who work with new technology. Semiskilled workers will continue to constitute the largest occupational category. These workers are engaged in production operations which generally are the most labor intensive and have potential for further technological change.

Technology in the 1970's

Technological changes in the motor vehicle and equipment industry are underway in major phases of production, with productivity gains and laborsavings anticipated. These changes include more extensive use of electronic computers, improved equipment for automatic assembly and inspection, more widespread use of plastics and other lightweight materials, more widespread application of numerical control, and improvements in transfer lines. (See table 5.) Modifications of automobile engines also are underway to meet stricter emission standards and to raise fuel economy.

Electronic computers

Computers are a key technology in the automobile industry, initially applied to business operations such as payroll and bookkeeping records and subsequently extended to an increasing number of research and production operations. According to International Data Corporation, more than 400 computers are in use in the industry, with further growth in computer use expected. Examples of computer applications gaining prominence, and their labor implications, are presented below.

Auto styling and design. Mathematical information representing automobile body surfaces can be stored in a computer memory system. A designer, working with a graphic display terminal, can use this information to design auto body parts. The computer translates the design into mathematical coordinates that can operate automatic drafting machines and numerically controlled (N/C) machine tools. Engineering, drafting work, and tool production operations can be more closely integrated, thereby speeding up the work flow. Computer use in design may affect labor requirements in the industry in several ways. First, the complex programming required may increase the need for com-

Table 5. Major technology changes in the motor vehicle and equipment industry

Technology	Description	Labor implications	Diffusion
Electronic computers	The use of graphic display terminals can integrate and speed workflow between design, tooling, and production. Time requirements for R&D work are lowered. Numerous applications in quality control increase productivity of inspection personnel. Computer control of machining and assembly operations may increase production rates and reduce labor requirements.	Employment increases in computer-related occupations such as systems analysts, programmers, and peripheral equipment operators. Declines expected for drafters and keypunch operators.	More than 400 computers are estimated to be in use. Continued growth expected in the number of computers and types of applications.
Machine assembly operations (automated assembly lines)	Automated assembly applications range from tightening bolts to welding car bodies together. Automatic assembly stations are frequently intermixed with manual stations, depending upon the nature of the job.	Reduced labor requirements in semiskilled assembly operations, and increased need for machine maintenance personnel.	Machine assembly has experienced considerable development over the past decade, and is expected to continue to grow in use.
New materials	Plastic materials offer advantages over steel and cast metal materials in weight savings and, often, fewer processing operations. Parts can be fabricated from metal powder into complex shapes and with fewer machining operations. More widespread use of aluminum and special steels also is anticipated.	Some reduction in semiskilled sheet-metal workers and machine tool operators.	Use of plastics and aluminum will continue to grow.
Numerical control	Automatic operation of machine tools by electronic control devices and coded tape instructions can reduce machining time and labor costs.	Decline in the number of machine tool operators needed, and possibly some increase in machine maintenance personnel.	Numerical control in limited use at present. Applications expected to grow in future, with emphasis on new solid-state programmable controllers and direct computer control.
Improved transfer lines	Transfer line productivity and flexibility have been increased by the introduction of multipurpose machines, interchangeable machine modules, storage banks for parts at intervals in the machine line, and an increase in the number of automatic operations.	Reduction in the number of machine tool operators and inspectors.	Equipment designed to increase transfer machine flexibility is in limited use, and should increase as transfer lines are modified or replaced in the future.

puter programmers. The need for drafters however, should decline. Such computer-aided design is expected to increase in the years ahead.

Engineering research and product development. Using computers, engineers can analyze large quantities of data—sometimes from computer simulation of real situations—to solve design or production problems in remarkably short periods of time. An auto parts manufacturer, for example, saved 9 months to 1 year of development time by using its computer capacities to perform preliminary design calculations on a new long-life piston ring.[2] Computer application to research and development operations is not yet commonplace, but it is a frequently used tool that will probably become commonplace in the future.

Computer control. The application of computers to the control of production operations is a major step in the evolution of computer technology. Computers are being used to keep track of parts and production materials and to forecast potential shortages that could disrupt production. Computer control can aid in attaining uniformity and quality control in machining. It also can aid in work scheduling and production line balancing to increase productivity by directing the proper materials to the worker at his place on the assembly line. Computers can be applied to a group of such operations, tying them together in such a manner as to provide computerized control over an entire manufacturing or assembly process. The computer system also can make available large quantities of current data to management to aid decisionmaking. The major auto manufacturing firms are using most of these applications but there are no data on the extent of their use.

Several machine tool manufacturers market computerized control systems for machine operations. One system links a small computer directly (no tapes are used) to four machine tool controllers. The system requires only one operator to load stock and oversee the operation of the system, and it can perform the work of ten conventional machines and operations.[3] Another system uses a small multipurpose computer, memory drum, and a teletypewriter input/output unit to operate simultaneously a combination (up to 16 units) of N/C machines, special purpose machines, and transfer machines. One operator can control the entire system.[4]

Numerical control

Numerical control is a process of operating machine tools through a series of electronic control devices and coded tape instructions. It is a process that is particularly suitable for the manufacture of metal parts in small volume because it eliminates the many expensive fixtures, jigs, and templates otherwise necessary. As such, numerical control techniques are in limited, but increasing, use for the fabrication of the tools and dies needed to operate the industry's many high-volume production machines. Extensive use is being made of numerical control in fabricating sheet-metal parts—a development which ranks among the major applications of numerical control techniques in the United States.

Increased use of numerical control techniques should, as has occurred in other industries, reduce the need for machine tool operators.

Applications of numerical control and direct computer control (discussed elsewhere in this chapter) can be expected to grow. This is one of several methods the auto industry can use to improve the flexibility and utilization of its basic production machines.

Transfer lines

Transfer lines—highly mechanized production lines—are becoming more flexible. Traditionally, transfer lines have been custom built to do one job. Any significant change in the job to be done has generally necessitated a significant change in the construction of the transfer line itself—an expensive and time-consuming process.

Flexibility is being increased by the use of "building block", or "modular", transfer lines, constructed from machinery and equipment consisting of interchangeable, standardized units. These lines can accommodate changes in parts design or retooling for new car models with delays and retooling costs minimized.

The inclusion of storage banks for parts at intervals along a transfer line provides a further increase in flexibility. These storage banks allow a line to continue in operation even if a station in the line stops. Although not a new concept, the use of storage banks has yet to be fully implemented. Computer simulation is being used by at least one manufacturer to predict optimum locations and sizes for storage banks within the transfer lines. The number of automatic operations performed on transfer lines also is increasing, especially time-consuming gaging and inspection operations, which allows a reduction in labor requirements and an improvement in quality control. The new transfer lines are mechanically more complex, requiring more highly skilled maintenance crews.

The development of solid-state programmable machine controllers also contributes to transfer line flexibility. These controllers operate faster and more reliably than the older magnetic-relay controllers they are replacing. It is their programmability that makes them important. Changing the application of a conventional magnetic-relay controller involves changing the physical wiring in the controller, and each such change can take an hour or more to make. The programmable controller needs only to be reprogrammed, which can be accomplished in minutes, rather than hours. Furthermore, it is possible that the use of programmable controllers will lead to more widespread use of computer control.

Machine assembly

Machine assembly (where it can be used) reduces the high labor content of assembly operations, which may in turn lower manufacturing costs. In addition, stricter safety standards and increased emphasis on product performance and quality can often be better met by machine assembly than by manual methods.

The potential impact of automatic assembly operations on labor requirements is considerable because assembly operations are the most labor intensive in the manufacture of autos. There are many simple, repetitive, and monotonous assembly operations that are candidates for machine assembly. Similarly, machine assembly can be applied to some operations that are physically difficult and fatiguing. Job skills for assemblers tend to shift toward machine monitoring and materials handling. The demand and skill requirements for machine maintenance personnel could increase considerably; these can be met by retraining machinists who might otherwise be displaced by the new process.

The diversity and productivity potential of automatic assembly machines are illustrated by the following example obtained by BLS staff during plant visits: One manufacturer uses both an automatic and a manual line to assemble and test torque converters used in automatic transmissions. When the automatic line is in full operation, a crew of 8 people per shift is expected to produce as much as is presently done by a crew of 13 people on the manual line. One part of the automatic line already in operation inserts blades into slots in the body of the torque converter—a process in which two people per shift (one attendant and one parts loader) on the automatic line can do as much work as four people per shift inserting blades by hand.

Several major automakers utilize industrial robots to perform many of the welding operations required on a passenger car body, including those that are the most difficult for employees to accomplish. The robots are programmed to make a particular type of weld on a specific body style. The first robot in the line is supplied computer data on the sequence of body styles forthcoming on the assembly line. The first robot also contains a master program for controlling the succeeding robots on the welding line. Each robot reportedly can do work equal to 1¼ welders, thereby reducing the number of welders needed. This is, however, somewhat counterbalanced by the need for a larger and more highly trained maintenance crew. Although there may be little or no labor savings, the quality of the weld is more consistent than is possible with manual welding.

New materials and processes

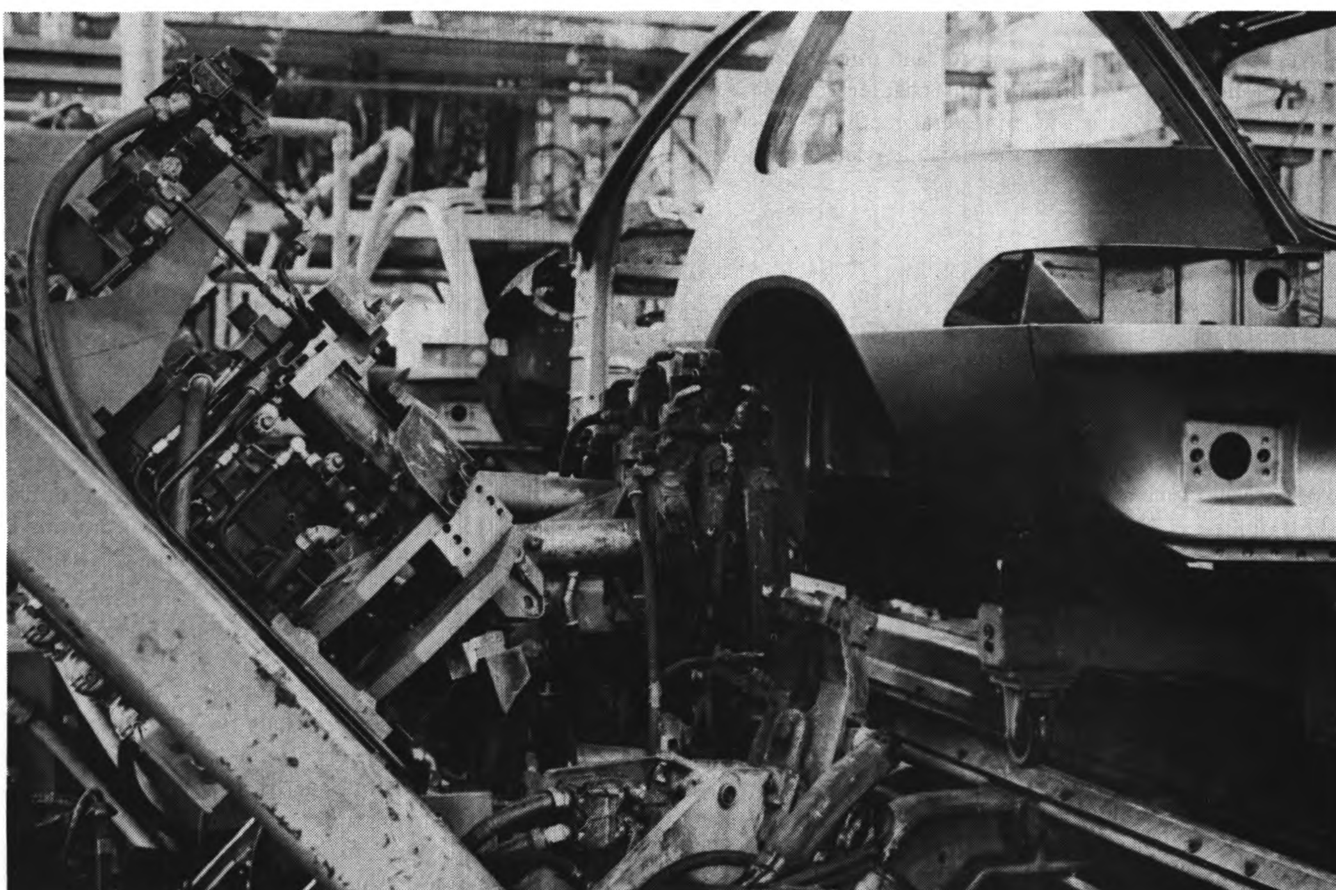
The use of plastic materials has grown considerably as improvements in both the plastic materials and the plastic-working technology have become available. Advantages of plastics over steel (in those cases where plastics meet rigidity and strength requirements) include lower weight and generally lower tooling costs. Increased use of plastics may reduce labor requirements because plastic parts often require fewer finishing operations than comparable metal parts and large, one-piece molded plastic panels (such as dash panels or front-end body panels) can often replace an assemblage of sheet-metal parts, reducing assembly time. Plastics (especially fiber-reinforced composites using glass or other filaments) are expected to grow considerably in use because of the increased emphasis on lowering vehicle weight to improve fuel economy. Aluminum and special steels also will be used more widely for a growing number of auto components to reduce weight.

The fabrication of metal parts from metal powder is more widely used in the automotive field than in any other industry, and may become even more important due to recent improvements in materials and manufacturing processes. Powder metallurgy parts can be made in complex shapes, of high strength, and to such close tolerances that many secondary machining operations and inspection procedures can be reduced or eliminated, thereby reducing labor requirements.

