Technological Change and Its Labor Impact in Four Industries

Hosiery/Folding paperboard boxes/
Metal cans/Laundry and cleaning

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U.S. Department of Labor
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Preface

This bulletin appraises some of the major technological changes emerging among selected American industries and discusses the impact of these changes on productivity and labor over the next 5 to 10 years. It contains separate reports on the following four industries: Hosiery (SIC 2251,52); folding paperboard boxes (SIC 2651); metal cans (SIC 3411); and laundry and cleaning (SIC 721).

This publication is one of a series which presents the results of the Bureau's continuing research on productivity and technological developments in major industries. Preceding bulletins in this series are included in the list of BLS publications on technological change at the end of this bulletin.

The bulletin was prepared in the Bureau's Office of Productivity and Technology, Jerome A. Mark, Associate Commissioner, under the direction of Charles W. Ardolini, Chief, Division of Industry Productivity and Technology 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 are: A. Harvey Belitsky (hosiery), Richard W. Lyon (folding paperboard boxes), Charles L. Bell (metal cans), and Robert V. Critchlow (laundry and cleaning).

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Contents

Chapter 1. Hosiery

Summary

Advances in technology, particularly in regard to pantyhose and tube-type socks, have been largely responsible for the strong productivity growth trend in the hosiery industry (SIC 2251 and 2252) in the last two decades. Technological advances include higher speed, more automated knitting and sewing machines, and specialized electronic equipment which increases the mill's flexibility in production scheduling. These developments are expected to continue to affect productivity favorably in the 1980's.

Productivity grew very rapidly during the period 1960–82, averaging 6.8 percent annually, compared with 2.6 percent in all manufacturing.[1] In addition to lower unit labor requirements associated with new automatic machinery, productivity has been increased by the elimination of some processing. While productivity growth has slowed down in recent years (1975–82, 2.6 percent), the rate is expected to improve with greater diffusion of new technologies.

Capital expenditures (in constant dollars) in the women's hosiery sector in the 5 years 1977–81 averaged only about 25 percent of the peak level of 1969. The relatively high outlays made in the last half of the 1960's were in response to the capital requirements for pantyhose production. In contrast, many of the firms engaged in manufacturing men's hosiery did not invest in the newest and most costly machines until recent years.

Employment in the hosiery industry in 1982 averaged about 63,000 persons, 41 percent below the 1969 peak. The sharp decline occurred in the first half of the 1970's, but since then, employment has been relatively stable. Women employees account for a very high proportion of the work force—75 percent in 1982.

Technology in the 1980's

Hosiery manufacture includes the major processes of knitting, sewing, dyeing, boarding, and packaging. Technological developments in these processes in the last two decades have greatly reduced unit labor requirements. Nevertheless, the industry remains highly labor intensive relative to other industries, in part because of the many discrete procedures which have not been automated and in part because the diffusion of existing automated equipment is still limited.

Major advances include the introduction of faster knitting and sewing machinery, the incorporation of electronic controls, and the modification of several operations. These modifications in hosiery manufacture have reduced the number or complexity of the processes. For example, hosiery made without a reciprocated (formed) heel greatly increases output per hour compared with traditional methods which include a formed heel. Similarly, the heat-setting process of boarding which shapes the stocking has been eliminated for some hosiery lines. This will be discussed in more detail in the productivity section.

Major technological changes in hosiery manufacture, their diffusion, and their labor impact are discussed below and are presented in table 1.

Knitting

Faster, more automated knitting machines have replaced large numbers of older machines in the last 15 years. In 1980, there were 29 percent fewer knitting machines than in 1963, while production was 53 percent greater. Unit labor requirements are considerably lower on the newer machines.

Some of the advances in knitting technology are a function of new or improved yarns. Stretch nylon, spandex (elastic fiber), and improvements in texturizing yarn which assure stretch-recovery properties have made possible the construction of today's hosiery.

Women's seamless hosiery is manufactured on multi-feed,[2] high-speed automated circular knitting machines. For pantyhose, the primary product, circular machines knit blanks (legs of pantyhose) which are similar to stockings, except that they are longer. In a subsequent operation, the upper parts of the knitted blanks are sewn together to form the panty.

Some of the newer four-feed machines can knit a pantyhose blank in about 1 minute, compared with about 10 minutes required on older two-feed machines 15 years ago. These machines have automatic lubrication controls, automatic stop motion controls for needle and thread breakage, and may utilize electronic processors.

[1] Rates of change are based on the least squares trends method.

[2] Feed on the standard machine refers to the number of strands of yarn; speed refers to the speed of the cylinder.

Table 1. Major technology changes in hosiery

Technology	Description	Labor implications	Diffusion
Knitting	Multifeed, high-speed machines for pantyhose and other hosiery have automatic controls, e.g., lubrication, stop motion, and monitoring. Newer machines incorporate microprocessors which control some operations. More advanced machines with microcomputers operated from a keyboard make production changes easier.	Unit labor requirements for knitting machine operators and maintenance workers are much lower than on older machines. Skill requirements for operators may be reduced. Fixer requires knowledge of electronics.	Diffusion of four-feed machines for pantyhose production advanced from 36 to 56 percent of machines between 1975 and 1980; a rapid rate of adoption is expected to continue in the 1980's. Microprocessors are increasingly utilized. Microcomputers are in limited use and their costliness may limit wide adoption in the near term.
Automatic sewing of upper part of pantyhose	Automatic line closer puts seam into pair of legs to form pantyhose; automatic gusset seamer sews in gusset; automatic line-closer/gusset machine completes both operations.	Unit labor requirements for operators are greatly reduced and skill requirements could be lower.	Automatic line closer is used by major firms; automatic gusset seamer is expected to gain wider acceptance by major firms in the 1980's.
Automatic toe closing	This machine combines toe turning and sewing; incorporates automatic controls. Requires less operating and maintenance time per unit than older, less automated sewing machines. Used for pantyhose and tube socks.	Output per operator hour is double that of the older, less automatic operation. Unit labor requirements for maintenance are reduced.	Machines are in use by a majority of pantyhose and tube sock manufacturers. Further diffusion is expected.
Automatic dyeing and extracting	New machines automatically control dyeing and extracting after manual loading.	Reduces unit labor requirements to about half that of the older machines with manual controls. No extractor operator is needed.	About 40 percent of hosiery output is processed by these units. They are likely to account for an increasing share of output during the 1980's.
Automatic handling and packaging	New packaging equipment automatically sets up package, inserts product, and attaches labels. Automatic conveyors (carousel types and others) move hosiery to packaging stations.	Reduces unit labor requirements for packaging to about half that of the manual process. Conveyors replace or reduce unskilled materials handlers.	Automated packaging is limited to plants with long production runs and significant diffusion is not expected. Costly automatic conveyors are also expected to be limited to large firms.

The time required to knit the legs is reduced in other ways. Reciprocation of the heel and toe is now omitted on more than 80 percent of the pantyhose, greatly reducing unit labor requirements. Reciprocation of the heel, for example, involves knitting a pocket shape into the heel area.

The new generation of hosiery and pantyhose machines incorporates electronic processors or microcomputers which reduce downtime for size and style changes, and for maintenance. Visual display units provide information to the operator, the fixer, and management which could increase quality and productivity. With the automated knitting machines, unit requirements for knitters and fixers are greatly reduced. Skill requirements for the operator may also be reduced. This reduction in unit labor and skill is changing occupational requirements; e.g., operator and fixer jobs are being consolidated (see the section on occupations).

The diffusion of the four-feed knitting machines for women's hosiery advanced from 36 to 56 percent of all knitting machines between 1975 and 1980. The outlook is for continued rapid replacement of the older knitting machines by automated machines in the 1980's.

In *hosiery other than women's*—primarily socks—technological advances in knitting have also been adopted in the last 10 years, particularly in speed, automation, and maintenance. The major products in this category are men's dress socks, girls' and boys' and women's socks, and casual and athletic socks.

For men's dress socks, the changes have been largely modifications to the traditional process that produces socks with reciprocated heel and toe. Modern knitting machines operate at higher speeds, but they are principally one- or two-feed machines. The newest machines have automatic lubrication and sophisticated electronic controls. They increase the mill's flexibility to change product lines with less downtime, and lower unit labor requirements for operators and fixers, compared with older machines.

For the "true rib" pattern, new double-cylinder knitting machines produce the pattern 30 to 40 percent faster than the older double-cylinder machine. These machines also improve quality, but require more highly skilled fixers. Their limited diffusion is due, to some extent, to their substantial cost relative to the payback period. It is expected that diffusion of these new double-cylinder machines will continue to be slow.

For socks other than men's dress socks, important advances have been made in higher production rates and lower unit labor requirements. Installation of electronic controls which permit greater production flexibility and reduce downtime is largely responsible for these improvements.

In addition, one of the major changes in sock manufacture is the elimination of heel and toe reciprocation. These "tube" socks have been widely adopted for casual wear. Output per hour is about 30 percent higher for the tube sock than for the traditional sock with heel and toe.

Electronically programmed controls

Sophisticated electronic equipment (microprocessors and microcomputers) is increasing in importance in the hosiery industry.

Microprocessors, used for monitoring and operating machinery, have received growing acceptance by hosiery manufacturers. These electronic devices are programmed to monitor or control one or more specified details of a machine's operation. Because of their relatively low price, and their effectiveness in reducing downtime, they are replacing the older electro-pneumatic and mechanical methods of control.

Microcomputers are increasing in importance only slowly. These units facilitate production changes. In knitting, for example, they are operated directly from the keyboard of a control panel on each machine, allowing the operator to make program changes (e.g., in size or style) with little or no downtime, while considerably increasing the flexibility of the machine. This is particularly important for shorter runs and fashion changes.

Unit labor requirements tend to be lower with more sophisticated electronic controls. Moreover, highly skilled mechanics are not required to make the style or size changeovers. In some cases, the operator's skill requirements are slightly reduced, and training could require less time. With such controls, however, the mill requires skilled fixers who are knowledgeable in electronics.

Currently, machines incorporating microcomputers account for less than 5 percent of the knitting machines used in the women's hosiery sector. In the men's sector, diffusion has been even more gradual. The costliness of the machine could remain an obstacle to much wider adoption for at least the next 5 years.

Automatic sewing of upper part of pantyhose

After the leg blanks of pantyhose are knitted, the upper parts are sewn together to form the panty. Two blanks are cut open at opposite sides and seamed together in front and back. In some mills, the automatic line-closing machine now performs this operation, replacing the labor-intensive manual operations performed on a traditional sewing machine. Then, after the blanks are sewn together, an automatic gusset seamer can be used to sew in the gusset or crotch to complete the panty section. With this machine, the sewing operator only loads the garment on the seamer and monitors it; the machine completes the job. An automatic line-closer/gusset machine is also used which combines both processes.

These automated operations greatly reduce the time otherwise required for an operator to perform the job manually on an older sewing machine. When an automatic gusset seamer and an automatic line closer are used together, the time required for both operations is much less than the job of manually sewing only the two legs together.

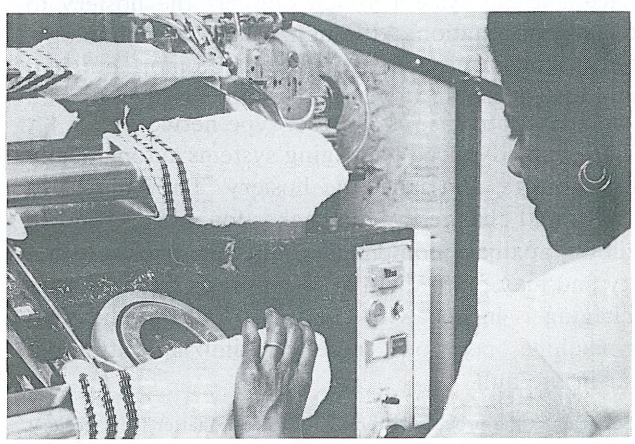
The sewing-machine operators handling the automatic machinery are basically loaders. They can be trained in a few weeks, much less time than is necessary to train operators for the conventional manual process.

The major manufacturers of pantyhose have introduced the automatic line closer in almost all of their production. However, most major manufacturers do not have automatic gusset seamers. Within the next 5 to 10 years, the principal hosiery manufacturers are likely to invest in the automatic gusset seamer.

Automatic toe closing

Toe-closing operations on a sewing machine have replaced the traditional reciprocated knitted toe for pantyhose and tube socks. According to one plant's estimate, doing away with the reciprocated toe for socks reduced the time for knitting by 18 percent.

New toe-closing machines combine the toe-turning and sewing procedures in one operation, and greatly increase output per hour over earlier sewing machines. They are more automated and require less manual work, particularly for positioning. They also yield more consistent quality by accurately controlling the shape of the toe seam. According to one estimate, newer machines double the output per operator hour over the



An operator pulls sock onto arm of automatic toe-closing machine

labor-intensive work required on earlier sewing machines. Moreover, they are relatively easy to operate and maintain since the operators load the machine and thereafter primarily monitor its operation.

Although an automatic toe-closing machine has been available since 1967, its diffusion has been relatively limited until quite recently. It has now been adopted by the majority of firms manufacturing pantyhose and tube hose, and greater diffusion is expected.

Automatic dyeing and extracting

After the hosiery is scoured, it is dyed.[3] Goods are loaded manually into the newer machines, which then dye and extract the hosiery automatically. The machine is programmed to control water ratio, temperature, timing, etc. These machines permit higher rotation speed and incorporate improved electronic controls, greatly reducing the cycle time. Also, dyeing and extracting are combined in a single unit, thereby eliminating labor handling between machines. The older machines with two separate operations and few controls still account for more than half of the hosiery produced.

The newer automated machines reduce unit labor requirements to about half that of the older machines. No extractor operator is needed. Also, relatively little training is required for dyeing machine operators. However, maintenance is much more complicated on the newer equipment, and a knowledge of electronic controls is generally important.

Currently, about 40 percent of hosiery output is processed by automatic dyeing and extracting units. Although these machines are quite costly, they are likely to account for an increasing share of output in the 1980's.

Automated handling and packaging

The labor-intensive process of packaging the hosiery has been modified during the past decade by many improvements, ranging from simple mechanization to sophisticated automation. The efficiency of this process depends to some extent on the automaticity of the materials-handling system which delivers the hosiery to the packaging station. Although not a new technology, highly mechanized conveyors are much more efficient than those available 15 years ago, and can operate with automatic controls in a carousel-type network.

The most advanced packaging systems automatically fold, package, and label the hosiery. They may also permit rapid changes by the packer for shorter runs. In addition, auxiliary equipment counts the packaged hosiery and may place them into shipping cartons. Faster packaging is in line with the faster knitting and sewing-machine operations, thereby optimizing output per hour in the mill.

[3] Scouring is the process of removing foreign matter from hosiery. Scouring and dyeing can be done in a one-bath procedure, saving time, water, and energy.

Automated packaging can reduce unit labor requirements to about half that of the largely manual operations, and could improve quality. This process is handled by packers (folders, baggers, boxers), who are generally semiskilled workers. Similarly, mechanized conveyors replace or reduce the number of unskilled materials handlers who move carts manually.

While the most advanced packaging systems have been adopted by some of the larger manufacturers with longer production runs (primarily of pantyhose), many manufacturers continue to use largely manual packaging procedures. The outlook is that the automated systems will continue to show only moderate diffusion in the next decade. Similarly, the diffusion of costly conveyor systems is also likely to be limited to the larger manufacturers.

Output and Productivity Outlook

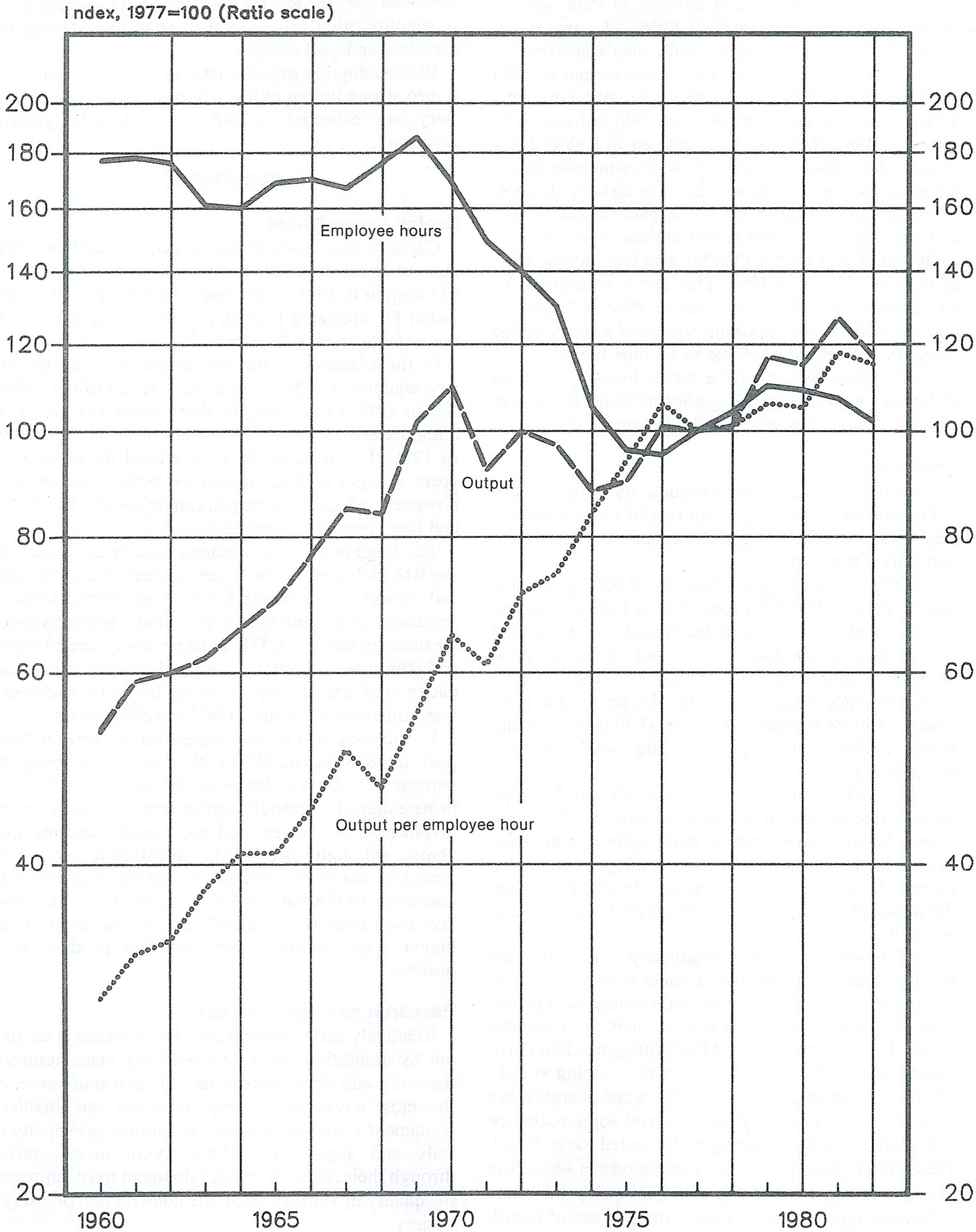
Output

The output of the hosiery industry increased at an average annual rate of 3.4 percent during the period 1960–82. In the first decade of that period, output rose almost steadily at an average rate of 7.2 percent annually to a peak in 1970. This compares very favorably with 5.3-percent growth for all manufacturing output in that time. However, in 1970–82, opposing trends in hosiery output resulted in an average annual rise of only 2 percent. Output was seriously depressed by the mid-1970's recession, but, after fluctuating sharply, it rose to an alltime high in 1981. In 1982, however, output fell again (about 8 percent), probably due to the most recent recession (chart 1).

The increase in women's hosiery was largely responsible for the industry's growth. Production in 1982 was more than double that of 1960. Women's hosiery accounted for about 42 percent of the industry's output in 1960, and 52 percent in 1982. Per capita consumption of hosiery rose from about 15 pairs in 1964 (earliest data) to about 20 pairs in 1982.

The principal product in women's hosiery in the last decade has been pantyhose, the combination in one garment of stockings and underpants. It was a relatively new product in 1968 (accounting for 14 percent of women's hosiery) but within only 2 years, output jumped to 70 percent. In addition to improvements in yarn, demand for pantyhose has been increased by a new marketing strategy which made them widely available in supermarkets and drug stores, whereas they were formerly sold mainly in specialty and department stores. Although a marked shift from dresses to pants has led to a considerable expansion of knee-high hosiery, pantyhose remains the principal form of hosiery. The more rapid growth in recent years is largely due to new styles, such as "control top" pantyhose, and to the importance of color and texture of hose.