Output and Productivity Outlook

Output

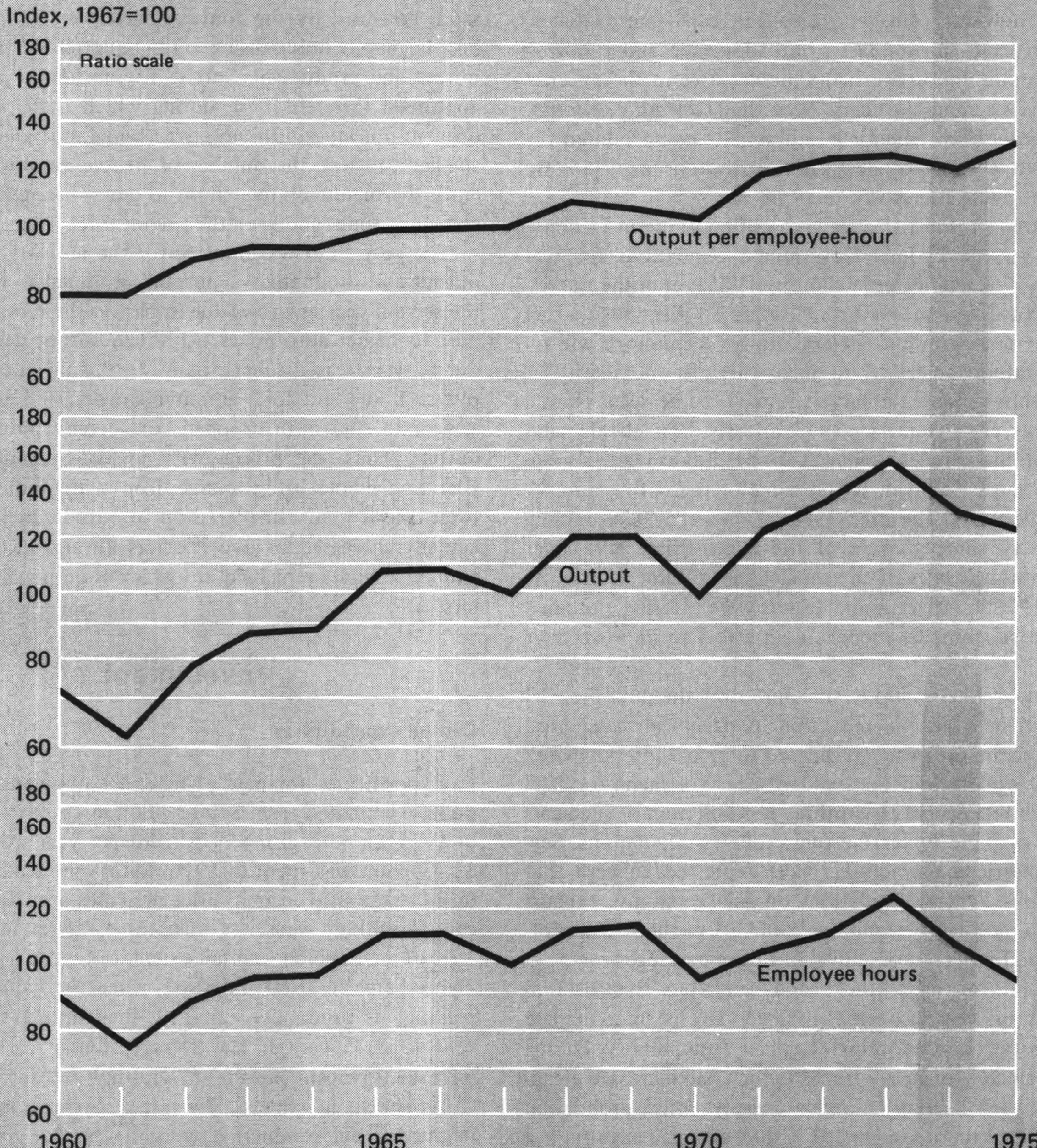
Industry output increased at an average annual rate of 4.8 percent between 1960 and 1975. (See chart 7.) The growth rate was higher during the 1960-67 period—averag-



Welding automobile body on automatic welding machine

Chart 7

Output per employee-hour, output, and employee hours in the motor vehicle and equipment industry, 1960-75



Source: Bureau of Labor Statistics.

ing 7.9 percent a year—than it was during the more recent 1967-75 period, when it averaged 3.2 percent a year. The lower growth rate of recent years reflects several negative economic factors: There was a moderate recession and a major industry strike in 1970, followed—from late 1973 to 1975—by an oil embargo, a period of high inflation, and a severe recession. What tends to be obscured in this growth rate figure is that output rose to record levels in 1971, 1972, and 1973. Auto sales began to rise again in late 1975, and continued strong during 1976.

Historically, "regular" size passenger cars have been the mainstay of U.S. auto manufacturers. During the late 1960's, however, smaller passenger cars—intermediates, compacts, and subcompacts, both domestic and foreign—became more important in the marketplace at the expense of regular size and large cars. According to *Ward's Automotive Yearbook*, intermediate and small cars accounted for almost 40 percent of new car registrations in 1966. By 1975 this figure had grown to 77 percent.

The trend toward smaller cars will continue in response to the present Federal Government regulations for fuel economy (27.5 miles per gallon by 1985) set in the Energy Policy and Conservation Act of 1975. To meet such a fuel economy goal with current automotive technology will require a rather large shift to small cars. The popularity of such a shift among car buyers remains to be seen. During the energy crisis from late 1973 to early 1974 the demand for small, fuel-efficient cars was strong. But as fears of gasoline shortages declined, so did some of the enthusiasm for the smallest cars. The strongest sales for 1975-76, according to industry sources, were of the intermediate and larger autos, although sales of the smaller cars did not decline. As of late 1976, however, some dealers were offering discounts on some subcompact models in an effort to improve their sales.

The most likely market structure over the next 5 to 10 years will be a general reduction in size in all categories. Passenger cars presently considered to be of "intermediate" size may well become the standard size. A demand for "full size" cars is expected to continue if production of such cars remains possible under the fuel economy regulations. Several domestic manufacturers have expressed concern that the various Federal regulations on fuel economy, exhaust pollution, and safety standards could affect the size, performance, and general desirability of future passenger cars.

Demand for light trucks and vans (less than 14,000 pounds gross vehicle weight) has been strong since the late 1960's as recreational vehicles gained in popularity. During 1973, demand for heavy trucks (which had increased steadily after a 1970 slump) also grew sharply. Truck production peaked at a record level in 1973, then dropped slightly, but surged to a new record in the 1976 model year. Truck trailer production dropped sharply in 1975, in part because of heavy purchases in late 1974 as customers sought to avoid purchasing 1975 units that were required by law to have expensive anti-skid braking equipment.

Productivity

Output per employee-hour increased at an average annual rate of 3.2 percent from 1960 to 1975. (See chart 7.) The increase averaged 3.6 percent annually during 1960-67, slightly higher than the 3.2-percent productivity growth rate achieved during 1967-75.

Growth in output per employee-hour was particularly strong in 1971 and 1972 as output rose sharply from 1970 in response to a very strong demand for new cars and trucks. Productivity continued to grow in 1973 as manufacturers reported a third year of record new car and truck sales; however, by the fourth quarter of 1973, retail sales had begun to fall, causing a final-quarter decline in both output and productivity levels. The decline in productivity continued through 1974, during which there was a sharp drop in output and in employee hours, but a considerably smaller drop in the number of people employed. Apparently the manufacturers chose to cut working hours (especially overtime) and keep their work force intact.

The year 1975 was unusual for the industry in terms of output and productivity. Output continued to decline (for the second year in a row) due in part to the recession and in part to higher auto prices. Although output declined, productivity increased substantially. In this instance, both employee hours and total employment declined at about the same rate—and both dropped considerably more than did output. Thus, the productivity increase resulted, for the year as a whole, from a large drop in the industry's work force and a much smaller drop in output. In fact, output actually increased in two quarters during the year, while employee hours remained at low levels during all four quarters.

Investment

Capital expenditures

Expenditures for new plant and equipment, in current dollars, increased from $790 million in 1960 to $2.1 billion in 1975, an average of 7.4 percent per year. An estimated $2.4 billion was spent in 1976. Since current-dollar figures do not take into account price increases over the years, real capital outlays were less than these figures indicate. The rate of increase in capital expenditures was significantly higher between 1960 and 1967, when the industry was expanding its productive capacity, than during the more recent 1967-75 period. The average annual rates of growth were 16.0 percent in 1960-67 and 6.9 percent in 1967-75.

As shown in table 6, the rate of increase in capital expenditures per production worker was also greater during the first half of the 1960-75 period. Plant and equipment expenditures per production worker in 1974 reached a peak of $4,266, or triple the 1960 total of approximately $1,400 per production worker, and then declined to $3,460 per production worker in 1975.

Capital spending is expected to increase strongly over the next several years. A recent McGraw-Hill survey of capital spending plans[5] indicates that planned expenditures for 1977 will jump to $4.15 billion, followed by an increase to $4.36 billion in 1978. One manufacturer plans to invest $15 billion by 1980 for new, redesigned, smaller passenger cars, while another manufacturer plans to spend almost $2 billion (worldwide) in 1977, and over $2 billion a year in 1978, 1979, and 1980.[6]

This high level of capital spending is necessary to design and produce car models that will meet Federal Government standards for safety requirements, exhaust pollution levels, and—most especially—fuel economy. While funds will be invested in all of the production phases, the emphasis will be on new tooling for updated car models.

The increasing importance of capital relative to labor is reflected in a decline in the ratio of payroll to value added, from 0.451 in 1960 to 0.419 in 1972, an annual average rate of decline of 0.1 percent. (See table 6.)

Funds for research and development

Expenditures for research and development (R&D) in the industry group of motor vehicles and other transportation equipment except aircraft[7] increased from $884 million in 1960 to a planned level of $2.4 billion in 1974, or at an average rate of 7.2 percent a year. Company R&D expenditures were 2.3 percent of net sales in 1960, increasing to a planned level of 2.8 percent in 1974. R&D expenditures are expected to rise to $3.1 billion by 1977.[8]

Research is underway to develop new automobile power plants that meet exhaust emission standards and provide improved fuel economy. Alternative types of power plants being considered range from modified conventional piston engines to alternative engine concepts including the rotary engine, diesel engine, and turbine, stirling cycle, and electric engines. The approach found most feasible by most major automobile manufacturers starting with 1975 models is modification of the piston engine through application of catalytic converters—a device attached to the exhaust system which uses platinum and palladium as catalytic agents to convert noxious auto exhaust emissions into water vapor and carbon dioxide. The "stratified charge" engine, a conventional piston engine with an unconventional cylinder head, reportedly has the capability to meet most of the strict emission standards to be implemented after 1978 and may, according to some experts, become more widely used in the early 1980's.

While some improvements in fuel economy may result from refinements in engine design, reducing automobile weight is probably the best way to improve fuel economy. Building smaller cars and substituting lightweight materials (such as aluminum and plastic) are two of the more obvious ways to reduce weight. One manufacturer has already introduced some new car models that are smaller and lighter than the corresponding models of previous years—and this trend will continue.

Table 6. Indicators of change in the motor vehicle and equipment industry, 1960-75

Indicator	Average annual rate of change[1]		
	1960-75	1960-67	1967-75
Capital expenditures per production worker	5.9	11.8	7.4
Payroll per unit of value added	[2]–0.1	–0.5	[2]–0.5
Research and development expenditures[3]	[4]7.2	6.8	[4]9.1

[1] Linear least squares trends method.

[2] Final year = 1972.

[3] Data are for motor vehicles and all other transportation equipment except aircraft, and are based on expenditures of manufacturing companies in the transportation industry (except aircraft companies) that have research and development programs. 1974 figures are based on corporate spending plans as reported by McGraw-Hill.

[4] Final year = 1974.

SOURCE: Bureau of Labor Statistics, Bureau of Economic Analysis, Bureau of the Census, National Science Foundation, and McGraw-Hill.

Employment and Occupational Trends

Employment

Employment in this industry rose from 724,100 in 1960 to a peak of 955,300 in 1973 and then dropped sharply as economic conditions turned downward and auto sales fell, to 774,100 in 1975 (chart 8). This pattern represents an average growth rate of only 1.6 percent a year between 1960 and 1975. During the first half of this period, 1960 to 1967, employment grew at an average annual rate of 3.6 percent. Between 1967 and 1975, however, employment declined by an average of 0.2 percent a year. As sales and production rose again in 1976, employment increased to 850,600.

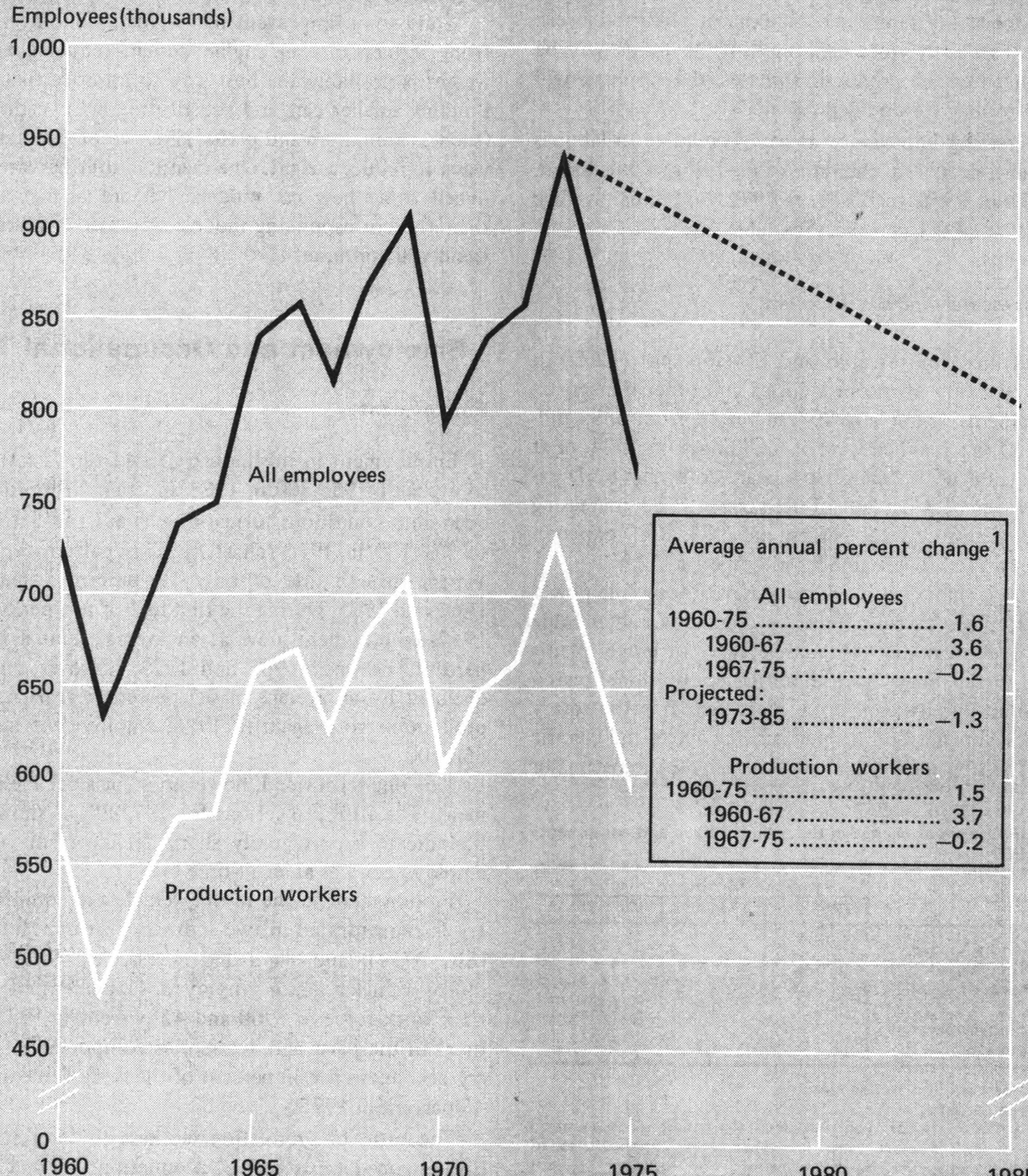
The long-term trend, however, is for a decline in employment. The BLS projections for 1973-85, as shown in chart 8, indicate a particularly sharp decline from 1973, when employment was at an all-time high.