Chart 1. Output per employee hour and related data, hosiery, 1960-82



SOURCE: Bureau of Labor Statistics.

While the composition of men's hosiery was also affected by new products and changes in yarn quality, output grew by comparatively little—21 percent between 1960 and 1982. As a result, men's hosiery declined from 33 percent of total hosiery output in 1960 to 22 percent in 1982. Per capita consumption of men's hosiery has been rather stable since 1964 but was at its lowest in 1982. This can be attributed to a shift away from natural fibers to more durable manmade fibers, offset by increased demand related to fashion changes. Those included leisure-wear styles, patterns and colors, and tube hosiery for casual and athletic wear.

Output of socks other than for men was almost twice as high in 1982 as in 1960. This sector accounted for 25 percent of total hosiery output in 1960 and about 26 percent in 1982. An important source of growth in this category is likely to continue to be tube hosiery.

Unlike other sectors of the textile industry, imports of hosiery have not been significant. Exports are also a rather minor proportion of the industry's shipments.

Productivity

Over the 1960–82 period, productivity of the hosiery industry grew at the very rapid rate of 6.8 percent per year. In all manufacturing, the productivity growth rate was only 2.6 percent.

Hosiery productivity increased in all but 3 years during the period 1960–75. From 1960 to 1970, productivity increased 7.1 percent annually and was associated with about the same rise in output and only a fractional increase in employee hours (chart 1). From 1970 to 1975, a sharper productivity gain (8.3 percent) was attained. However, during that period both output and hours declined, -3.2 percent and -10.6 percent, respectively.

From 1975 to 1982, the industry's productivity growth rate slowed down considerably to 2.6 percent a year. In those years, output once again rose an average of 4.3 percent annually, but employee hours also increased—at the rate of 1.6 percent. In manufacturing, the productivity growth rate also slowed to 1.4 percent annually in those 7 years.

The industry's strong productivity growth rate through most of the last two decades is associated with advances in technology, particularly in regard to pantyhose and tube socks, which reduced unit labor requirements. For example, many of the knitting machines producing women's hosiery in 1970 were running at only 250 rpm, whereas the newer machines can operate more than three times faster. Pantyhose and some socks are knit without time-consuming reciprocated toe and heel. New stretch yarns permit the manufacture of some hose in only one size, contributing to larger batch production.

Several types of hosiery omit the process of boarding, i.e., placing the hose on forms that shape it. Probably less than 20 percent of pantyhose are still fully boarded. Since unboarded hosiery is shapeless until stretched over the leg, the elimination of boarding tends to simplify other processes such as dyeing, drying, inspection, and packaging.

Wider adoption of some new technologies and continued strong output of less labor-intensive types of hosiery are expected to affect productivity growth favorably.

Investment

Capital expenditures

Capital expenditures for hosiery equipment have been increasing rapidly in the last several years to a peak of $55 million in 1981 (latest data). In real terms (i.e., adjusted for changing prices), however, they have been quite stable at very low levels.[4]

In the women's sector, the largest real outlays for new equipment were made in the last half of the 1960's and in 1970. In contrast, in the 5 years 1977–81, real outlays were only about 25 percent of the peak in 1969. In 1981, they were at the lowest level for at least 18 years, except for 1976. Outlays per production worker, however, reflected the drop in employment in the 1970's and have remained relatively strong.

The large outlays for women's hosiery equipment in the late 1960's and in 1970 were in response to the special capital requirements for new pantyhose knitting machines, since pantyhose were initially made on regular stocking machines. When the economy turned down and pantyhose production dropped sharply, excess capacity was considerable. Outlays for new machinery were then sharply reduced in succeeding years.

In the sock sector, real expenditures were at their peak in 1966; in the 1970's, they averaged nearly 40 percent less. Unlike the women's sector, most of the firms engaged in manufacturing men's socks have not invested in the newest and most costly knitting machines, although many of the machines in use are 25 years old and more. Outlays were made to recondition machines. In the last several years, however, real outlays have been rising, mainly due to the demand for higher speed knitting machines that produce tube hosiery.

Research and development

Relatively little research and development is carried out by domestic hosiery or machinery manufacturers. Research and development, as well as manufacture, of the most advanced knitting machines and auxiliary equipment have been carried out abroad, principally in Italy and Japan. In addition, yarn manufacturers through their research and development have improved the quality of yarn, enabling the construction of today's hosiery.

[4] Deflated Bureau of the Census expenditure data.

The larger domestic hosiery manufacturers do, however, make modifications to and improvements in their machinery. For example, one hosiery manufacturer recently produced a unitary cam for its women's hosiery knitting machinery which takes less than 1 hour to change, compared with at least 4 hours previously required for their commercially purchased cam. In addition, hosiery manufacturers make some spare parts in their own machine shops or in shops within the community, reducing downtime caused by long delays for new parts.

Employment and Occupational Trends

Employment

Employment in hosiery manufacturing averaged about 63,000 persons in 1982, 41 percent below the 1969 peak of 107,000. The sharp decline occurred in the first half of the 1970's, and hit its lowest level in 1975. Since then, however, it has been relatively stable (chart 2).

Employment was about equally divided between the two major sectors (women's hosiery and socks) in 1982, as was the case in 1960. Employment in each of the sectors in 1982 was about 40 percent below its 1960 level. But employment patterns between those two periods varied, reflecting differences in output and technology. Employment in the women's hosiery sector rose in the last half of the 1960's to a high in 1969 of more than 70,000 workers, as pantyhose production rose sharply. The 1970's saw an almost steady decline to a low of 28,000 workers in 1977. Since then, employment has been relatively stable.

In contrast, employment in the sock sector declined slowly but steadily from its high in 1960 to a low in 1975. By 1975, only about 30,000 workers were in plants producing men's and other socks, compared with 51,000 in 1960. Since then, employment in this sector stabilized at only slightly above the low point.

The ratio of hosiery production workers to all hosiery employees has remained relatively high. This is associated with the difficulty or cost of automating some processes, and the relatively limited diffusion of some new machinery. In 1982, production workers constituted 90 percent of all hosiery workers, compared with only about 68 percent in all manufacturing.

Women employees account for a very high proportion of the hosiery work force—about 75 percent in 1982, compared with 64 percent in all other knitting industries. The rate is somewhat higher in the women's hosiery sector than in the sock sector.

Occupations

Technological changes in the last decade have reduced unit labor requirements and changed the relative importance and duties of many occupations. The impact has been most pronounced in the women's hosiery sector, and the occupations affected include knitters, sewing-machine operators, boarders, and occupations in packaging. Two BLS surveys suggest a sharp decline in these occupations from 1970 to 1981[5] while output increased more than 15 percent.

Sewing-machine operators constituted the largest occupational group. These operators sew the upper part of pantyhose on increasingly automated sewing machines by joining together the leg blanks, with or without a gusset. In number, they declined about 20 percent from 1970 to 1981, but increased sharply as a proportion of the total—from 10 percent to 23 percent.

Folders and boxers are the second largest occupational group, although a change in packaging from boxing to bagging greatly reduced their number. Overall, the occupational group of baggers, folders, boxers, and automatic packaging-machine operators declined 50 percent from 1970 to 1981. While these manual tasks are being replaced by mechanized and automated equipment in some plants, they remain highly labor intensive.

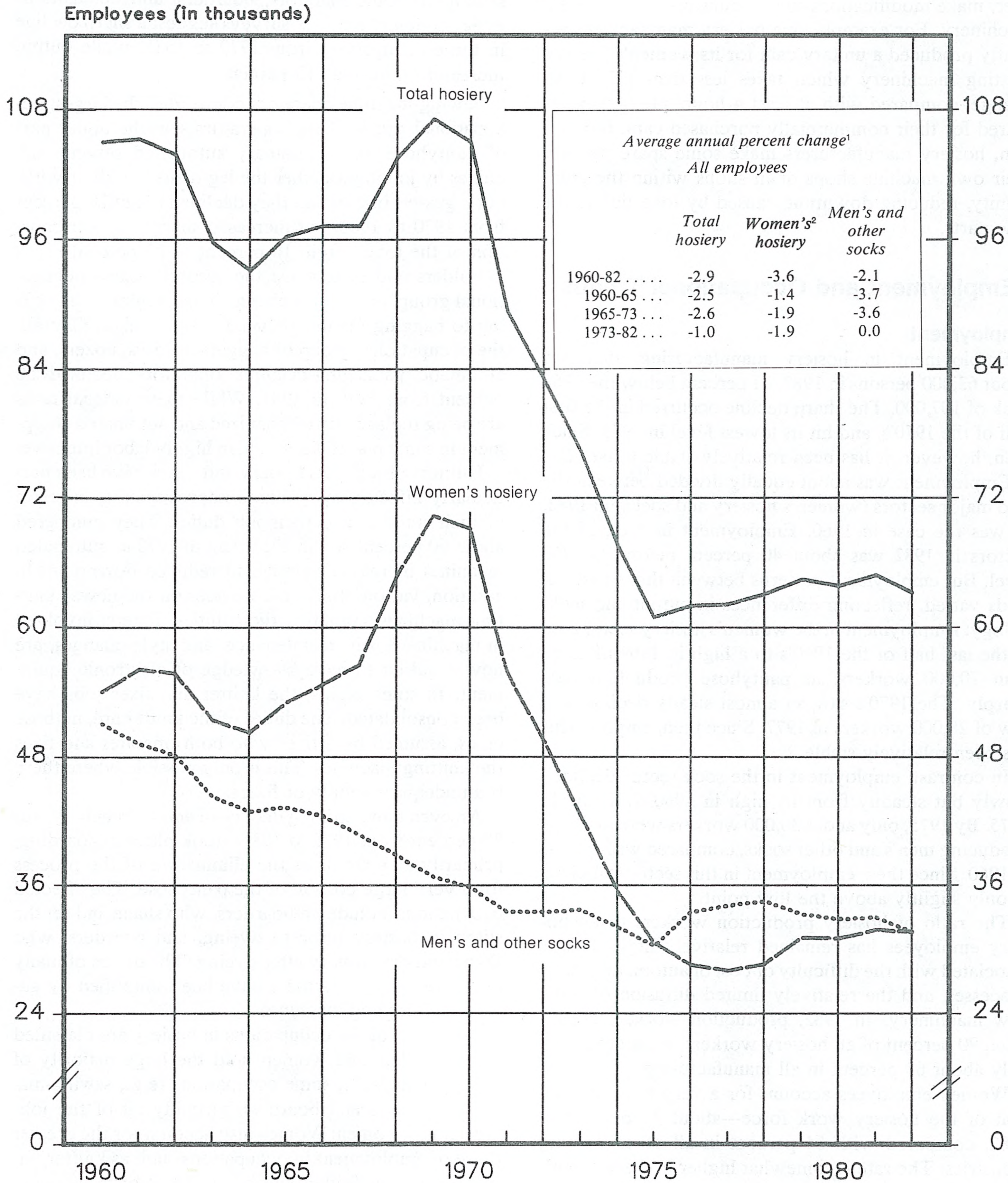
Knitters of seamless hosiery and fixers have been particularly affected by machine improvements, in terms of their number and their job duties. They numbered about 60 percent less in 1981 than in 1970 as automated machines increased output and reduced downtime. In addition, various automatic devices on the newer knitting machines simplified their duties. Fixers, involved in machine repair, maintenance, and style changes, are now required to have knowledge of electronic equipment. In some plants, the knitter and fixer jobs have been consolidated. The duties of the knitter are, in those cases, assumed by a fixer who both operates and fixes the knitting machines. This is only possible where there is an adequate supply of fixers.