Employment in the motor vehicle and equipment industry is concentrated in two industry sectors: Motor vehicles (SIC 3711), and parts and accessories (SIC 3714). The motor vehicles sector employed 41 percent of the industry's work force in 1960 and 42 percent in 1975. Employment in the parts and accessories component of the industry accounted for 43 percent of the work force in 1960 and 45 percent in 1975.

The ratio of production workers to total employment has remained fairly stable; production workers accounted for 78 percent of total employment in 1960 and 77 percent in 1975. The rate of employment growth for production workers during 1960-75 was 2 percent—about the same as the all-employee growth rate indicated earlier. As shown in chart 8, the rates of growth in employment of production

Chart 8

Employment in the motor vehicle and equipment industry, 1960-75, and projection, 1973-85



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

Source: Bureau of Labor Statistics.

workers during the shorter term 1960-67 and 1967-75 periods closely parallel trends for total employment.

Occupations

Technological and other changes are expected to alter the occupational structure of the motor vehicle industry by 1985. Employment is expected to increase in only three of the eight major occupational groups presented in chart 9—managers, officials, and proprietors; sales workers; and operatives. In the other major occupational groups employment is expected to decline.

Increased use of computers in design, engineering, and production applications should bring about several changes among professional and technical workers and clerical workers. The number of computer specialists (primarily systems analysts and programmers) is expected to increase by 8 percent. Greater use of computer terminals should increase the productivity of drafting technicians and engineers, although the effect of this on employment is unclear. If the volume of work were to remain unchanged, employment might decline. But there is a strong possibility that computer techniques will be used more intensively to improve vehicle design and weight optimization—new analytical work which could absorb people who might otherwise not be needed. An increase of 34 percent is expected for computer peripheral equipment operators. Keypunch operators are expected to decline by 58 percent as punchcard data entry is supplanted by more sophisticated forms of data entry.

Operatives (semiskilled workers) will continue to be the largest occupational category in the motor vehicle industry, making up about 50 percent of the work force. Many of these workers are engaged in production operations that are relatively labor intensive and have potential for further automation. Semiskilled metal workers (drill press operators, lathe operators, welders, etc.) are expected to decline by 20 percent in response to more widespread use of numerically controlled machines, industrial robots for welding and inspection operations, and more automatic transfer lines.

Although some advances are anticipated in automatic (or machine) assembly operations, the job category of assemblers is expected to grow by 34 percent to employ almost 168,000 people by 1985—by far the largest single occupation in the industry. The general increase in automated production and inspection operations should serve to limit any increase in the number of inspectors needed. Training for many of the semiskilled jobs is relatively brief, consisting primarily of on-the-job instruction for periods of several days to several weeks. Hence, shifting semiskilled workers from one position to another generally should not cause great dislocations.

The impact of advanced production machines on occupational skills was discussed with officials from several auto manufacturers visited by BLS staff. In general, a shift toward skilled workers is expected—especially in computer-related occupations—with a decline in unskilled workers and semiskilled machine operators. Maintenance workers would be the occupation most greatly affected, with demand for these workers rising in step with increases in the use of N/C machines, industrial robots, and other automated machines. Skilled machinists who are displaced by automated machines can be retrained to maintain the new equipment.

Adjustment of workers to technological change

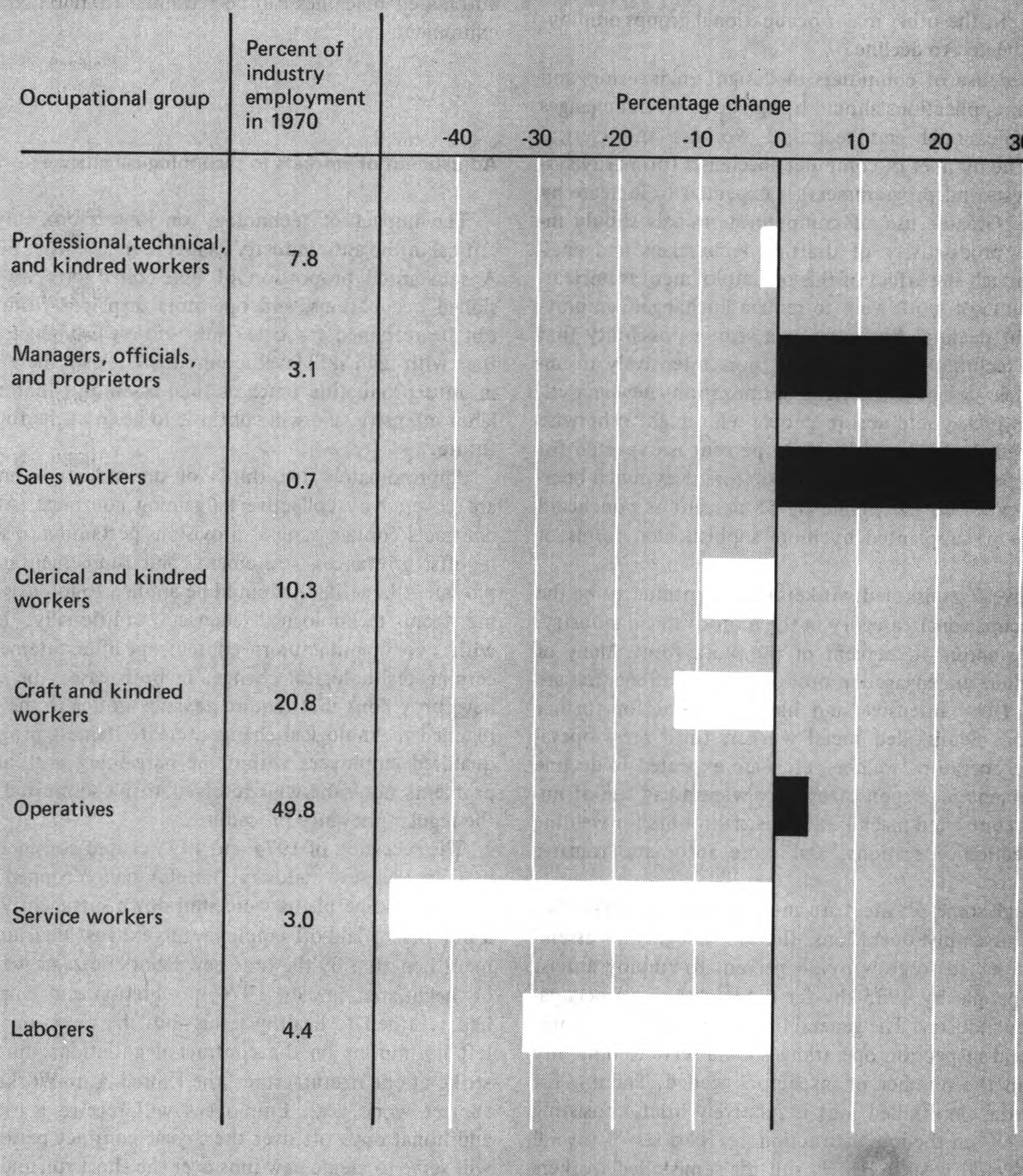
The impact of technology on jobs is probably not as critical in the auto industry as it is in many other industries. A substantial proportion of blue-collar jobs are in semiskilled occupations, and operators displaced from one job can be retrained for other jobs more easily than in industries with high skill level requirements. Also, there are areas in auto production (such as final assembly) that are fairly labor intensive, and will continue to be so in the foreseeable future.

Approximately two-thirds of the industry's employees are covered by collective bargaining contracts. All of the contracts contain general provisions pertaining to seniority, layoffs, grievances, retirement, and supplementary unemployment benefits that could be applied to job losses resulting from technological change. Additionally, contracts with two manufacturers contain specific statements concerning technological change. In both cases, the contracts have provisions that require advance notice to the union of planned technological changes, create training programs for qualified employees within the bargaining unit, and allow problems not otherwise resolved to be submitted through the regular grievance procedures.

The recession of 1974 and 1975 caused considerable turmoil in the auto industry. Employment dropped substantially and some plants were shut down sufficiently long for a number of laid-off employees to exhaust their unemployment benefits. By the time new labor contracts were due to be negotiated in late 1976, production and employment had returned to healthy levels—but the recession probably left its imprint on the contract negotiations. In a 4-week strike at one manufacturer, the United Auto Workers won a shorter work year. Employees will receive a total of 13 additional days off over the 3-year contract period, which will serve to create new jobs over the short run and preserve job security in the future. The other manufacturers have since agreed to this pattern.

Chart 9

Projected changes in employment in the motor vehicle and equipment industry, by occupational group, 1970-85



Source: Bureau of Labor Statistics.

FOOTNOTES

[1] These data exclude employees in a number of industries which produce components for the motor vehicle industry. According to estimates of the Motor Vehicle Manufacturers Association, more than 517,000 workers are engaged in producing motor vehicle components and thus are classified in industries other than SIC 371, motor vehicles and equipment.

[2] "Computer Speeds Design Production of Piston Rings," *Automotive Industries*, November 15, 1968, pp. 79-85.

[3] "N/C and C/C, New Keys to Productivity," *Automotive Industries*, October 15, 1972, pp. 33-36.

[4] "Computer Controlled Machining," *Automotive Industries*, July 15, 1970, pp. 51-52.

[5] *Preliminary Plans for Capital Spending in 1977-78*, McGraw-Hill Fall Survey, Fall 1976.

[6] "Capital Spending to Set Record in '77," *Automotive Industries*, October 1, 1976, pp. 14-15.

[7] Motor vehicles and other transportation equipment except aircraft consists of SIC's 371, 373, 374, 375, and 379. Separate data for the motor vehicle industry, SIC 371, were not available until 1972. The importance of motor vehicles within this industry group is illustrated by the fact that the motor vehicle segment accounted for over 98 percent of the industry group's R&D funds in 1972 and 1973.

[8] R&D expenditures for 1960, National Science Foundation; planned R&D expenditures for 1974 and 1977, McGraw-Hill.

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Chapter 4. Railroads

Summary

The introduction of more powerful locomotives, rolling stock of greater capacity and specialization, advances in the unit train, and the widespread use of computers are among the technological advances that have led to continuing reductions in labor requirements among Class I line haul railroads (SIC 401), which account for over 90 percent of total railroad employment.[1] In addition, improvements in track and roadbed construction methods have resulted in labor-savings in maintenance; new and improved maintenance equipment has deemphasized the importance of muscle power and hand tools in favor of single-purpose and sophisticated combination machines. Moreover, piggybacking, which involves the loading of a highway trailer or a container onto a flat car by the use of a ramp or mechanical loader, makes possible transshipment of a container through several transportation modes, thus bypassing labor-intensive reloading operations.

During the 1960-75 period, capital expenditures in new plant and equipment increased at an average annual rate of 5.3 percent, ranging from a low of $820 million in 1961 to a high of approximately $2.5 billion in 1975. (This increase would be less in real terms due to increases in plant and equipment prices over this period.) These figures represent all outlays for new equipment whether rented or leased.

Productivity as measured by output per employee-hour has increased rapidly in the railroad industry in the last 20 years, placing it among the industries with the highest average increases in productivity. In the 1947-60 period, output per employee-hour increased at an average annual rate of 4.3 percent; over the 1960-75 period the rate of increase rose to 4.9 percent. In 1975, however, output per employee-hour declined by 3.4 percent, reflecting the recession-induced decline in freight traffic. Expectations for output and employment for the next decade suggest that improvements in productivity will continue.

Employment has shown substantial declines since 1960; between 1960 and 1975, total employment declined at an average annual rate of 2.7 percent, from 821,200 to 514,600. This decline reflected the effects of technological changes and other major factors such as the sharp declines in passenger service and "less than carload" freight traffic, deferred maintenance of track and roadways, and contracting out to equipment suppliers work formerly done by railroad employees. During the next decade, industry experts anticipate that employment in the industry will level off or decrease only slightly because of expected traffic increases, the undertaking of deferred maintenance made possible by recent Federal legislation, and other nontechnological factors.

Technology in the 1970's

The technological and other changes that have taken place in the railroad industry in recent years point toward continued growth in productivity. Among these changes are motive power developments which include increases in tractive power (effective pulling force delivered to the draw bar) of locomotives and six-axle drive units to lessen the amount of inertia to be overcome by the locomotive units. Another category of change relates to freight cars. Improvements in materials and design have made possible substantial increases in capacity and reductions in car weight relative to capacity. Other technological changes, as shown in table 7, include relocation and improvement of shop facilities, piggyback traffic and unit trains, automatic classification yards, new applications of computers including nationwide control of freight car movements, signaling and communication improvements, detection devices, microwave communication (a radio frequency), automatic car identification, and notable maintenance-of-way improvements including the mechanized laying of welded rails.

Motive power developments

Increases in tractive power have led to a reduction in the number of locomotives in use compared with the 1950's. Over a 10-year period, the number of locomotives declined from 30,248 in 1957 to 27,687 in 1967; however, in 1973, the number increased to 27,800, and by year-end 1975, there were 28,000 locomotives in service.[2] About 99 percent of the locomotives in 1967 were diesels, compared with 90 percent in 1957, and 25 percent of these were "second generation" which had been introduced since 1961. These second-generation diesels require considerably fewer unit employee-hours for annual maintenance and inspection than earlier diesels. The increased horsepower range for second-generation diesels (2,500 to 4,000 compared with 1,200 to 1,500 for earlier diesels) has led to greater tractive power and a consequent rise of about 12 percent in gross ton-miles hauled per engine over the 1957-67 period.

Table 7. Major technology changes in the railroad industry

Technology	Description	Labor implications	Diffusion
Motive power developments	More powerful units; solid-state electronics improve electrical systems; higher tractive power per unit; greater overall reliability reduces maintenance.	Unit employee-hour requirements for maintenance of second-generation diesels are considerably less than those for diesels of the first series.	Virtually all Class I locomotives are diesels; about two-thirds were second generation by 1975.
Freight car improvements	Special cars developed for commodity groups, better bearings; higher capacity with reduced ratio of car weight to capacity. Design and material improvements reduce loading and maintenance requirements.	Decline in loader, trucker, and maintenance employment.	Private fleet ownership expected to increase with continuing emphasis on expensive, special-purpose cars. Shippers' pressure for cars, rather than capacity, may slow increase in average car capacity.
Facility relocation and improvements	Repair station consolidation, including spot shop development, accompanied dieselization, resulting in greater efficiency. Car and locomotive washing and interior cleaning mechanized. Proportion of cars out of service for repair reduced.	Reduced labor requirements for general laborer and stationary fire worker.	Concept in widespread use. Further consolidation and use of spot shops expected for both locomotives and cars.
Piggyback and unit trains	Trains comprised of trailers or containers of general merchandise loaded on flatcars move on expedited schedules. Unit trains carry a single bulk commodity between two terminals. They are a vital link in production processes and their movement is on a strict time schedule.	Work previously done by railroad workers shifted to freight forwarders and trucking firms.	Continued growth of piggyback, 1½ - 2 million carloadings in 1975. Greater use of unit trains likely.
Automatic classification yards	Large yards in which cars are sorted and switched by destination. Digital and analog computers used to control car speeds and to aid in switching. Small yards equipped with automatic features now feasible. Increased car utilization, customer service, and laborsavings result.	Reduced employment for blue-collar worker supervisors and yard crews.	More than 60 major classification yards in operation. Increasing numbers of major classification yards, as well as some small ones, being equipped with "automatic features".
Computers	Both digital and analog computers in use. Computers have provided information processing and switching capacity that gives management better freight car information and control. Also, computerized data are used by management in forecasting traffic trends and analyzing the market.	Decline in employment for clerks, messengers, and telephone switchboard operators. Introduction of new occupations such as computer programmer, keypunch operator, methods analyst, tape room supervisor, communication engineer, and electronic engineer.	Widespread use of analog computers. Practically, all Class I roads using digital computers. There were about 250 central processing units in the industry in mid-1975.
Centralized traffic control (CTC)	Central control of train movement over stretches of track of 50 - 100 miles or more. A model of the track is operated by one worker who pushes buttons or switches to keep trains moving in accordance with their priorities. Capacity of track is expanded and laborsavings result.	Reduced employment of workers for locomotive maintenance.	At least one-fifth of all main track operated under CTC. Further diffusion likely.
Miscellaneous signaling and communication	These developments enhance equipment utilization, promote safety, and decrease maintenance costs.		
(a) Detectors	Detectors—mechanical or infra-red devices—locate and report dangerous conditions in equipment along the right of way. Several types developed for different purposes.	Reduced employment for station agents.	Use of detectors will increase. Rising train speed increases importance of detecting dangerous conditions early.