An even more striking decline in employment—about 80 percent from 1970 to 1981—took place in boarding, primarily as a result of the elimination of the process for a very large portion of the pantyhose. The affected occupations include preboarders, who shape and set the stitch in hosiery prior to dyeing, and boarders, who shape and dry hosiery after dyeing. The duties of many of the remaining boarders have been simplified by automatic boarding machines.

Nearly all of the occupations in hosiery are classified as semiskilled, and women hold the large majority of these positions. In some occupations (e.g., sewing-machine operator and boarder), virtually all of the jobs are held by women. Women also account for the greater share of employment in occupations such as knitter, inspector, pairer, folder, and boxer. Most of these occupations can be learned with relatively short-term training on the job.

[5] *Industry Wage Survey: Hosiery, September 1970,* Bulletin 1743 (Bureau of Labor Statistics, 1972), pp. 10-11; *Industry Wage Survey: Hosiery, August 1981*, Bulletin 2151 (Bureau of Labor Statistics, 1982), p.8.

Chart 2. Employment in hosiery, 1960-82



[1] Least squares trends method.
[2] Full- and knee-length women's hosiery.

SOURCE: Bureau of Labor Statistics.

The principal occupations held by men—fixers and sewing-machine repairers—are highly skilled and require extensive training. These are the highest paying jobs in the industry. Fixer training, which combines on-the-job and classroom training, usually requires 3 years to attain one level of the craft and an additional year for the top grade. Shortages of such skilled labor have been a problem.

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 workers and management. In general, such programs are more prevalent and detailed in formal contracts.

Only a small number of labor-management contracts are found in the hosiery industry. About 5 percent of all hosiery workers are in plants covered by collective bargaining compared with about 15 percent in all textile industries. The major union is the Amalgamated Clothing and Textile Workers Union.

The principal form of job security for organized hosiery workers is seniority. Contract provisions generally state that preferences in layoffs and reemployment shall be given to employees on the basis of qualifications and seniority. Provision for payment to employees who are permanently separated from a firm because of a technological change or plant closing is rare in these labor-management contracts. However, at the time of a plant closing, negotiations over severance pay may take place.

Retraining for jobs may be the major factor in employees' adjustment to more sophisticated machinery, particularly where a labor shortage exists. Officers of leading hosiery manufacturing firms refer, especially, to shortages of trained fixers and maintenance personnel in electronics and air-conditioning.

Skill shortages and training are complicated by demographic factors. During the 1950's and even part of the 1960's, young, trained fixers were available. Moreover, most companies were located in rural areas which offered only limited alternative job opportunities to fixers. Currently, however, the average age of fixers is about 55, and younger, experienced fixers are in short supply. Consequently, manufacturers have had to become involved in training to replace those who retire.

Fixers are also more mobile and shift employment among the many hosiery plants that are, for example, concentrated in North Carolina. Some fixers have also taken jobs that have become available in other industries with higher wage scales. According to a survey of hosiery executives, shortages of some skills will continue to have a major impact on the industry through the year 2000.[6]

Although training is usually provided on the job under supervision, some special programs are also available. One of these is a comparatively short, intensive, cooperative training program for fixers. It was instituted in 1979 through the joint efforts of more than 100 hosiery manufacturers and the Catawba Valley Technical College, located in North Carolina within close radius of most of the hosiery firms. It is a 1-year program which involves daily classroom work (theory and practice on machines) and a minimum of 20 hours per week of on-the-job training under supervision. The program attempts to train fixers who will, in time, be eligible for higher level jobs.

[6] Kurt Salmon Associates, Inc., and the National Association of Hosiery Manufacturers, *The Future of the U.S. Hosiery Industry-Report on the Findings of a Modified Delphi Survey of the U.S. Hosiery Industry through the Year 2000* (Atlanta Ga., December 1978).

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Chapter 2. Folding Paperboard Boxes

Summary

Technological changes are underway in the major steps in the manufacture of folding paperboard boxes (SIC 2651). New computer and laser methods of preparing dies used in cutting and creasing presses, the more widespread use of advanced model offset and gravure presses for carton printing, and the use of advanced reciprocating platen cutting and creasing presses represent significant changes. Benefits of this new technology include productivity gains, quality improvement, and raw material savings.

Output of folding paperboard boxes experienced slow growth over the period 1963–82, increasing at an average annual rate of only 0.6 percent.[1] However, the annual growth rate in output rose to 0.9 percent during the more recent period 1973–82. The level of output of folding paperboard boxes is related to general business conditions and consumer spending, as well as competition from other packaging materials.

Productivity in the folding paperboard boxes industry failed to keep pace with the rate of increase in manufacturing. Between 1963 and 1982, output per employee hour increased at an average annual rate of 1.9 percent—well below the 2.3-percent average annual rate of gain achieved in manufacturing. The productivity increase resulted when output rose at an annual rate of 0.6 percent, and employee hours declined at an average annual rate of 1.3 percent as modernization and mechanization lowered labor requirements.

Employment in the folding paperboard boxes industry declined slightly from 1963 to 1982 as inefficient plants were closed and new technology was introduced more extensively. During that period, employment declined at an average annual rate of 1.1 percent, with the total work force in 1982 numbering 43,700—down by about 7,600 workers from 1963.

Although the introduction of new technology has not led to widespread displacement, employment cutbacks and skill changes in some key occupations, including diemaker and cutting and creasing press operator, have resulted. Advances in printing technology have affected press operators, camera operators, and platemakers. Women are employed in about 1 out of every 4 production worker positions, including those affected by mechanization of material handling. Training to provide workers with the skills needed for advanced technology has been a major method of work force adjustment.

[1] Rates of change are based on the least squares trends method.

Industry structure

The folding paperboard boxes industry in 1977 consisted of 574 establishments, 79 percent of which were located on the Eastern Seaboard and in the North Central States.[2] Proximity to markets and accessibility to folding boxboard supplies are major considerations in plant location. In 1981, over 40 percent of total output was for use in packaging food and beverages.

The number of establishments in the industry is declining, but average capacity to produce folding paperboard boxes is increasing. Between 1977 and 1981, the number of plants was estimated by the Department of Commerce to have decreased by nearly 6 percent, as less efficient production facilities were closed.[3] Over the same period, average cutting and creasing press capacity—an indicator of plant production capability—increased by an estimated 20 percent.[4]

Technology in the 1980's

Technological change in the folding paperboard boxes industry generally involves improvements to existing technologies, rather than sharp departures from past methods. However, in some operations, including the preparation of dies used on cutting and creasing presses, computers and other innovations have reduced labor requirements and modified craft skills. Other major changes include the more widespread use of offset and gravure printing; advanced reciprocating type platen cutting and creasing presses which require less labor; more automatic removal of waste material following cutting of cartons; and faster and more automatic carton handling, gluing, and packing methods. In

[2] *1977 Census of Manufactures* (Bureau of the Census, August 1981), p. 26C-9. 1977 is the latest year for which Census data are available.

[3] *1982 U.S. Industrial Outlook* (U.S. Department of Commerce, Bureau of Industrial Economics, January 1982), pp. 50–52.

[4] *Paperboard Packaging*, August 1981, p. 51.

general, mechanization is requiring a greater involvement in machine monitoring. Occupations affected by new technology include diemakers; printing press operators, camera operators, and platemakers; cutting and creasing press operators; and material handlers and packers. Table 2 describes major innovations in the industry, their impact on labor, and prospects for further diffusion.

Production Steps and Major Innovations

Production of folding paperboard boxes typically begins when a roll of paperboard is cut into separate sheets and fed into a sheet-fed printing press where the design is printed onto the paperboard. (In long production runs using web-fed presses, the paper is fed continuously from the roll into the press and the sheet-cutting step is eliminated.) After printing, the sheet is sent through a cutting and creasing press which cuts out each carton blank and puts creases where the carton is to be folded. The carton blanks, still held together as a full sheet by small connections, then proceed through stripping where they are separated and the excess paperboard removed. (On web-fed cutter/creasers, the carton blanks are automatically stripped of excess paperboard and placed on a conveyor delivery belt.) After

Table 2. Major technology changes in folding paperboard boxes

Technology	Description	Labor implications	Diffusion
Improved printing processes	Offset printing (predominantly sheet-fed) has displaced letterpress as the major method of printing cartons. In offset printing, photographic methods are used to prepare printing plates faster and at lower cost compared to letterpress printing where the plates are made from hot metal. Gravure printing, which also involves photographic methods to prepare printing cylinders, is being used more extensively for longer production runs, with technological advances in color scanners among improvements reported. Flexography, a form of letterpress printing which utilizes light and flexible rubber or plastic plates, is in growing use for longer press runs. Computers are being used more widely on offset printing presses to control ink and water flow rates, press speed, and related variables.	Gains in output per employee hour have been reported in conversions from letterpress to offset printing. New skills related to camera work and film processing are required in both offset and gravure installations at firms which perform these tasks in-house. Automated platemaking equipment reduces labor requirements of platemakers in offset installations. Computer control of press operations increases monitoring functions and decreases direct, manual involvement in control of press operations.	Offset printing (sheet fed) reportedly is the process used for about 50 percent of total printing of folding paperboard boxes. Web-fed gravure acounts for slightly over 20 percent and flexography for less than 20 percent of total printing volume. Letterpress is used in about 10 percent of production. About 1 out of 5 plants using offset presses carries out preparatory work in-house, and most of these use automated platemaking equipment. Computer control of press operations is expected to become more widespread.
Radiation ink curing	Infrared and ultraviolet ink curing systems are being employed to reduce the delay between carton printing and cutting and creasing imposed by relatively slow-drying conventional lithographic inks.	Labor required to store sheets printed with conventional offset inks for drying before cutting and creasing is reduced. In-line processing, made possible with ultraviolet curing, would eliminate this labor. Press maintenance due to clogging caused by sprays used to facilitate drying of conventional inks also is cut back or eliminated.	The high cost of conversion to ultraviolet curing and the high price of ultraviolet inks deter their widespread use. Less expensive infrared drying systems, however, may see more rapid growth since they can be installed on existing presses at relatively low cost.
Improved equipment for cutting and creasing	New model reciprocating platen cutting and creasing presses are being used to cut and crease folding paperboard boxes after printing. These advanced cutter/creasers are faster than older models and match the capacity of modern presses. Thus, on web-fed gravure presses, printing and cutting and creasing can be made continuous rather than separate production steps.	Crew requirements for reciprocating platen cutting and creasing presses are lower than for cylinder flatbed machines. Some new model cutter/creasers remove some or all scrap automatically, thereby reducing labor requirements in stripping operations. Labor involved in stacking and handling of printed sheets prior to cutting and creasing is eliminated with in-line, continous production on web-fed gravure presses. Operators of new model cutter/creasers at some firms have received on-the-job and classroom instruction in operating and maintenance procedures.	Platen cutting and creasing presses accounted for just under 40 percent of total cutter/creasers in use in 1981, and more widespread adoption of this relatively expensive technology is anticipated.

Table 2. Major technology changes in folding paperboard boxes—Continued

Technology	Description	Labor implications	Diffusion
Computer and laser methods to prepare the dies used on cutting and creasing presses	Computers are being used to generate die layouts and to produce tapes to control lasers in the cutting of die boards.	Computer and laser methods of diemaking change craft skills of diemakers and eliminate key manual steps in die construction. Laser cutting is highly accurate and replaces the jigsaw in cutting the wood dieboard. After cutting, however, hand methods are still used to insert the steel cutting and creasing "rules" into the die pattern. One manufacturer reported that laser cutting of one type of die required only 2 hours, compared to 7 hours using conventional manual methods. Trainees reportedly need only a few weeks of training on tape controlled laser die-cutting systems to become proficient. New positions related to computer operations needed.	The number of laser die-cutting systems is expected to increase significantly. Although expensive and in relatively limited use (25 systems for all industries in the United States in 1981), they provide high quality dies. The reported shortage of skilled diemakers could be an incentive to further diffusion of laser systems.
Automatic stripping of paperboard waste	Devices which remove automatically the paperboard material attached to carton blanks following cutting and creasing are being used more extensively.	Although stripping of paperboard waste remains relatively labor intensive, the use of airhammers greatly lessens physical effort. The occupation of stripper is expected to decline in importance as new technology is adopted.	Automatic stripping devices are installed as components of advanced platen cutting and creasing presses which account for nearly 40 percent of cutter/creasers in use. Adoption may be expected, in general, to parallel installation of these improved presses.
New technology to glue cartons	Faster drying glues, new air-brush and extrusion gluing systems, and automatic controls are increasing efficiency in gluing operations. New programmable, computer-controlled gluers store carton dimensions for automatic set-up and perform quality control and inspection tasks.	Productivity in gluing line operations has increased, and manual tasks of folders and gluers cut back. New computer-controlled gluers require lower operator skill levels and limited training.	Rate of adoption of improved gluing procedures may be expected generally to keep pace with the introduction of more efficient equipment in other production steps. The potential for wide adoption of computer control is high.
Improved packing methods	Automatic equipment to place cartons in containers for shipment is being used more widely. Improved material handling methods, including automatic conveyor systems, are being used to transport and load shipping containers. New types of film stretch wraps are being employed in place of packing of cartons in corrugated cases.	Productivity gains reported as production is faster and labor time of bundler-packers, fork-lift operators, and other material handlers is reduced.	Most firms are further mechanizing material handling tasks. New and stronger film stretch wraps will likely be used more extensively.

stripping, the cartons can be packed for shipment. Some types of cartons also are folded and glued prior to leaving the plant.

Printing methods

The technology of printing folding paperboard boxes is undergoing substantial change. The most significant development is the expansion in use of offset, and to a lesser extent gravure printing, which involve photographic methods to make the plates used on printing presses, and a corresponding sharp decline in letterpress printing in which printing plates are made from hot metal. Flexography, an adaptation of letterpress printing that uses rubber or plastic printing plates, is in limited use for longer press runs.

The printing method used by manufacturers of folding paperboard boxes depends on the length of the production run, the quality desired, the complexity of graphics, color requirements, and related factors. In general, web presses, which accept paperboard stock continuously from a large roll, are used for longer press runs, and sheet-fed presses, which handle separate sheets of paperboard stock, are used for medium and short runs.

The shift to predominantly sheet-fed offset and web-fed gravure printing has affected employment and skills of press operators, camera operators, platemakers, and others. In addition to offset and gravure printing being used more widely, productivity and employment in folding paperboard boxes plants are being affected by diffusion of faster presses incorporating automatic controls, new platemaking methods, the use of improved inks and drying techniques, and related developments.

Offset lithographic printing is of high quality and is well suited for exacting multicolor work. Offset printing plates reproduce anything that can be photographed and can be prepared quickly and inexpensively. In offset printing, the photo image to be printed is developed onto a metal printing plate—usually aluminum. The platemaking process is different from hot-metal typesetting, and involves new skills relating to camera work and film processing. The thin, lightweight offset plates are much easier to handle than the heavy lead plates used on letterpress printing presses. The time required to prepare a press for running (makeready time) can be substantially less with offset than with letterpress. Plate-to-plate register on multicolor work is accomplished by labor-saving plate mounting systems and precise register adjustments incorporated into the design of offset presses in contrast to the manual loosening, moving, and retightening of heavy metal plates to obtain correct color-to-color register necessary with letterpress. As an example, makeready requiring 24 hours for a six-color production run with letterpress equipment has been accomplished in 4 hours with offset presses.

Additional advances in the offset process, raising productivity, include computer control of ink and water flow rates, ink shades, and press speed. Mechanical improvements, especially innovations in sheet handling through the press, allow running speeds to be raised, and automatic platemaking equipment reduces labor requirements of platemakers and changes skill requirements in film processing.

Web-fed offset presses are being employed to a limited extent in the industry. Printing plates of increased durability, that can make more impressions than before, increase the capability of offset for longer press runs. At the same time, automatic color register controls and faster plate changes on web-offset presses enhance their capability for short-run work.

The web-fed gravure process also is being used more widely in the printing of folding paperboard boxes. Gravure is a high speed process, and its primary importance is in long runs of high quality multicolor work. Growth of gravure printing has been considerable over the past 10 years and over 20 percent of printing of folding paperboard boxes is by this process. Among technical advances being incorporated into the gravure process are color scanners which permit close control of color and balance, and color data processing systems that let color copy and text be viewed, moved, and stored. These prepress innovations improve quality in subsequent printing. Changes in press operations include better register and tension controls, improved butt splicing and ink drying, and computerized press management systems. In the future, computerized press controls may be employed to adjust ink viscosity and color to compensate for atmospheric changes and variation in the inks. Factors which could slow diffusion of gravure printing include the high cost of and extended time required for cylinder preparation.

Radiation ink curing

Radiation ink curing methods, including infrared and ultraviolet processes, are replacing the use of conventional oil-based lithographic inks which dry relatively slowly. In infrared drying, infrared reactive ink is used in combination with infrared lamps which accelerate drying. A major benefit is the reduction in labor to store printed cartons for drying prior to cutting and creasing. Moreover, the need for spray powders, which prevent smearing of conventional inks, is substantially lessened. Thus, materials and labor for press cleanup are reduced.

In ultraviolet ink curing, a photosensitive ink or coating polymerizes instantly into a dry film when exposed to ultraviolet light. Drying time is virtually eliminated. Thus, ultraviolet curing eliminates storing of printed cartons prior to cutting and creasing and thereby removes an obstacle to continuous processing with offset printing. One barrier to broader adoption of ultraviolet ink curing is the relatively high cost of inks. Special graphics that promote or enhance carton contents are seen as a possible primary application of the ultraviolet process.

Cutting and creasing presses

Advances in cutting and creasing presses increase productivity and improve quality of folding paperboard boxes. Formation of carton blanks from paperboard sheets or rolls following printing is performed on equipment that cuts out the cartons and creases them where they are to be folded. New and faster cycling reciprocating platen presses being introduced operate at speeds upwards of three times faster than the older cylinder flatbed presses and require fewer cutting and creasing press operators and feeders.

Increases in the speed of cutting and creasing equipment to match the capacity of modern printing presses has enabled the industry to achieve in-line printing and cutting and creasing operations. In web-fed gravure operations, for example, printing and cutting and creasing can be joined in a continuous process.

Diemaking

New technologies involving computers and lasers are being employed to prepare the dies used in cutting and creasing presses. These technologies increase productivity in diemaking and modify craft skills of diemakers. Dies are arrangements of steel rules, both sharp and round edged, which form the pattern of cuts and creases required for a particular type of carton.

In conventional diemaking, the skilled diemaker, after a series of preliminary steps, arranges and secures the steel rules to form the die. The sequence of steps undertaken by the diemaker involves the use of jigsaws and other handtools to carry out repetitive, highly skilled tasks. The process is exacting and labor intensive.

Automated diemaking systems mark a sharp departure from conventional diemaking. In these systems, computers draw the dies in accordance with specifications for a particular type of folding paperboard box and generate the tapes used to guide laser or chemical milling equipment in cutting or etching of the dies. In the preparation of dies for use with the reciprocating cutting and creasing press, a laser beam cuts grooves in a hard plywood board into which cutting and creasing knives are then positioned by hand. Computers also are being used in connection with other major steps of diemaking including, for example, the control of machine tools in cutting and shaping the steel rules. Using these methods, productivity is increased and the need for the traditional craft skills of the diemaker is eliminated.

The rearrangement of diecutting production facilities is affecting employment of diemakers, structural designers, and sample makers at plants where dies formerly were prepared by conventional methods. New skills and occupations, including computer programmers, are needed and training in computer methods and electronics is being provided. Moreover, the trend to subcontract the laser cutting of dieboards to specialized service companies has curtailed demand for diemakers and designers.