Table 7. Major technology changes in the railroad industry—Continued

Technology	Description	Labor implications	Diffusion
(b) Microwave	High-capacity radio carrier wave currently being used by railroads to supplement or supplant wire message carriers.	Decline in employment of line and ground workers.	About 50,000 route miles expected. Rapid growth tied to development of total information system.
(c) Automatic car identification (ACI)	Reflecting labels picked up by transmitter, decoded, and sent to central operations. Equipment location and progress easily recorded.	Decline in employment of clerks and office personnel.	By 1980, universal use expected.
Maintenance of way innovations (MW)	Single and multipurpose machines aid in track laying, tie placement, and ballast surfacing. Continuous rail that replaces 39' sections and concrete ties are in use. Off-track machines combined with use of radio increase labor utilization. Track defects detected by electronically equipped cars. M/W scheduling aided by computers to obtain maximum equipment and labor use.	Decline in employment of section workers, bridge and building carpenters, bridge and building painters, and extra gang or section workers.	Widespread use of single-purpose machines; use of combination machines and concrete ties expanding; continuous rail used extensively.
Innovations in passenger service	Air conditioned, electrically driven cars in Northeast Corridor Experiment. Automat food service on some trains. Computerized ticketing.	Decline in employment of sleeping car conductors, chefs and cooks, waiters, and baggage handlers.	Successful use of Northeast Corridor concept may be extended to other areas such as between Washington, D. C., and Miami, Florida.

Six-axle drive units first became available in the early 1960's. They have the advantage of increasing the ability to utilize high horsepower and are particularly desirable for railroads operating over steep grades. By 1966, the six-axle drive accounted for more than one-half of all units delivered.

Significant improvements in freight cars also have been taking place. There has been a shift away from general-purpose toward special-purpose cars and an increase in the average capacity. The average new car purchased in 1968, for example, had a capacity of 80 tons compared to an average of only 52 tons for those being retired. In 1975, the average new car had a capacity of 89 tons compared to an average of 62 tons for cars retired. There has also been a reduction in car weight relative to capacity due to material and design changes. New materials such as steel alloys and aluminum have helped increase the amount of freight that can be hauled by a given amount of locomotive power, increasing tons hauled per crew member. Also, the greater strength and easy cleaning of the new materials reduce maintenance requirements.

Changes in journal (axle) lubrication procedures and introduction of roller bearings have led to a great reduction in the number of car setouts—cars set off on sidings for later repair. The development of journal pads eliminated the need for the use of loose waste and provided better retention of oil or grease. The Association of American Railroads estimated that in 1975 about half the car fleet was equipped with roller bearings, contributing to a decline in the number of car setouts per million car miles. In the 20-year period between 1955 and 1974, setouts per million car miles fell from 4.13 to 0.74. This significant improvement brought about greater car utilization and a decrease in employee-hour requirements for crew workers who are responsible for maintenance of cars.

Relocation and improvement

The repair of rolling stock, both locomotives and cars, has been shifted from scattered locations to central "spot shops" where production-line techniques are utilized. The central facility is subdivided into various work stations where specialized equipment is available for any type of repair or inspection required. Thus, the time spent carrying tools to the equipment to be repaired has been eliminated. When locomotive or car parts are disassembled, there is coordination of the repair of parts to avoid holding equipment needing repair because some minor part is lacking. More strategic positioning of equipment in spot shops also has been taking place. Hydraulic jacks, electric hoists, hose reels, acetylene, oil, and revolving bins for parts have been located in more strategic locations. More efficient boilers are being used for heating, and automatic "car wash" techniques have cut cleaning time by as much as one-half. Large vacuum units are being used for cleaning car interiors.

Piggyback traffic and unit trains

Piggyback traffic, or trailer-on-flat-car (TOFC) services, and more recently container-on-flat car (COFC) services represent significant transportation developments. Piggybacking involves the loading of a highway trailer onto a flat car by the use of a ramp or a mechanical loader. COFC service is not as widespread since a mechanical loader is always necessary; however, the elimination of wheels on containers provides a space saving which makes COFC service relatively more attractive for shipment between rail, air, and sea transportation. Goods need to be handled only one time–at the shipper's dock–in either TOFC or COFC traffic. Thus they can arrive at the consignee's dock without being subjected to reloading–a major cause of breakage, delay, and pilferage. Standard container sizes have been established by the American Standards Association. These will allow easier interchange between railroads and other modes of transport.

Piggyback loadings almost tripled between 1960 and 1973, from 554,115 to 1,543,374.[3] After declining sharply in 1970 and 1971, TOFC rose in 1972 and increased to 1,535,374 loadings in 1973, the highest year on record. TOFC loadings in 1973 were up 15 percent over 1972 and 14 percent above the previous record set in 1969. The 1974 loadings also exceeded 1.5 million. But in 1975, piggyback loadings were hit hard by the recession and fell to 1.2 million. According to one estimate, TOFC may account for 10 to 15 percent of all rail freight by 1980, compared with 5.6 percent of total carloadings in 1973.[4]

Like TOFC, the unit train is a high-priority train which hauls a single commodity. It decreases the cost per ton carried, compared to previous methods used. These savings result because unit trains bypass switchyards and are subject to quick turnaround. In both unit and piggyback trains, laborsavings among yard crews have resulted from the reduction in loading, unloading, and switching operations.

Automatic classification yards

Major laborsaving technological changes have taken place in classification yards. An early innovation was the change from flat yards to hump yards. This introduced a slight incline into the switch yard so that the engine only needs to reach the top of the hump at a relatively slow speed and gravity provides the necessary momentum to keep the car going into the desired classification track. Another change has been the installation of mechanical retarders along the track which also has resulted in laborsavings. They are operated by electro-pneumatic or hydraulic power and "squeeze" the wheels of cars passing through them, causing them to be slowed to the desired speed. These retarders were formerly operated manually but are now controlled by computers. There also has been a change in the location of the switching operation from the yard to a console operator in the tower. The console operator in the tower can now simply operate switches on the console instead of having a worker in the yard throw the switch for each car or group of cars.

A piggyback loader preparing to place a trailer onto a flatcar

Computers

Computers, introduced in the railroad industry in 1955, have had a major impact on railroad operations. By mid-1975, about 250 central processing units were in use in the industry.[5] Computers are being used by nearly all Class I railroads to assist in locating and switching cars, scheduling trains, and making motive power assignments to trains. They are also used in analyzing market trends to aid in investment and planning and for inventory control and scheduling of equipment use and road maintenance. Their advanced applications include simulation of operating areas such as classification yards. Simulation permits information to be obtained on the potential effects of changes in operating procedures and physical configuration without the expenditure of time and money otherwise necessary for trying new procedures or constructing new facilities.

Signaling and communication improvements

Railroad operations are being affected by progress in signaling and communication technology. For example, centralized traffic control (CTC) activates signals and switches over long stretches of track by remote control. Train movement is controlled and monitored by a single operator at a central unit. CTC expedites rail traffic over the fewest possible miles of track, without using written train orders. It provides better utilization of track and has thus increased the ability of the railroads to handle an increased traffic volume with a reduction in locomotive maintenance. At least one-fifth of all main track operated is under CTC and the number of track miles is likely to grow steadily because of the increasing use of computer programming of train operations to include dispatching and scheduling.

Detection devices

Hotbox detectors, which measure temperature changes of journals and/or roller bearings on passing railroad cars, are coming into increasingly widespread use. Mounted alongside the track, they scan the journal box or the hubs of the car wheels and relay the journal temperature of each wheel to central locations where the information is recorded on tape. If an overheated journal box is indicated, a recorder monitor informs the train engineer. The number of hotbox detectors in use is rising as are other detector devices such as "presence" detectors—which are placed where debris may be found on the track—clearance or high-wide load detectors, and high-water and smoke detectors. The use of detective devices contributes to the safe operation of trains, greater utilization of existing equipment, and reduction in maintenance and repair time. It has resulted in a decrease in employment of station agents who formerly checked the train visually.

Microwave

Microwave, a radio frequency that begins at 952 megacycles per second for railroads, is being increasingly adopted by the railroads. It provides the band width needed for the rising volume of messages and data. Microwave transmission obviates pole line installation. Also, because of reduced line maintenance and need for fewer telegraph poles, fewer line and ground workers are needed. Increased transmission reliability, lower maintenance costs, and greater flexibility of operation also lead to savings.

Two key uses of railroad microwave are VHF radio and facsimile transmission (as of waybills). Waybills contain information needed for centralized control of operations. Several roads are now using facsimile transmission and it is expected to become one of the principal uses of railroad microwave. There is increasingly greater use of VHF radio in yard and road operations and in maintenance-of-way work, as well as in dispatching from wayside to train. Industry estimates of route miles of private railroad microwave indicate a figure of 50,000 route miles in 1975, compared with less than 200 miles in 1952 and roughly 22,000 miles in 1966.[6]

Automatic car identification

Automatic car identification (ACI) is a system which identifies cars carrying specially printed labels through the use of wayside scanners. A standard ACI system was adopted for industrywide use starting in the spring of 1969. At the present time over 90 percent of the cars are labeled and about 500 ACI scanners are in operation. While demonstrating the possibilities of increased car utilization and a reduction in labor requirements used in sorting and switching cars, ACI is still being evaluated within the industry.

Maintenance-of-way changes

Maintenance work done on railroad track, terminals, and associated plant structures is called "maintenance of way." Muscle power and hand tools served this purpose for a number of years after World War II. These are gradually being replaced by single-purpose machines which can perform such operations as unscrewing bolts, pulling and driving spikes, packing ballast, and hoisting into place such heavy materials as ties and rails.

With the introduction of sophisticated combination machines that can raise and align the track, and level and tamp the ballast in the roadbed in a single operation, maintenance-of-way methods took another step forward. Other machines also have been developed which can perform operations such as removing old ties and inserting new ones. The net effect of these changes has been to reduce maintenance labor requirements.

The growing use of continuous rail also is contributing to lower maintenance labor requirements. Continuous rail eliminates joints at the rail-end and thus saves the labor which once cut off, lifted, and relayed short pieces of conventional rail. Concrete ties are currently being tested for widespread use. These ties generally have longer useful lives than wooden ones although they are more expensive. Adoption of concrete ties would result in lower labor requirements for track maintenance. Other developments which have acted to reduce maintenance labor requirements include improved paints and paint application methods and the use of prestressed concrete for bridge construction. Use of two-way radio has also proven beneficial by permitting the work force to maximize work time before clearing the track ahead of an oncoming train.

Prefabrication of track panels and retarder units reduces the time and labor required for track repair. New snow removal attachments for some maintenance-of-way equipment and specialized portable snow removal equipment are supplanting manual snow removal.

Output and Productivity Outlook

Output

Output in the railroad industry (a BLS measure based on revenue traffic units) rose at an average annual rate of 2.1 percent during the 1960-75 period. Most of this increase occurred between 1960 and 1967 when output rose at an average annual rate of 3.7 percent. During the remainder of the period, 1967-75, output increased at an average annual rate of 1.1 percent. Industry experts indicate that output should increase through 1985.

One point of interest in regard to industry output is the advantage the railroads hold over the other modes of transportation in the amount of fuel required to move freight and passengers. A study supported by the National Science Foundation indicates that the railroads are less energy intensive than any other freight mode except pipelines, and that they have almost a four-to-one advantage over trucks. In the transporting of passengers, the railroads hold a big advantage over airplanes and automobiles in energy use, but they are more energy intensive than buses. In view of the recent sharp rises in fuel costs, the lower fuel requirements should have a favorable effect on output. This may give the Nation's railroads a competitive advantage over over-the-road trucks, enabling the railroads to seek out lightweight, high unit-value cargo and to enlarge their piggyback operations. For example, in 1973, when fuel costs rose and shortages were high, railroad output grew by almost 10 percent over 1972. Fuel is among the more important inputs, and the amount required to move a gross ton-mile has declined steadily. For example, between 1948 and 1966, this measure dropped by 80 percent, due mainly to the transition from steam to diesel engines.[7]

Additional growth in output also is likely because of the heightened demand for coal as a fuel for generating electricity. Coal is already the largest single commodity group carried by the railroads, accounting for about one-fourth of the total tonnage in 1974.[8] However, pending Federal legislation would permit pipelines to carry coal slurry from the mine to the ultimate user (electrical generating plant). The economies of pipeline operations are not fully proven. Nevertheless, passage of the planned legislation could offset greatly the increase in railroad output originating from the transportation of coal.

Productivity

For the past 25 years, output per all-employee-hour in the railroad industry has increased rapidly, placing it among the industries with the highest average increase in productivity. Many factors contributed to this increase, including the new technology mentioned earlier, the decline in labor-intensive passenger services, and increased capital expenditures. During the 1947-60 period, the average change in productivity was 4.3 percent per year. During the 1960-75 period, productivity rose at an even faster rate, 4.9 percent on an average annual basis. (See chart 10.) As already mentioned, output is expected to rise through 1985. Industry experts expect industry employment to level off or decrease only slightly during the same period. Should the output and employment expectations be met, productivity in the railroad industry is likely to continue to grow through the mid-1980's.

Investment

Capital expenditures

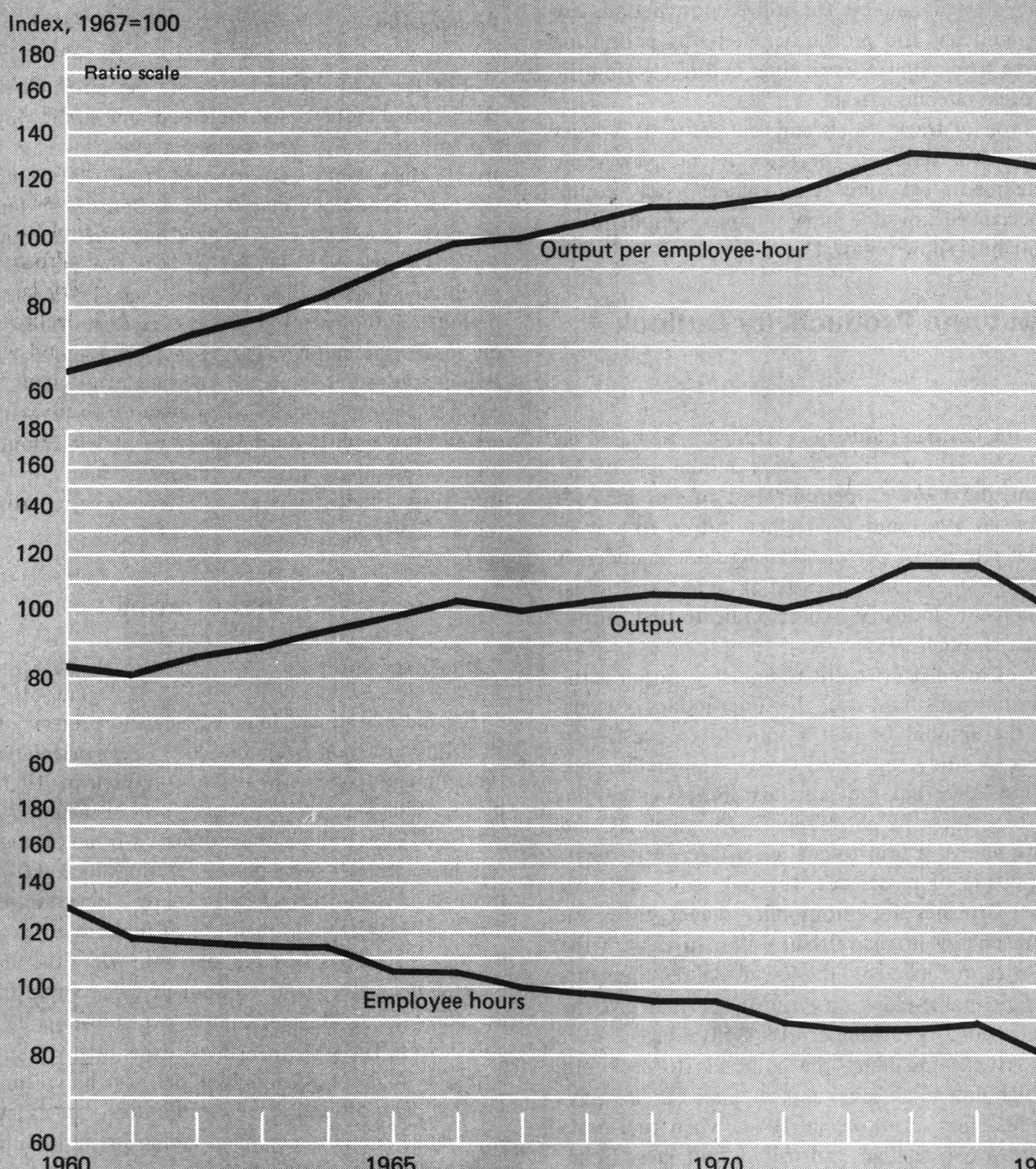
Capital investment in new plant and equipment averaged \$1.4 billion a year over the 1947-75 period; these expenditures ranged from a low of \$820 million in 1961 to a high of \$2.5 billion in 1975. Expenditures in the 1947-57 period averaged \$1.5 billion, then dropped to an average of \$1.1 billion in the 1957-61 period. During the 1960-75 period, however, expenditures rose to reach an average of \$1.7 billion.[9] The average annual rate of increase of expenditures during this period was 5.3 percent. When the increases in general machinery and equipment prices over this period are considered, the real capital expenditures are considerably lower. The goal for capital expenditures stated by the industry is about \$3.3 billion per year between 1970 and 1980.[10] The difference between industry goals and current experience implies that maintaining or improving the railroads will be a major challenge.

Funds for research and development

The need for greater efficiency in the face of rigorous intermodal competition has led to increased emphasis on

Chart 10

Output per employee-hour, output, and employee hours, Class I railroads, 1960-75



Note: 1975 data are preliminary.

Source: Bureau of Labor Statistics.

research and development (R&D) expenditures in the railroad and in its supply industries. R&D in the industry is a continuous process which has led to numerous changes in equipment, methods, and materials.

An example of current resources devoted to railroad research is the 10-year national program of track-train dynamics designed to improve rail systems. This program includes the study of the characteristics of track, cars, and locomotives and of the human factors involved in rail operations. A cooperative effort of the railroads themselves, together with the Association of American Railroads (AAR), the Federal Railroad Administration (FRA), manufacturers of supply equipment to the industry, and the Canadian Government, the program is currently funded at a rate of about $2 million a year.[11]

At the FRA, R&D projects underway in 1974 totaled slightly over $51 million.[12] The FRA budget for fiscal year 1974 totaled $44 million, of which $30 million was budgeted for research.

Research efforts at the AAR emphasize solutions to general problems of the industry as opposed to the testing of products. The AAR research and test budget for 1976 was above $4 million, five times the 1971 level of $800,000.[13] Total research outlays for 1976, including all industry and government programs, amounted to over $10 million.

Employment and Occupational Trends

Employment

Total employment in the industry declined steadily between 1960 and 1975, from 821,200 to 514,600, at an average annual rate of 2.7 percent, as shown in chart 11. From 1960 to 1967, the average annual rate of decline was 3.3 percent; during the 1967-75 period the rate of decline slowed to 2.3 percent. The number of production workers declined steadily between 1960 and 1975, from 742,800 to 453,400, at an average annual rate of 2.9 percent.

Changes in employment reflect changes in product mix and technology and the shift of employment to outside firms which supply equipment to the industry. For example, the sharp decline in passenger traffic has led to decreases in such occupations as rail passenger conductors, train attendants, and rail passenger brake and flag workers. A growing proportion of the freight car fleet is not owned by the railroads (14.0 percent in 1960, 16.6 percent in 1966, and 19.4 percent in 1975).[14] This has contributed to a drop in labor requirements for railroad maintenance employees, even though some cars owned by companies other than railroads are maintained by railroad employees. Similarly, "piggybacking" has shifted work previously done by railroad workers to freight forwarders and regular trucking firms. The leasing of equipment that is related to technological changes in the railroad industry—communication and computer systems, for example—generates employment in other industries which manufacture and service such equipment.

During the next decade, industry experts expect employment in this industry to level off or decrease only slightly. Some of the factors underlying this view of future employment include the expected increase in railroad traffic, the termination of the past decline of the very labor-intensive passenger operations, the near-complete decline of the very labor-intensive "less than-carload" service, and the expected substantial increase in long-needed maintenance work as a result of funds made available by the Railroad Revitalization and Regulatory Reform Act of 1976.

Occupations

The impact on occupations of technological changes, the decline in passenger service, the shift of employment to outside firms which supply equipment to the industry, and other changes in the industry may be observed from an analysis of each of the seven summary reporting occupational categories, as defined by the Interstate Commerce Commission (ICC). Six of these categories registered declines in employment between 1960 and 1975 and one category increased slightly, as shown in table 8.[15]

It is difficult to isolate the impact of technological change on occupations from the other changes taking place in the industry. In general, those occupations requiring

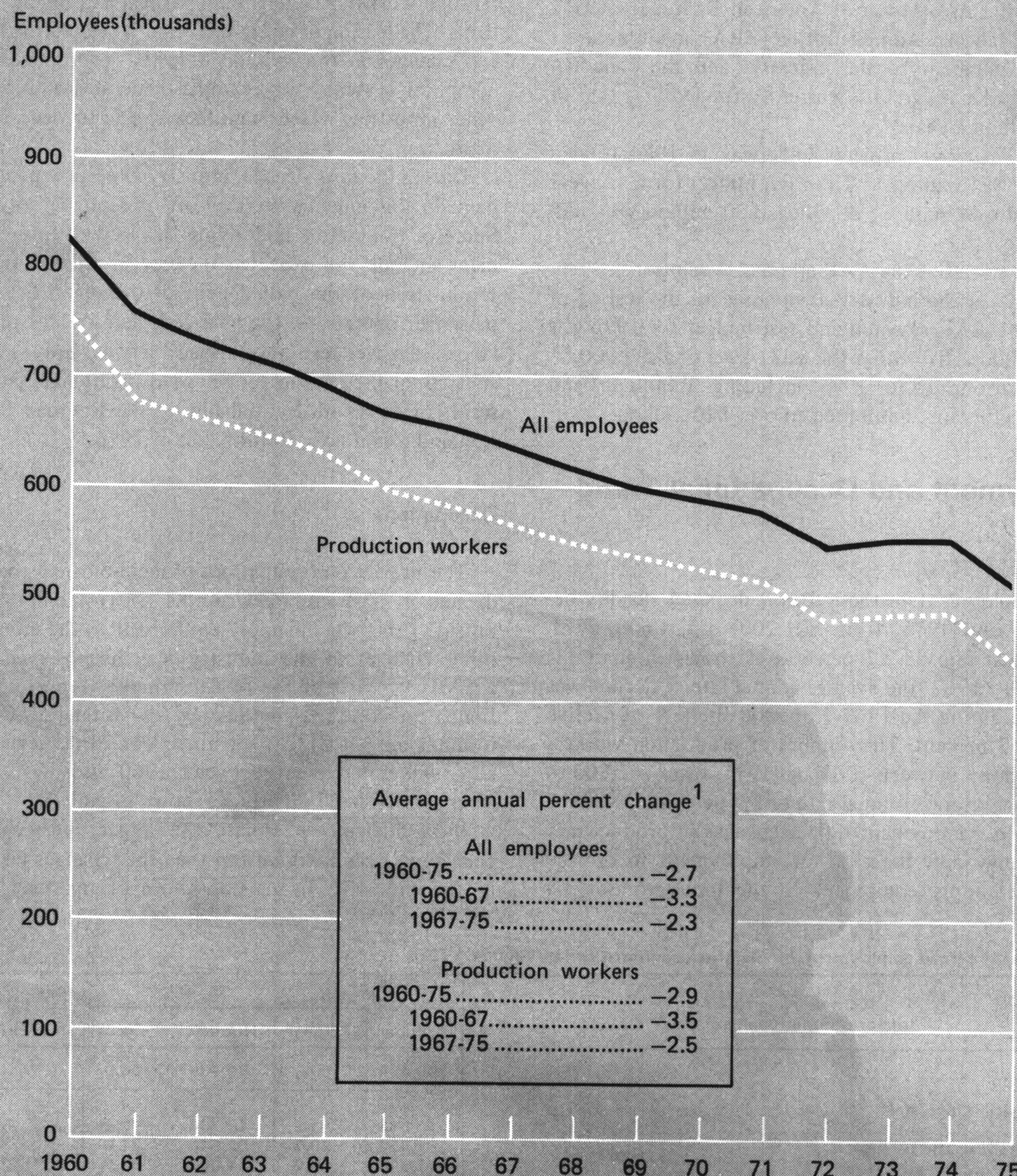
Table 8. Class I railroad employment, by major occupational group, 1960 and 1975

ICC reporting title (major occupational group)	1960		1975		Average annual percent change 1960-75
	Number	Percent	Number	Percent	
Total	780,494	100.0	487,789	100.0	–3.1
Executives, officials, and staff assistants	15,043	1.9	16,704	3.4	0.7
Professional, clerical, and general	161,452	20.7	102,645	21.0	–3.0
Maintenance of way and structures	118,516	15.2	81,507	16.7	–2.4
Maintenance of equipment and stores	184,006	23.6	104,578	21.4	–3.7
Transportation (other than train, engine, and yard)	89,873	11.5	27,092	5.6	–7.7
Transportation (yardmasters, switch tenders, and hostlers)	12,082	1.5	8,698	1.8	–2.2
Transportation (train and engine)	199,522	25.6	146,565	30.0	–2.1

SOURCE: Interstate Commerce Commission and Association of American Railroads.

Chart 11

Employment in Class I railroads, 1960-75



[1] Least squares trend method.

Source: Based on data from Interstate Commerce Commission.

little formal education, training, or experience to enter such as helper or laborer have been adversely affected by technological and nontechnological changes. Many skilled occupations also have been adversely affected by technological change. For example, the decline in the employment of machinists and skilled trade helpers is closely associated with the decreased employee-hour requirements for maintenance of the newer locomotives. However, employment in these two occupations was also affected by nontechnological changes. The declines of employment in the occupational categories shwon in table 8 are thus attributable to technological change and other changes taking place in the railroad industry.

During the next decade, industry experts expect employment in the various occupational categories to level off or decline only slightly. Some of the reasons underlying this view concern changes in the nontechnology factors that contributed to the past decline, for example, deferred maintenance. Funds made available through the Revitalization and Regulatory Reform Act of 1976 for long-deferred maintenance are expected to reverse the employment trend for both skilled and unskilled maintenance workers. Another factor is the expectation that AMTRAK will stimulate growth in passenger traffic.

Most of the jobs created by new technologies are related to the use of computers. These jobs, found in the few railroad companies leading in computer applications, were previously unheard of in the industry. Thus, for example, among division officers and assistants (a traditional ICC reporting category) are such titles as supervisor of computer centers and supervisor of data collection; among professional and subprofessional assistants are assistant computer engineer and assistant manager of applied research; and among supervisory or chief clerks is manager, electronic data processing center. Likewise, new job titles in the clerks and clerical specialists category include automation analyst, IBM operator, and tape librarian. Also, IBM clerk, assistant computer programmer, lead computer programmer, and console operator are new job titles found in the occupational category "mechanical device operator (office)."

Adjustment of workers to technological change

Some adjustment techniques to lessen the impact of technological change on nonoperating employees are contained in labor-management contract provisions. These include advance notice of change, guarantees of job security, transfer and retraining rights and benefits, limitations on subcontracting, income maintenance plans, and unemployment and retirement benefits.

In the 1960's, provisions dealing with technological change became prevalent in collective bargaining agreements, following widespread job losses arising from changing technology. The provisions generally were patterned after the provisions of the "Washington Job Protection Agreement" signed by the railroad brotherhoods and 141 rail lines in May 1936, which was intended to ease the impact on employees of the wave of inter-railroad coordinations then taking place in the industry. The agreement, which is still in effect in amended form, requires advance notice of a merger and provides for moving expenses and reimbursement for losses in home sales by relocated employees, an allowance which maintains the former wage rates of downgraded employees for several years, and a severance allowance for separated workers.

An example of contracts incorporating such provisions was a 1965 national contract, negotiated for nonoperating, nonshopcraft employees, which included job guarantees, limitations on job subcontracts, and income protection.