Computer methods of die preparation also are being used in smaller firms. One company which uses a digital plotter and a business computer to design dies reduced die construction time by 30 percent. In this system, the die layout generated by the computer is attached directly to the dieboard, and the diemaker completes the die by conventional hand methods. However, carton design is no longer his responsibility.

Stripping and finishing

Automatic stripping of waste material is improving efficiency in folding paperboard boxes plants. Platen cutters and creasers with stripping devices are available which can remove automatically waste material following cutting of the carton blanks. Newly available "blanking" diecutters completely separate carton blanks from waste material and count and stack them for packing. Although much waste removal is still accomplished manually using airhammers, this method is costly and generates substantial waste. The trend toward automatic production suggests that machine methods of stripping will be used more extensively during the 1980's.

New technologies to process cartons that must be glued and folded prior to shipment are being adopted. Improved glues, new airbrush and extrusion gluing systems, and more versatile equipment of conventional type incorporating automatic controls are major changes that raise quality and lower labor requirements of folders and gluers. For example, recently introduced programmable computer-controlled gluers have memories for storing dimensions of as many as 20 different cartons and automatically perform set-up, quality control, and inspection tasks. Productivity is increased as a result of faster makeready and changeovers. Labor skill levels are reduced and required operator training is limited.

Packing

New methods of packing and handling reduce labor and material requirements of bundler-packers in preparing folding paperboard boxes for shipping. Machines that automatically pack cartons in corrugated cases are replacing manual methods in that task. Material and other cost savings also have been reported from stretch wrapping cartons in film, rather than packing them in corrugated cases, and from the use of fiberboard sheets in place of heavier wood pallets.

Output and Productivity Outlook

Output

Output of folding paperboard boxes (SIC 2651) is tied closely to business conditions and consumer spending, with 43 percent of the physical volume of shipments for use in packaging foods and beverages in 1981.[5] Although over 500 companies produce the multitude of products which make up the folding paperboard boxes industry, the four largest firms reportedly account for 22 percent of total annual shipments.[6]

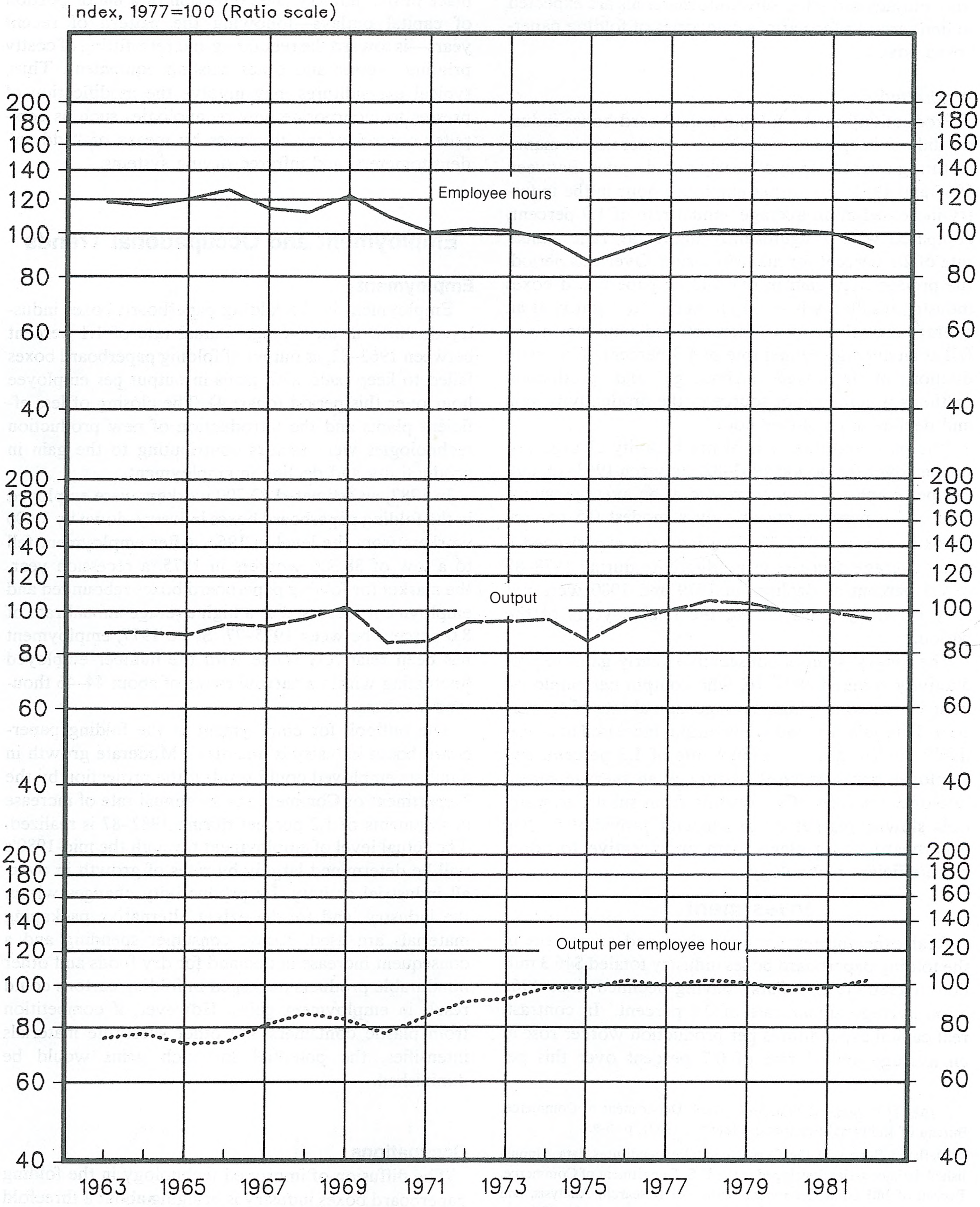
Over the period 1963–82, output of folding paperboard boxes experienced slow growth and increased at an annual rate of only 0.6 percent (chart 3). The rate of growth in output during 1963–73 was an even lower 0.3 percent, however, while output during 1973–82 increased at a higher annual rate of 0.9 percent. The small annual growth rate has been attributed, in part, to changes in product mix and the use of increasingly less dense folding boxboard, which have been reflected in lowered tonnage figures.

The outlook for 1982–87 is for output of folding paperboard boxes to increase at an annual rate of 1.2

[5] *1981 Marketing Guide*, Paperboard Packaging Council, Washington, D.C., 1982. The folding carton industry, for which statistics are compiled by the Paperboard Packaging Council, is broader in scope than SIC industry 2651, Folding paperboard boxes. In addition to those products in SIC 2651, it includes cartons for wet foods and perishable bakery products which are classified in SIC industry 2654, Sanitary food containers. Shipments of cartons for foods and beverages, including these two end uses, accounted for 60 percent of the total in 1981.

[6] *1982 U.S. Industrial Outlook* (U.S. Department of Commerce, Bureau of Industrial Economics, January 1982), pp. 50–52.

Chart 3. Output per employee hour and related data, folding paperboard boxes, 1963-82



SOURCE: Bureau of Labor Statistics.

percent if higher levels of consumer expenditures for nondurable goods are realized.[7] However, competition from plastics and other substitute materials are expected to limit growth for various categories of folding paperboard boxes.

Productivity

Productivity in the folding paperboard boxes industry did not keep pace with the rate of increase in manufacturing over the span of nearly two decades. Between 1963 and 1982, output per employee hour in the industry increased at an average annual rate of 1.9 percent, compared with a significantly higher average annual rate of 2.3 percent for manufacturing. Over this period, the productivity gain in the folding paperboard boxes industry resulted when output increased slightly, at an average annual rate of 0.6 percent, and employee hours fell at an average annual rate of 1.3 percent. The introduction of improved technology and production methods was the major source of the productivity gain and decline in employee hours.

The pace and direction of productivity change was uneven over the period 1963–82. Between 1963–73, output per employee hour increased at an average annual rate of 2.0 percent, but at only a modest 0.5 percent annually during 1973–82. The industry experienced a slight average decrease in productivity during 1978–82 of 0.3 percent as declines in 1979 and 1980 were not fully offset by gains during the final 2 years of the period.

The longest span of consecutive yearly gains in productivity covered 1970–76, when output per employee hour increased at a high average annual rate of 4.5 percent. This gain resulted when output increased at a relatively modest average annual rate of 1.3 percent, and employee hours declined sharply, at an average annual rate of 3.0 percent. Competition from substitute materials slowed market expansion and provided folding paperboard boxes plants with an incentive to adopt more efficient technology.

Investment

Real expenditures for new plant and equipment in the folding paperboard boxes industry totaled $46.3 million in 1980 (1972 dollars), having declined since 1963 at an average annual rate of 0.6 percent.[8] In contrast, real capital expenditures per production worker rose at an average annual rate of 0.7 percent over this period—standing at $1,275 in 1980—and contributed to the gradual improvement in productivity that has taken place in the industry. The direction of a major portion of capital outlays—following the pattern of recent years—is toward the rebuilding and retrofitting of costly printing presses and other existing equipment. Thus, typical expenditures may involve the modification of presses to incorporate new technologies such as computer control of ink thickness by means of "add-on" densitometers, and infrared drying systems.

[7] *1983 U.S. Industrial Outlook* (U.S. Department of Commerce, Bureau of Industrial Economics, January 1983), p. 5-9.

[8] Deflated Bureau of the Census capital expenditures data. Unpublished deflator series developed in the U.S. Department of Commerce, Bureau of Industrial Economics, Office of Research, Analysis, and Statistics, to calculate constant 1972 dollar expenditures for SIC 265, paperboard containers and boxes. Deflated expenditures data for 1980 are the latest available.

Employment and Occupational Trends

Employment

Employment in the folding paperboard boxes industry declined at an average annual rate of 1.1 percent between 1963–82, as output of folding paperboard boxes failed to keep pace with gains in output per employee hour over this period (chart 4). The closing of less efficient plants and the introduction of new production technologies were factors contributing to the gain in productivity and decline in employment.