The agreement of April 27, 1973, between the National Carrier's Conference and the Railroad Yardmasters of America provides that if one of the carriers proposes ". . . a major technological change, the organization may, in relation thereto, serve and propose proposals for changes in rates of pay on an individual position basis based upon increased duties and/or responsibilities by reason of such . . . major technological change" (defined as involving five employees or more). Similar wage reopening provisions in the event of a major technological change were negotiated with the American Railway Supervisors Association, the Hotel and Restaurant Employees Union, the Brotherhood of Railroad Signalmen, and the Brotherhoods of Maintenance of Way Employees and Railway Airline and Steamship Clerks. (The agreements with the latter two unions defined "a major technological change" as one involving 25 employees or more.)

There are about 332,800 nonoperating railroad employees, organized into 19 separate organizations. The unions covering operating personnel—approximately 132,600 workers—were reduced from five to two by a 1969 merger. The two unions are the United Transportation Union and the Brotherhood of Locomotive Engineers.

FOOTNOTES

[1] Class I railroads have been defined by the Interstate Commerce Commission as companies reporting average revenues of $5 million or more for 3 years consecutively. Effective January 1, 1976, the base was raised to $10 million.

[2] Association of American Railroads, *Yearbook of Railroad Facts, 1976 Edition* (Washington, D.C., AAR), p. 50.

[3] *Yearbook,* p. 27.

[4] *Yearbook,* pp. 25, 27.

[5] Association of American Railroads.

[6] *Railroad Technology and Manpower in the 1970's,* Bulletin 1717 (Bureau of Labor Statistics, 1972), pp. 31-32.

[7] *Railroad Technology and Manpower,* p. 82.

[8] *Freight Commodity Statistics, Year Ended December 31, 1974* (Interstate Commerce Commission).

[9] Data for 1960-69 in *Survey of Current Business,* January 1970, pp. 25-29. For 1970-75, see *Survey of Current Business,* national income issue for July of each year. Data for earlier years from Securities and Exchange Commission.

[10] Association of American Railroads, *American Railroad Industry: A Prospectus, America's Sound Transportation Review Organization* (Washington, D.C., AAR, June 1970).

[11] *The Signalman's Journal,* November 1973, p. 259.

[12] *Modern Railroads,* January 1974, pp. 52-55.

[13] Association of American Railroads.

[14] *Yearbook,* p. 51.

[15] *Wage Statistics of Class I Railroads in the Unites States,* calendar years 1960 and 1975 (Interstate Commerce Commission).

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Chapter 5. Retail Trade

Summary

For retail trade as a whole,[1] productivity growth (output per hour of all persons) and change in the occupational distribution of employment will probably be accelerated by the diffusion of various technological advances. Differences will persist in occupational requirements among subdivisions of the industry as the rate of introduction of innovations continues to vary.

As vendors expand their practice of marking identifying information on more lines of merchandise, thus eliminating store-marking tasks, the movement of a wider variety of stock to the selling area is being expedited in most general merchandise and apparel stores, and the workload of stock clerks is being decreased. By collecting more data at the point of sale in numerous variety and department stores, electronic data processing systems (replacing traditional cash registers) help generate more accurate records for prompt management of inventory, selling space, and staffing patterns and also facilitate a rapid customer credit check by sales clerks. Store terminals linked to suppliers' computers are speeding up reordering, shortening delivery lags, and reducing inventory and stock room labor requirements in a significant proportion of chain grocery and drug merchandising. In food marketing, product coding and a computer-assisted front-end (automated checkouts) improve checker ringing speed. Microfilming improves the availability of information to managers at all locations and levels in chain store sales and to counter customers purchasing such stock as automotive repair parts in multi-line department stores or paint at hardware suppliers. A new central distribution system which uses catalog merchandising, telephone ordering, and home delivery from a warehouse is supplementing grocery and drug retail stores in a few localities. Customer self-service may spread further as additional prepackaging evolves.

Increases in output are expected to contribute to the growth of gross national product at a slightly lower rate through 1985 than in the past decade, according to BLS projections. Productivity will benefit from economies of scale occurring with growth and specialization of product retailing which make possible larger orders of single items. Conversely, productivity may be depressed by a continuing increase in the number of different products offered.

Once innovations are introduced, it is likely that competition will speed their diffusion and accentuate shifts in the occupational distribution of employment. Increased volume may require more hours of work of sales clerks, cashiers, stock handlers, and stock clerks. The use and maintenance of more sophisticated information systems will possibly reduce the overall hours of work of managers and buyers depending, in part, upon the degree of centralization in decisionmaking in multi-store organizations. It is likely that relatively fewer operatives and craft workers will be needed in retail stores whose arrangements with vendors shift some workload to wholesalers or manufacturers.[2]

Technology in the 1970's

Enhancing the effectiveness of marketing techniques through the adoption of advances in computer capabilities should contribute to an improvement in productivity. Also, other major innovations listed in table 9 are expected to add to productivity gains through their laborsavings. For example, unique identification for all grocery and drug products is possible with newly developed codes. Both lines of products are usually packaged with machine readable identification imprinted on the label of each container by the producer of the label. When an automated checkout reads the coded label in a supermarket, the work of the checkout clerk is lessened.

Increasingly, stock clerk tasks are being reduced as more goods are delivered by the vendor with some merchandise identification. A terminal which serves as a sales register and a recorder for the detailed price tag information is linked to an in-store central controller . In multi-unit general merchandise stores, the in-store central controller is also linked to a regional data center. Such a point-of-sale system may increase output by supplying accurate and timely data for improving merchandise mix and cutting inventory shortages. The system may also replace manual processing of accounting and personnel records. Generally, its use reduces the workload of managers, buyers, and clerks.

The use of bank credit card authorization systems is spreading in apparel speciality shops and department stores. Since such systems may improve the availability of credit to the customer, they tend to increase sales. This innovation is expected eventually to involve national public policy as electronic funds transfer (EFT) creates interstate legal problems in transferring money.[3] Microfilming is improving data availability both in individual stores and at multiple widespread chain locations as well as at the customer counter of automotive accessory suppliers and hardware stores.

Table 9. Major technology changes in retail trade

Technology	Description	Labor implications	Diffusion
Vendor source-marked merchandise identification tickets and electronic cash registers	One design of on-line point-of-sale terminals reads magnetically encoded vendor marked merchandise tickets by contact and a second design reads color-coded tickets with an optical scanner. Both designs require an automatic on-line ticketmaker to process hand-entered data and a computer to record transactional and inventory data on magnetic tape and to compute sales expense.	The entry time of office and stockroom clerks for pre-sale data and of cashiers for post-sale data and reconciliation time of bookkeepers are reduced.	Point-of-sale terminals and vendor marked tickets are restricted primarily to large department, apparel, and discount stores.
Additional computer functions	Store charge account credit is audited by an electronic cash register which informs the salesperson directly and quickly on customer credit status; for bank check and credit card authorization the salesperson communicates with and is answered by the bank computer. Terminals at major retail outlets connected by telephone to the vendor's computer reduce delivery time lags. Data entered at point of sale and stored in store's minicomputer are transferred nightly to data centers for automatic processing of purchases, audit, sales commissions, and inventory needs. Summary reports provide information for managerial decisionmaking on such matters as store hours and staffing patterns.	Advanced computerization reduces unit labor requirements of clerks and salespersons and adds to the workload of computer-related personnel, particularly programmers.	Computerized credit authorization is limited for store charge accounts to stores using electronic cash registers and for bank check and credit card accounts to shops purchasing bank data on credit status of customer's account. A great many retail food stores are linked with suppliers' computers. Stores having computerized accounting generally accumulate data for summary reports. In 1974, one in every 300 retail units was computerized, compared to one in every 400 in 1968.[1]
Microfilming	Microfilm systems maintain internal records and distribute information to multiple locations for display on microfilm viewers; microfilm lists are used at sales counters to show availability of items stocked.	Unit labor requirements of salespersons are reduced as customers utilize microfilmed information for increased self-service. Additional time for technicians is necessary to maintain microfilm systems, including hardware.	Many multi-store companies use the systems; also lists are available principally at catalog stores and automotive repair parts departments.
Central retail distribution	Groceries and drugs selected from a catalog are delivered from warehouses to system's members who order by telephones connected to the distributor's computer.	Without customer self-service, unit labor requirements to assemble orders are increased while the work of stocking shelves and pricemarking items is eliminated.	The system is limited at this time to a small number of operations in California, Arizona, and New Mexico; may have potential growth for high-rise apartments in other areas.
Supermarket automation	Universal Product Code (UPC) provides a unique identification to each product; an electronic supermarket checkout counter, through an optical scanner, reads the code, flashes prices on a screen for the customer, and transmits information to a central computer for processing. Advantages include pricing savings and tighter inventory control. Almost 65 percent of consumer products marketed in grocery outlets were marked by UPC by the 1975 year-end.	Depending on store policy, stock clerks may or may not need to mark prices and price changes on individual items. Also a grocery magazine survey reports an electronic front-end permits a 30-percent increase in operator ringing speed and a possible overall 10- to 15-percent reduction in unit labor requirements for cashiers and baggers.[4]	Checkout equipment using scanners was in operation in 50 supermarkets in early 1976. Their introduction into additional stores depends on improving electronic checkout performance through such advances as 80-percent coverage of grocery items by coding and the development of scales capable of simultaneously weighing and marking meat and produce with a code symbol.[3]

[1] Based on a study of 1.3 million businesses in SIC's 52-59 conducted jointly by the periodical *Computers and People* and the firm of Ed Burnett, consultant. In addition, International Data Corporation projects that retail trade will amount to 18 percent of the electronic data processing market in 1975-84 compared to 7 percent in 1974.

[2] "The Supermarket Scanner that Failed", *Business Week*, March 22, 1976, page 52B.

[3] Ibid.

[4] "1974 The Year of Electronics," *Progressive Grocer*, December 1973, page 51.

Merchandise identification and point-of-sale terminals

Increasingly, the manufacturer or the wholesaler is delivering merchandise to retail department, discount, and apparel stores marked with an identifying punch ticket including such information as the seller's number, style number, color, and size. The store then adds its department number and retail price. When the vendor supplies a merchandise identification ticket, the clerical effort for the retail store is lessened, the time required to get merchandise to the selling floor is reduced, and the accuracy of merchandise identification tends to be increased.

General merchandise stores emphasize the importance of collection of detailed price tag information when introducing an electronic data processing system at the point of sale; supermarkets introducing automated checkout stands are more concerned with speed. The supermarket mechanism consists of a laser beam installed behind a window which scans a stamp-sized bar code on each item and signals a mini-computer to locate the item's price in its memory for display on the checkout clerk's console. Many department stores use price tags which may be read both by people and by optical character recognition (OCR) equipment. One type of point-of-sale terminals reads magnetically encoded tickets while a second type reads color-bar coded merchandise cards. Both types require linkage to a computer of fairly substantial capacity for storage and processing of data.

The electronic cash register prints instantly a completed sales check as well as enters data on the system's journal tape for transactional and inventory information. Consequently, labor requirements per unit of sale are decreased and accuracy of data entry is generally improved. Fewer hours of clerical and bookkeeping effort are necessary to maintain routine sales and inventory records. Also as more timely, detailed, and accurate information becomes available for inventory and selling space management, more inventory may be displayed and less stored, with resulting reduced unit labor requirements for material handling.

Computer credit approval

Improved credit approval systems speed up customer service while still protecting store assets. A check of a customer's credit with a department store frequently is accomplished at the point of sale through the use of an electronic sales register. The salesperson enters the charge account number into the register and the store's mini-computer reports the customer's credit status. This method replaces a data search and reply by one and sometimes two credit department clerks. Also, clearance from the computer to extend store credit is usually less time consuming for the salesperson.

When a bank credit card or a personal check on a local bank is presented by an apparel store customer, for example, the salesperson may contact the bank's computer directly for credit approval. This procedure eliminates the practice of having supervisory sales personnel authorize the acceptance of customer checks and shifts the task from the retail store to the bank.

Linkage with supplier's computer

Terminals are being located at major retail outlets such as main offices of chain apparel and grocery stores and department store branches which provide access by telephone to the vendor's computer. The procedure is usually planned by vendors and is expected to expand to include small independent outlets. When the order is typed and accepted by the vendor's computer, the retailer has a paper record of the transaction and also a tape to be used in the store's own computer for control purposes. This automated system is expected to reduce the time lag in deliveries and to permit smaller inventories, thus reducing stock handling and possibly warehouse and stockroom supervisory duties and clerical work in the accounting department.

Computer-generated reports

When an electronic data processing terminal replaces a cash register in a retail store, manual entry of records by clerks is substantially lessened. Labor requirements per unit of sales of stock clerks and bookkeepers typically are reduced and the workload of computer programming and maintenance personnel is expanded.

Data entered at point of sale for each item are usually stored in the store's mini-computer until night and then transferred to data centers for further processing. Bookkeeping and accounting labor requirements are reduced by automated posting and summarizing of such data as sales and taxes, payroll, inventory changes, and customer credit card purchases. Sales data are transmitted from a regional to the headquarters data processing station where national unit sales information is compiled. Computer-generated summaries permit a statistical approach to decisionmaking at different managerial levels. Some reports have many uses. For example, records of transactions by number, dollars, and time of day may be useful for determining both store hours and staffing patterns. A department store industry study shows that computer-generated reports contributed substantially to a sizable rise in annual stock turnover between 1967 and 1974.[4]

As more precise information becomes available on the comparative dollar return of different items per square foot of selling space, general merchandise retailers are expected to restrict somewhat the variety of merchandise stocked. Consequently, a greater market share of specialized equipment such as stereos and citizen band radios will probably shift from general merchandise stores to speciality shops whose numbers and need of trained sales and service personnel will probably expand.

The computer supplies data for improved merchandise selection in some chains by reporting back to each store an automated rejection of reorders of its excessively slow moving goods; consequently some of the items reordered by a typical store may be cancelled because of their poor sales performance in the particular store despite satisfactory average turnover for the chain. As additional detailed information is computerized, the decisionmaking process tends to be more routinized and the relative number of managers and buyers may be reduced. More support workers, such as administrators, typists, and secretaries, may be needed, as well as accountants.

Microfilming

In chain store merchandising, large quantities of records must be stored; these records are needed frequently at locations remote from the computer. Hard-copy recordkeeping is being extensively replaced by microfilm systems for classifying, storing, retrieving, copying, and distributing information. The updated data base is recorded on microfilm and displayed for use when needed. In addition to internal recordkeeping, microfilm lists are being maintained at the sales counter on the availability of items in mail order catalogs and in automotive repair parts inventory. Also, a microfiche reader is being used by a nationwide chain of paint stores to assist customers in paint selection by showing a deck of color fiches which displays rooms with specifications for color-coordinated painted walls and furnishings.

Compared to conventional printed pages for reference on available stock, microfilm is easier to update, saves space, is less likely to be removed or misfiled, is more resistant to wear and tear, and is more economical to distribute. When information systems use a microfilm format, the unit labor requirements for recordkeeping are reduced because much less clerical labor is required for updating and reissuing files. Also, when production information is made directly available to prospective buyers, self-service may replace or reduce the time required of sales employees.