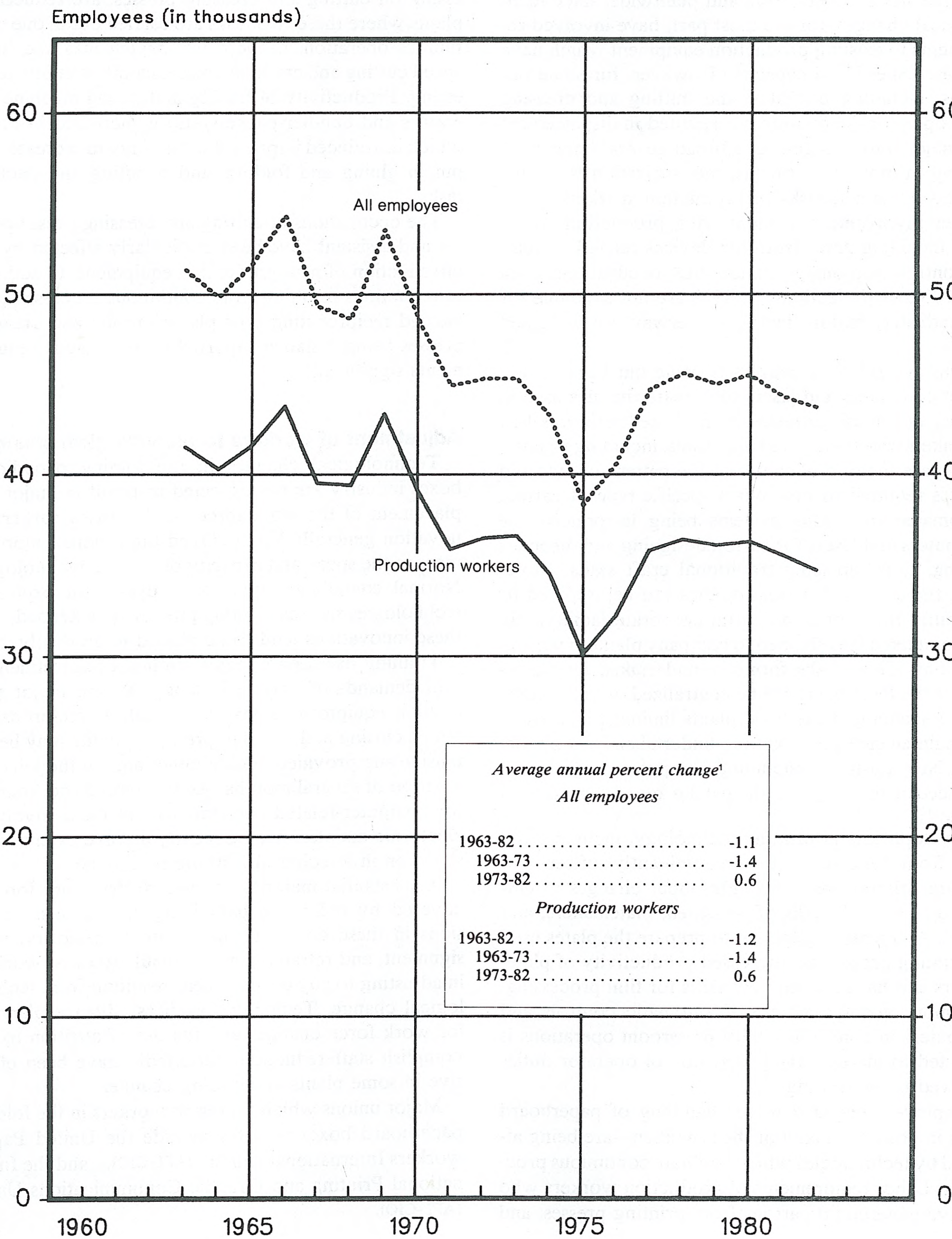
In 1982, an estimated 43,700 workers were employed in the folding paperboard boxes industry. down by 7,600 workers from the level in 1963. After employment fell to a low of 38,300 workers in 1975, a recession year, the market for folding paperboard boxes rebounded and employment increased at a high average annual rate of 8.0 percent between 1975–77. Since 1977, employment has been relatively stable with the number employed fluctuating within a narrow range of about 44–46 thousand workers.

The outlook for employment in the folding paperboard boxes industry is uncertain. Moderate growth in numbers employed could result if the projection by the Department of Commerce of an annual rate of increase in shipments of 1.2 percent during 1982–87 is realized. The actual level of employment through the mid-1980's will be determined largely by rates of growth in overall industrial activity, by productivity changes within the industry, and by the extent alternative packaging materials are used. Rising consumer spending and a consequent increase in demand for dry foods and other nondurable products packaged in folding cartons could result in employment gains. However, if competition from plastic containers and other substitute materials intensifies, the potential for such gains would be diminished.

Occupations

The diffusion of improved technology in the folding paperboard boxes industry is bringing about a threefold impact: Some positions are being eliminated; the job content of others is being altered; and new positions

Chart 4. Employment in folding paperboard boxes, 1963-82



[1] Least squares trends method.

SOURCE: Bureau of the Census. Data for years prior to 1963 are not available. 1982 data are estimates.

are being added. The impact of technology on occupations has not been extensive and plantwide, since technological changes, for the most part, have involved refinements to existing production equipment which have increased speed and capacity. However, for some positions, including diemaker and cutting and creasing press operator, innovation has resulted in displacement and major skill changes. As a broad general impact occurring in most departments, mechanization is requiring fewer manual tasks of production workers and a greater involvement in monitoring production equipment including new electronic devices related to quality control. Although detailed BLS occupational data for 1980 and projections for 1990 are not available for this industry, major changes underway are discussed below.

Employment of diemakers is being cut back by the use of computers and lasers to prepare the dies used in cutting and creasing presses. As indicated earlier, skilled diemakers traditionally use handtools, including jigsaws, to prepare the dies which form the pattern of cuts and creases required to turn out a specific type of carton. Automated diemaking systems being introduced use computers and lasers for carton designing and dieboard cutting, thus replacing traditional craft skills. Moreover, the cutting and creasing dies can be prepared by computer methods at a central corporate facility, and the completed dies shipped to company plants in various locations. Thus, tasks formerly undertaken by diemakers at the local plant can be centralized with the functions remaining at the local plants limited primarily to die maintenance and reknifing undertaken by a smaller staff. New positions, including computer programmer, are needed to carry out diemaking by advanced laser methods.

Developments in printing technology, including the shift from letterpress to predominantly offset and gravure printing, have brought about changes in employment and job skills of pressmen, platemakers, and others. Automatic equipment to prepare the plates used on printing presses has increased productivity of platemakers and has required new skills for film processing. The more widespread use of automatic controls and computers in connection with pressroom operations is expected to increase the proportion of operator duties involved in monitoring.

Employees engaged in the handling of paperboard stock in process—many of them women—are being affected by technologies which facilitate continuous processing. Labor requirements of production workers who remove paperboard cartons from printing presses, and place them on storage racks for drying prior to processing on cutting and creasing presses, are reduced at plants where these two tasks are carried out in one continuous operation. Modern fast drying inks and high-speed cutting and creasing presses facilitate in-line processing. Productivity of folding and gluing machine operators and bundler-packers also is increased in plants which introduced improved technology to increase output in gluing and folding, and bundling and packing tasks.

The occupations of cutting and creasing press operator and assistant have been particularly affected by the introduction of new production equipment. In addition to reductions resulting from continuous processing, advanced reciprocating type platen cutting and creasing presses being installed reportedly lower labor requirements significantly.

Adjustment of workers to technological change

Technological changes in the folding paperboard boxes industry are not expected to result in major displacement of the work force. As indicated earlier, innovation generally has involved the gradual improvement in the speed and capacity of existing technologies. Normal equipment replacement cycles for expensive technologies such as printing presses are extended; thus these innovations tend to be phased in gradually.

Training has been a major method of adjustment to skill demands of new technology. Where major production equipment is involved, such as reciprocating platen cutting and creasing presses, training may be extensive and provided in classrooms and on the job over a period of several months. As a general trend, training for computer-related occupations and those involving electronic maintenance frequently involve extended instruction in a technical institute or college.

A substantial majority of the industry work force is covered by collective bargaining agreements. Provisions in these contracts that relate to seniority, reassignment, and retraining are available to assist workers in adjusting to any displacement resulting from technological change. Techniques such as advance planning for work force changes and the use of attrition to accomplish staff reductions reportedly have been effective in some plants undergoing change.

Major unions which represent workers in the folding paperboard boxes industry include the United Paperworkers International Union (AFL-CIO), and the International Printing and Graphic Communications Union (AFL-CIO).

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Chapter 3. Metal Cans

Summary

Technological change has had widespread impact on the metal can industry (SIC 3411) during the past 15 years. The major advance, the two-piece can line, fundamentally alters the can manufacturing process. This technology, which has been widely diffused throughout the beverage sector, increases speed and automaticity, and significantly reduces unit labor requirements for skilled and unskilled workers. In coming years, the thrust of technological development is likely to occur in the food can sector, as it adapts the two-piece technology for its use.

Productivity in the metal can industry rose at a moderate average rate of 2.6 percent annually between 1960 and 1982, equal to the average rate for all manufacturing.[1] However, unlike most other industries, the greatest rise occurred toward the end of the 1970's and early 1980's and is associated with technological and structural changes. From 1979 to 1982, productivity gains accelerated to 5.5 percent (average annual rate) as employee hours and output dropped sharply, at the rate of 8.2 and 3.1 percent, respectively. Productivity gains are expected to continue, although probably at a slower rate than during the past decade.

Expenditures for new plant and equipment nearly tripled between 1960 and 1980 to reach $205 million (in current dollars). Nevertheless, after adjustment for inflation, outlays in 1980 were less than two-thirds the peak outlays in 1975. The overall decline in real investment since 1975 reflects low profitability, industrywide excess capacity, modest long-term growth projections, and the decision by several of the major can companies to diversify into nonpackaging industries.

Employment in the can industry declined during the 1970's, reversing the trend of the previous decade. By 1982, employment had fallen to 52,200, 30 percent below the peak year of 1970. The sharpest decline, which followed the 1974–75 recession, reflects increased usage of labor-saving machinery, the closure of a number of large plants, and a drop in output. With the likelihood of only modest long-term growth in the 1980's, continued closings of marginal plants, and greater use of new technologies, the downtrend in employment will probably continue. Changes in work rules and job consolidations are also expected to contribute to the decline.

[1] Rates of change are based on the least squares trends method.

Industry Structure

Changes in the structure of the metal can industry have had a positive impact on productivity and technological development. Average industry productivity has probably been improved by the increased number of smaller, more efficient, specialized plants which are replacing large, older establishments.