New central retail distribution system

Introduced into the Southwest and the Far West in 1970, and still restricted to a few warehouses in these areas, central retail distribution is a new method of merchandising products to system members who order by telephone from their homes for home delivery. The distributor operates from a warehouse equipped with semiautomatic facilities, often located on industrial land. A quarterly catalog covering over 3,000 items, principally groceries and drugs, is circulated to permanent members who give their orders directly to the distributor's computer.[5] A quick delivery is made within a specified number of hours, typically four. The customer pays a small delivery fee and receives a monthly billing and a money-back guarantee on the merchandise. A central distribution system requires a sizable capital investment, an integrated physical distribution network, and intensive computerization, and offers the in-house buyers service and convenience not afforded by traditional retailers such as supermarkets. Central warehouse distribution eliminates labor requirements for item pricing and display and adds the tasks of assembly of orders by stock clerks and delivery by drivers and route sales workers. In the near term, the expansion of a central distribution system is not expected to affect retail food distribution significantly. However, over time, as the proportion of the elderly in the population increases and their residency in urban areas becomes more concentrated, more consumers may prefer this type of marketing.

Supermarket automation

At an electronic supermarket checkout counter, an automatic reader using a laser light source reads a bar code imprinted by the producer of the label for the container of the purchased items; the sales data are transmitted by wire to a centrally located computer capable of identifying and pricing each item from a master file. The tabulation is returned instantly to the supermarket where the customer receives a printout of the purchases and their prices and the computer updates the store's file of inventory data.

Savings from electronic checkouts originally anticipated by retail food stores included decreased unit labor requirements for checking, price marking and remarking, recording, checker training, and front-end administration.[6] Because of resistance by consumer groups to planned elimination of item pricing, most stores are continuing price marking so that jobs for this task have not been eliminated. The grocery industry set up a public policy subcommittee which recommended, in March 1976, a continuance in stores using automated checkouts of individual price marking, as practiced in conventional supermarkets. The committee also recommended discussion with consumer and labor representatives regarding continued experimentation with alternative methods of price information and other aspects of the Universal Product Code (UPC) system. Other possible benefits are reduction of pricing errors, tighter inventory controls, more accurate comunications from store to warehouse and manufacturer, and improved in-store evaluation of shelf-allocation changes and pricing policy. One supermarket with an electronic checkout reported a remarkably high increase in productivity when 95 percent of 175 products were scanned.[7] Fully computerized checkstands, including a terminal, scanner, and controller and a communications unit to transmit automatically compiled orders to the warehouse, were in operation in 50 supermarkets in early 1976.[8] Gains in productivity should result from further technological advance in product coding and computer-assisted front-ends. Also, the number of hours of employment of sales clerks, cashiers, stock handlers, and stock clerks is expected to rise in the last half of the 1970's. A greater volume of merchandise is expected to be marketed to satisfy the growth in consumer demand stemming from an increase in the number of families and an expected rise in the annual number of births.

Output and Productivity Outlook

Output

Output, measured by the net value added to national product originating in retail trade (in constant dollars),[9] grew at an annual average rate of 3.5 percent from 1960 through 1975. The yearly rate reached 4.5 percent in 1960-67 and dropped off to 2.8 percent for 1967-75.

The following tabulation, based on projections of the U.S. Department of Commerce, shows that in 1975 grocery stores were the leading subdivision in retail dollar sales; department stores were the second highest. These two subindustries accounted for 32 percent of total dollar sales and are expected to continue to represent about this proportion through 1985. Sales of department stores and eating and drinking places are expected to gain somewhat in relative importance while grocery, drug, furniture, apparel, and household appliance store sales will probably undergo a slight relative decline.

SIC	*Industry subdivision*	*Percent of total sales*	
		1975	*Projected 1985*
52–59	All retail trade	100.0	100.0
5411	Groceries	21.3	19.7
5311	Department stores	10.4	11.8
5812,5813	Eating and drinking places	8.3	9.6
5912	Drug stores	3.1	2.8
5712	Furniture stores	1.9	1.6
5621,5631	Women's apparel accessory stores	1.8	1.6
5331	Variety stores	1.6	1.4
5611	Men's and boys' apparel stores	1.0	.8
5722	Household appliance stores	.9	.8
	All other	49.7	49.9

Productivity

Because of limitations in available data, the BLS has not developed productivity measures for the industry. However,

Coded label being read at an automated grocery checkout

through an examination of the relationship between output and aggregate hours, some indication of productivity movements may be obtained. (See chart 12.) With the exception of 1961, 1974, and 1975, output rose every year throughout the 1960-75 period; hours rose in 10 of the 15 years. The annual rate of increase in output exceeded the rate of growth in hours over the period.

Unit labor requirements should continue to be lessened by a sustained emphasis on self-service, not only in the sale of foods and soft goods, but also hardware, electronics, appliances, and furniture. When the customer makes unassisted selections of purchases, store productivity increases through the release of employee-hours for other chores, for example, stocking shelves and counters in food and variety stores or tagging and arranging stock in hardware, appliance, and furniture stores. According to a private study, most executives of department stores, chains, and discount stores expect that the self-service proportion of all department store volume will be substantially higher by the mid-1980's compared to the mid-1970's; in addition, most of the retailers surveyed consider that warehouse outlets (a type of self-service marketing) will multiply their share of the furniture market by the mid-1980's. Productivity probably will tend to be decreased by managerial decisions to expand merchandise mix to satisfy customer preferences and by consumer requirements (as incomes rise) for style and service in respect to the products they buy. However, the increasing number of speciality shops may add economies of scale and benefit productivity.

Employment and Occupational Trends

Employment

Retail trade engaged a total of 15.2 million persons in 1975, of whom 88 percent were employees, 10 percent proprietors, and the remainder unpaid family workers. Compared to 1960, the number of persons working in retail trade was up 40 percent; the number of supervisory workers increased by 87 percent and nonsupervisory workers by 49 percent. The proportion of self-employed dropped from more than 1 in 5 of total industry employment in 1960 to less than 1 in 8 in 1975. For the 1960-75 period, employment of all persons grew annually at a 2.7-percent rate and of wage and salary workers at a 3.3-percent rate. Preliminary figures for 1976 indicate a rise in total employment to 15.5 million and in wage and salary workers to 13.4 million. Employment of all persons is expected to reach 18.1 million in 1985, with employees accounting for 86 percent of the total. (See chart 13.) Aggregate hours of employment in retail trade grew at the more modest rate of 1.4 percent annually during the 1960-75 period. The ratio of part-time retail employees (who usually are assigned a regular weekly shift of less than 40 hours) to full-time workers (who typically work a 40-hour week) rose from 1:2.7 in 1963 to 1:1.7 in 1974. The increase in the proportion of part-time workers contributed significantly to the decline in the length of the average workweek during the 1963-74 period.

Women accounted for 47 percent of all employees in the retail trade work force in 1975 compared to an average of 39 percent in all industries. Sixty-eight percent of the employees in general merchandising were women; the proportion in drug stores was 61 percent and in food stores 37 percent.

The importance of different subindustries as a source of employment shifted between 1960 and 1970 and the trend, according to BLS projections, is expected to continue through 1985. Of the 33-percent rise in the number of employees projected for 1970-85, more than one-third is expected to occur in eating and drinking places, about one-fifth in general merchandise stores, one-sixth in food stores, and one-tenth in automotive dealers and service stations.

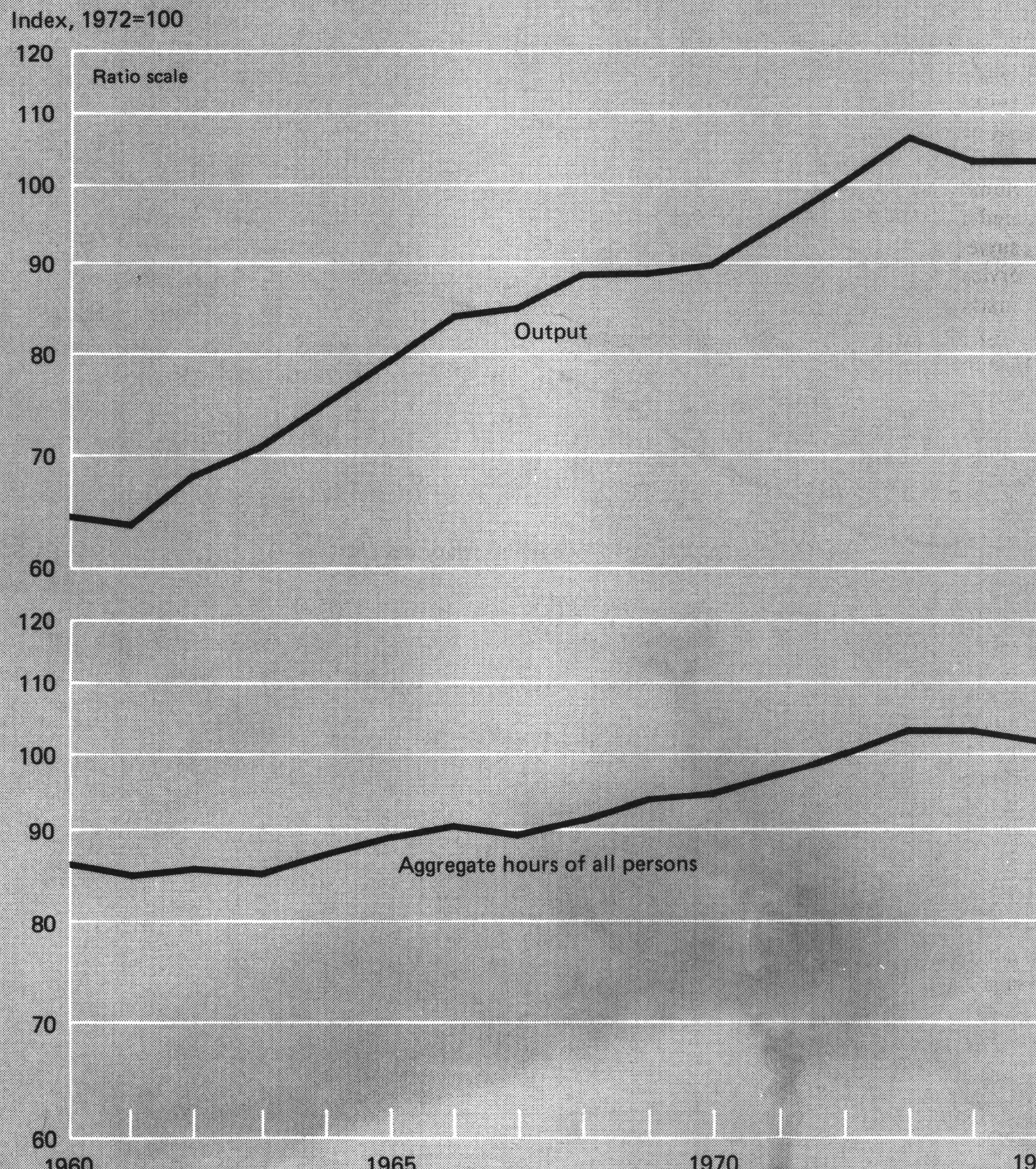
SIC	*Industry subdivision*	*Percent of total employment*		
		1960	*1970*	*Projected 1985*
52–59	All retail trade	100.0	100.0	100.0
58	Eating and drinking places	19.8	21.7	25.5
53	General merchandise stores	15.9	20.7	21.1
54	Food and dairy stores	17.6	15.8	15.9
55	Automotive dealers and service stations	15.2	14.5	13.5
59	Miscellaneous retail stores	12.9	11.8	10.9
56	Apparel and accessory stores	7.0	6.2	5.4
57	Furniture and home furnishings stores	5.1	4.5	3.9
52	Building materials and farm equipment	6.5	4.8	3.8

Occupations

Although the number of job opportunities in retail trade will expand for all major occupational groups through 1985, according to BLS projections, the proportionate increases will differ. The maximum relative gain is expected to occur for the professional and technical groups (57.8 percent) while the minimum is expected for operatives (8.7 percent). (See chart 14.) Because of the differences in the size of these occupational groups, the absolute increases vary significantly from the percentages. For example, the professional and technical group shows the maximum percentage gain but this represents relatively few jobs. The occupational group projected as needing the largest additional number of workers is the service workers caregory,

Chart 12

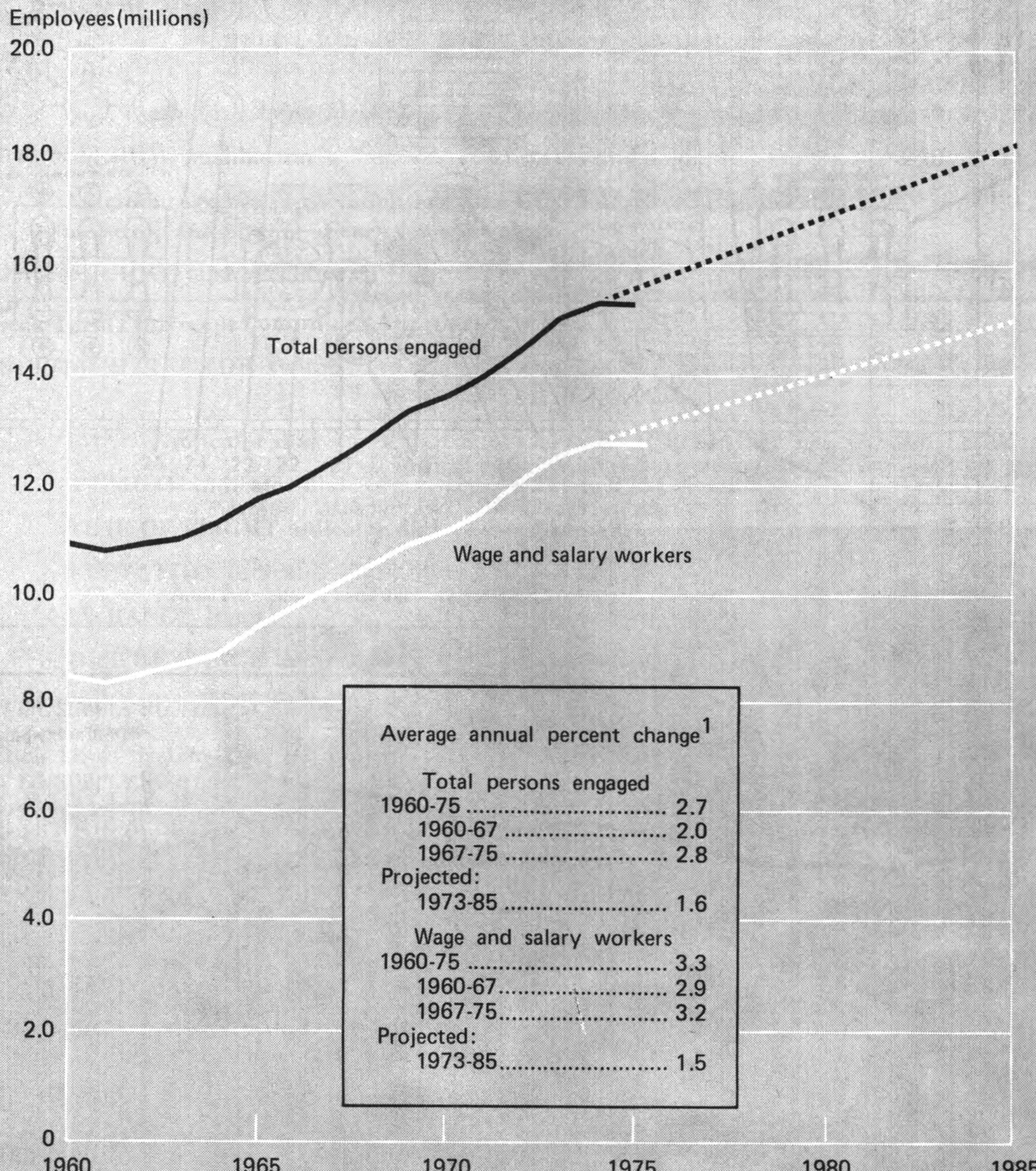
Output and aggregate hours of all persons in retail trade, 1960-75



Source: Bureau of Labor Statistics.

Chart 13

Employment in retail trade, 1960-75, and projection, 1973-85



Average annual percent change[1]

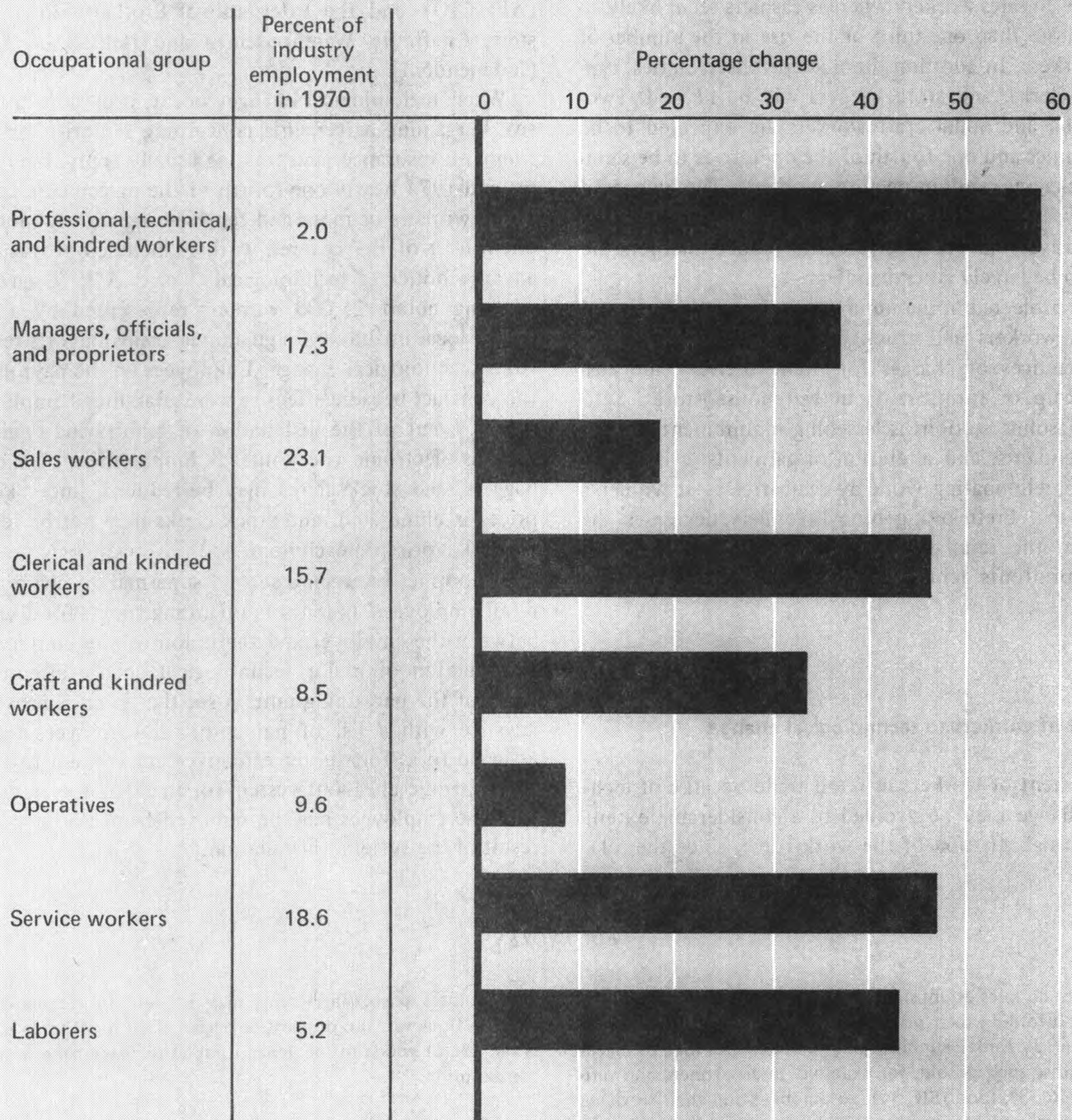
Total persons engaged	
1960-75	2.7
1960-67	2.0
1967-75	2.8
Projected:	
1973-85	1.6
Wage and salary workers	
1960-75	3.3
1960-67	2.9
1967-75	3.2
Projected:	
1973-85	1.5

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

Source: Bureau of Labor Statistics.

Chart 14

Projected changes in employment in retail trade, by occupational group, 1970-85



Source: Bureau of Labor Statistics.

followed by clerical and kindred workers; managers, officials and proprietors; and sales workers.

In the professional and technical job categories, two-fifths of the anticipated openings are expected to be for writers, artists, and entertainers (occupations related to marketing), one-fifth for pharmacists, and one-seventh for accountants. Additional computer specialists, principally programmers and system analysts, also are expected to be needed. Of the increased number of managers, officials, and proprietors, more than three-fifths probably will be restaurant, cafe, and bar managers and one-fifth sales managers. Sales clerks are projected to account for three-fourths of the increase in sales workers whereas cashiers seem likely to represent more than one-third of the rise in the number of clerical workers. In addition, bookkeepers, secretaries, typists, stock clerks, and store keepers will be needed. Two-fifths of the additional craft workers are expected to be auto mechanics and one-fourth of the operatives to be semi-skilled packaging and inspection workers. The increased number of service workers will probably be employed almost exclusively in food service; the added laborers are expected to be largely stock handlers.

A loss is projected in the number of jobs for delivery and route sales workers and truck drivers as a result of the growing practices of charges for home delivery and customer pick-up of furniture from warehouse stores. Self-service at gasoline stations is lessening requirements for gas station attendants, and alteration of garments at home by customers is eliminating work by seamstresses at women's apparel shops. Preticketing by wholesalers decreases the workload at the retail level for keypunch operators, and computer printouts tend to reduce stenographic requirements.

Adjustment of workers to technological change

Displacement of workers in retail trade because of technological change may be avoided to a considerable extent through normal attrition of the work force, since the relatively large proportion of part-time employees in this industry leads to a high turnover rate.

Measures by management and labor to meet the requirements of advancing technology include on-the-job retraining and comprehensive programs for job security. Neither wholesale nor retail trade is highly unionized; in 1970 less than 25 percent of all workers were organized. Employees in retail trade are represented by the Retail Clerks International Association (AFL-CIO), the Retail, Wholesale and Department Store Union (Independent), the Amalgamated Meat Cutters and Butcher Workmen of North America, (AFL-CIO), the Amalgamated Clothing Workers of America (AFL-CIO), and the International Brotherhood of Teamsters, Chaffeurs, Warehousemen and Helpers of America (Independent).

When technological changes occur, provisions in collective bargaining agreements concerning seniority rights, retirement, insurance, and training usually apply. In addition, by mid-1974 nearly one-fourth of the agreements covering 1,000 workers or more and representing slightly more than one-fourth of the covered workers included provisions for advance notice of technological change. A 1976 agreement covering about 25,000 workers represented by a Retail Clerks local introduced a guarantee against layoffs resulting from technological change. Employees on the payroll when the contract became effective were guaranteed employment in the event of the installation of laborsaving equipment such as electronic checkouts.[10] Employment of checkers, baggers, and stock clerks may be reduced, since "keying" prices is eliminated, and stock clerks may not be required to mark a price on each item.

A contract between a second supermarket chain and its retail employees' union sets up arrangements for discussion between the employer and the union of any contemplated introduction of major technological change affecting the work of the bargaining unit. Also, the union is provided in advance with a list of names of all employees regularly assigned to a store on the effective date of a substitution of an electronic checkout system for an existing system. None of these employees may be removed from the payroll as a result of the system's installation.[11]

FOOTNOTES

[1] Retail trade sales establishments are classified according to the commodities affording their primary source of receipts, as follows: Building materials, garden supplies, and mobile homes (SIC 52); general merchandise such as sold, for example, in department and variety stores (SIC 53); food (SIC 54); automobiles and their servicing (SIC 55); apparel and accessories (SIC 56); furniture, home furnishings, and equipment (SIC 57); prepared food to be consumed immediately as at eating and drinking places, exclusive of hotel-operated restaurants and counters (SIC 58); and miscellaneous such as sold in drug, liquor, sporting goods, and book stores (SIC 59). This study treats retail trade as an entity and groups SIC's 52 through 59.

Retailers buy inventory from wholesalers and manufacturers and may perform such vertically integrated operations as warehousing and product processing. Items may be sold to commercial purchasers. However, the primary objective of all retail trade activities is the sale of goods to the general public for personal or household consumption.

[2] Retailers with multi-store operations who perform many functions of wholesale trade are frequently implementing technological advances originating in wholesaling. See "Wholesale Trade" in *Technological Change and Manpower Trends in Five Industries*, Bulletin 1856 (Bureau of Labor Statistics, 1975), pp. 48-57.

[3] "Bankers See EFT Among Changes Bringing Them to New Marketing Era," *Advertising Age*, March 29, 1976, p. 103.

[4] Jay Scher, *Department and Speciality Store and Merchandising Results of 1974* (New York, National Retail Merchants Association, 1975) p. 38-39.

[5] William J. Nichols, "Central Distribution Facilities Challange Traditional Retailers," *Journal of Retailing,* Volume 49, Number 1, Spring 1973, p. 45-50.

[6] Thomas Wilson, "Automated Front End Briefing," exhibit from slide presentation made through the U.S. Department of Commerce, Domestic and International Business Administration (Washington, McKinsey and Company, 1974).

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

[8] "The Supermarket Scanner That Failed," *Business Week,* March 22, 1976, p. 52B.

[9] The U.S. Department of Commerce, Bureau of Economic Analysis (BEA), compiles data on the real product of retail trade. Current-dollar retail sales grouped by type of store as published annually in a BEA-Census series are converted to constant dollars with appropriate deflators from the BLS Consumer Price Index. Deflated sales are then aggregated, using as weights the 1958 gross margin estimates (operating expenses plus profits) for each type of trade outlet. Problems related to product mix and deflators limit the acceptability of this output measure.

[10] Contract between five Retail Clerks locals in Michigan and workers at A & P, Kroger, and United Super Market Association includes an employment guarantee applying to employees on the payroll on May 5, 1974.

[11] Giant Food Inc., which operates over 100 supermarkets in Maryland, Virginia, and the District of Columbia, reports that similar guarantees are included in all contracts between the company and the unions representing all its retail employees (with the exception of store managers).

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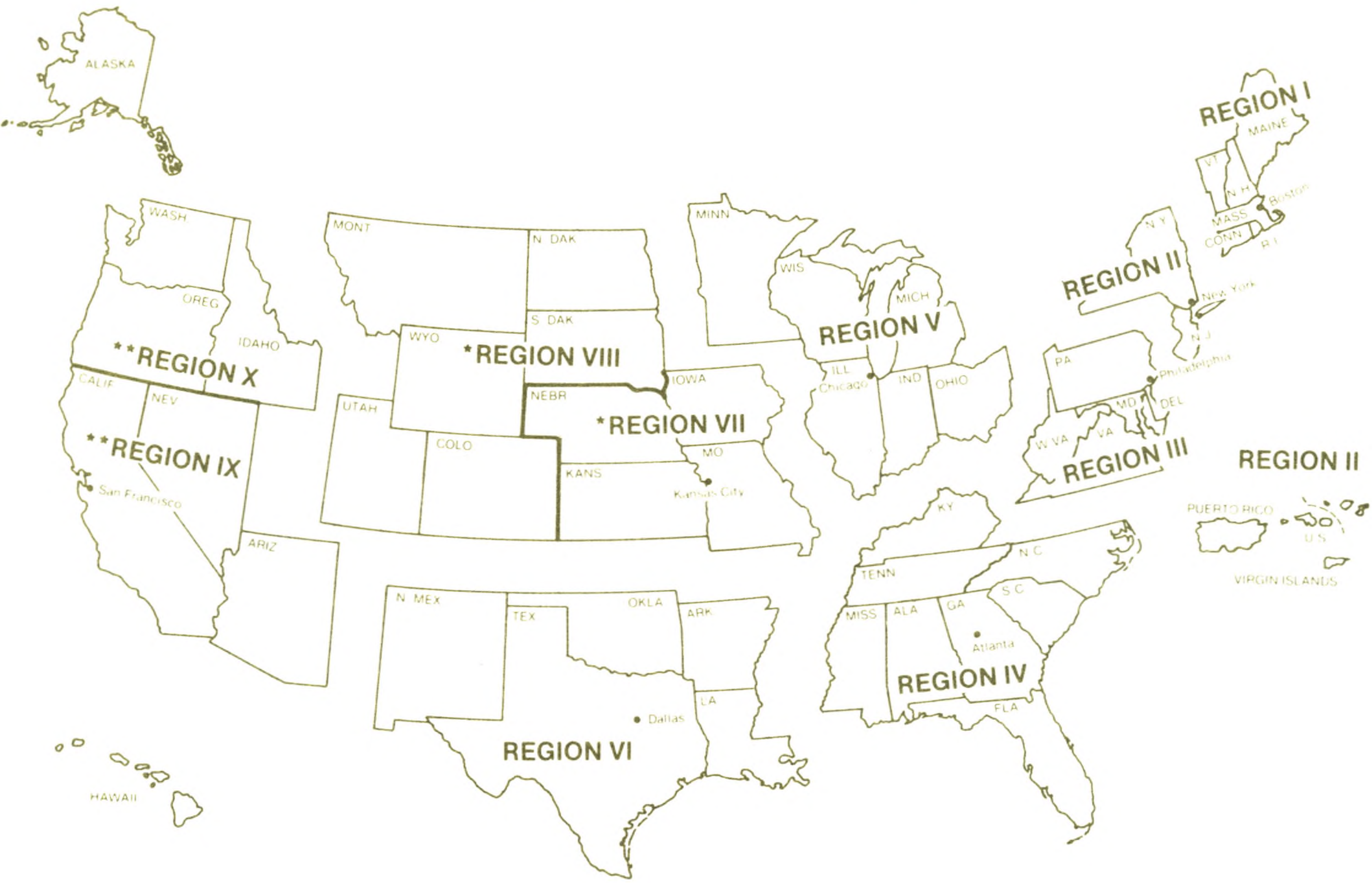

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