The metal can industry is composed of establishments primarily engaged in the manufacture of metal cans, can lids, and parts of metal cans for packaging three major groups of products: beverages, food, and general nonfood products. Plants owned by the can companies and those owned and operated by can users, such as the brewers and food processors, are included in these data.

The metal can industry has historically been dominated by a few large companies, which retain a predominant position in the industry today. Nevertheless, concentration ratios have significantly declined in the last two decades. The market share of the four largest firms fell from 80 percent in 1958 to 73 percent in 1963 and to 59 percent in 1977.[2] A large part of the decline can be attributed to the increase in productive capacity of the so-called self-manufacturing (or "captive") plants, which are owned and operated by large-scale food processors and brewers. To reduce packaging and transportation costs, these companies have built their own canmaking plants adjacent to bottling or canning facilities and equipped them with the latest can manufacturing technology.

The productivity level is believed to be higher for self-manufacturing plants. Generally, these plants are smaller and may specialize in the production of a limited number of standard-sized cans in large volume runs. Of total can shipments, the self-manufacturing share increased from about 18 percent in 1961 to 28 percent in 1980. Their market share will probably continue to rise during the 1980's.

The major can companies have responded by offering other types of services, including the building of "dedicated facilities" near can users. These plants are known as "dedicated" because a can company contracts to dedicate a share of the plant's output to a specific customer.

[2] These data come from the Census of Manufactures which is conducted every 5 years.

Productivity growth has also been positively affected by the presence of the basic aluminum producers in the metal packaging market since the mid-1960's. They first developed the costly, sophisticated, high-speed two-piece technology (described below). Since the major can companies with large investments in an older steel technology were reluctant to convert to the new process, aluminum companies successfully began the manufacture and marketing of their own cans to the beverage and beer industries. The major can companies followed suit. By 1982, almost 60 percent of all cans manufactured were the aluminum, two-piece type.

Also, average industry productivity levels have been improved by the shutdown of numerous large, technologically and structurally obsolete establishments, and the construction of many small, more efficient, and better located plants. Between Census years 1963 and 1977, the number of plants increased from 270 to 403, while the number of very large plants (more than 500 workers) declined from 30 to 18. Shipments from plants with more then 250 employees fell from 67 percent of the total in 1963 to 52 percent in 1977. During the same period, plants with between 100 and 250 workers more than doubled in number and increased their share of the market from 17 to 31 percent.

Census data tend to substantiate that the smaller establishments have been more labor efficient than the larger ones. In 1977 (latest available data), smaller plants (with less than 100 workers) produced 18 percent of the industry's total value added with only 11 percent of all employees. In contrast, the largest plants (with more than 500 workers) accounted for only 15 percent of the industry's value added yet employed 24 percent of all workers. In addition, a special 1967 Census study which divided can industry establishments into quartiles according to their labor efficiency (as measured by value added per employee hour) yielded a similar result. The average size plant in the most "efficient" quartile, i.e., highest value added per employee hour, employed only 76 workers, compared to an industry average of 216.

Technology

Developments in technology in the metal can industry are being directed towards reducing labor, material, and energy costs, and increasing automation. The most important innovation of the last two decades—the two-piece can line—is a radical departure from conventional manufacturing methods. This is a continuous process system which is currently used extensively for beverage can production and is expanding in modified form into other can sectors. It both simplifies and reduces the number of processing steps, and lowers unit labor costs while substantially boosting capacity. Many of the more modern lines are computer-controlled.

Although most other technological developments represent modifications or improvements to existing processes, they nevertheless impact favorably on productivity by reducing unit labor requirements. As an example, high-speed palletizers and labeling machinery are being adopted. Also, prompted by proposed health regulations, the industry is replacing its soldered can lines (solder has a high lead content) with newer welded side seam processes. To shorten drying time and reduce energy costs and air pollution, alternative drying methods, water-based coatings, and ultraviolet inks are becoming more commonplace.

Two-piece cans

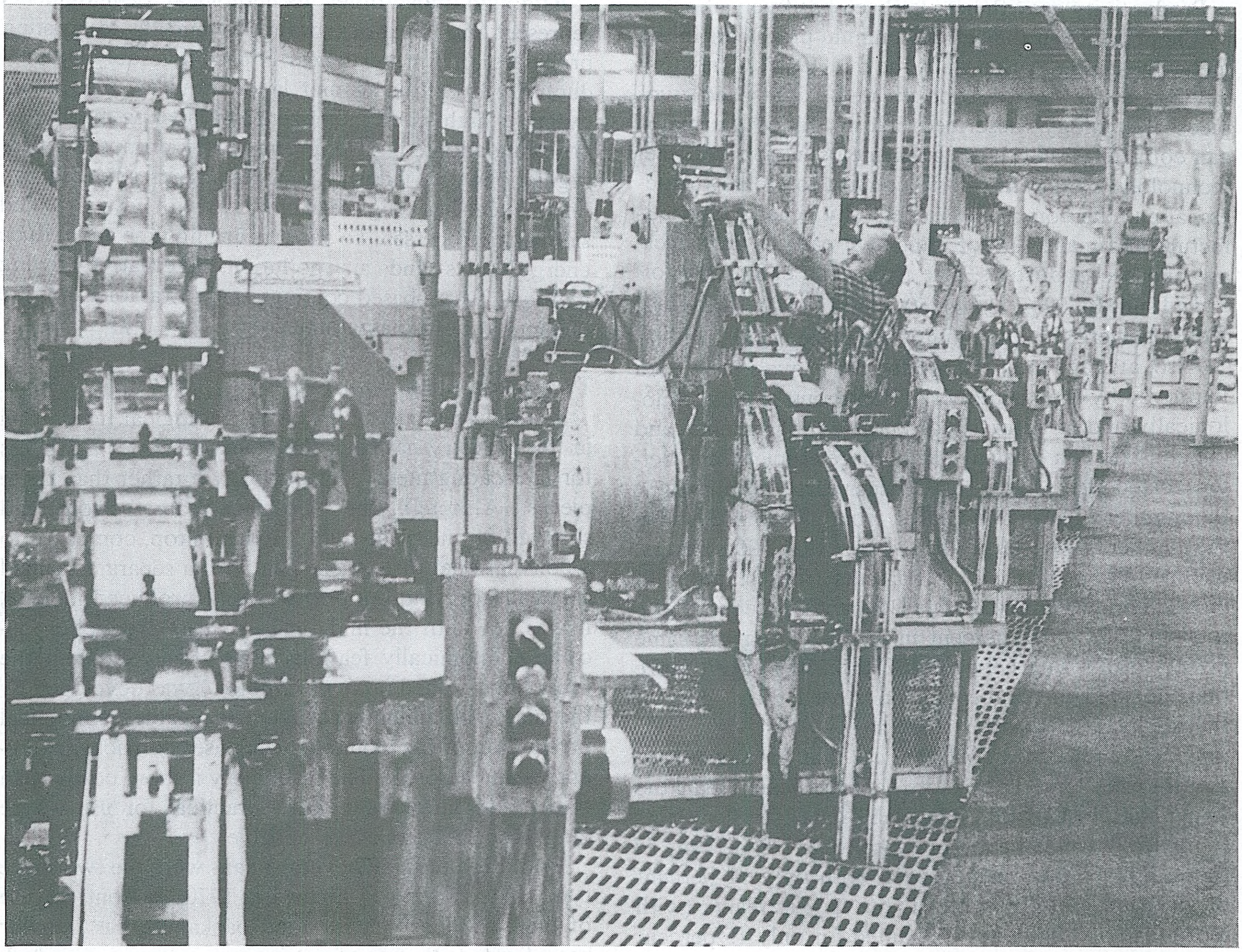
The single most important technological innovation in this industry has been the development of a process for fabricating metal cans out of two rather than three pieces. Although the two-piece can (bottom and sidewall of one piece with a separate top, compared to a conventional three-piece can with a separate seamed sidewall, top, and bottom) was first produced in 1958, it was not until the mid-1960's that its production became economically feasible. This occurred when the drawn-and-ironed (D&I) technology was developed by the major aluminum producers to enable economical production of the elongated cans used to package beverages and aerosols. The machinery is more costly than three-piece lines and is most practical for use where long production runs are possible.

By 1982, almost all beverage cans were the two-piece type, up from only 11 percent in 1970.[3] In contrast, use of the two-piece can for food packaging has thus far been limited. Because food in cans is vacuum-packed, the D&I can is not a viable alternative to the three-piece container; its thin walls could buckle under external pressure. Carbonation prevents this from occurring in beverage cans.

Consequently, an alternative two-piece technology, the drawn-and-redrawn (D&R) process, was developed in 1975 to produce a stronger, shallow can with a sidewall and bottom of essentially the same thickness. Another recent innovation now being introduced combines the draw/redraw technology with partial drawing and ironing. In 1982, only about 13 percent of food cans were the two-piece type, but this percentage should be substantially greater by the late 1980's. Until recently, the D&R technology was not practical for larger-sized cans.

In the typical D&I process, a coil of metal (most frequently a 37 to 60 inch-wide sheet of aluminum, although steel-based metals are also used) is automatically fed through a multiple press with as many as 12 cuppers. Each cupper forms a circular disc which is drawn

[3] Industry shipment data for 1965–80, *Current Industrial Reports*; for 1981 and 1982, adjusted Can Manufacturers Institute data.



Production line which draws and irons the walls of two-piece cans

to form a shallow cup. The cup is then automatically conveyed to a "body maker" machine where a punch presses it through a series of rings to stretch out the sidewall. In subsequent steps, the can is trimmed, washed, sprayed, and dried prior to decoration. The entire process is fully automated. Tenders or operators monitor the equipment.

This process eliminates several of the steps necessary for conventional three-piece can assembly. In the three-piece line, the metal is first uncoiled, sheared into sheets, then decorated (the decorating steps are discussed below) and slit into individual body blanks. Each step requires at least one operator. The body blank is subsequently rolled into a near cylinder and either soldered or welded.

Significant labor savings result from the adoption of the two-piece line. The two-piece can line reduces total labor requirements by an estimated 25 to 30 percent when compared to an equivalent conventional three-piece line. (Because of a wide range of possible system variations, comparisons are a rough approximation.) A number of steps are eliminated, operating speeds are higher, and capacity is substantially greater. Maximum speeds are approximately 1,500 cans per minute, well above three-piece line capabilities. Capacities for two-piece lines average between 250 and 275 million cans a year, compared to 120 million cans for a three-piece tin-free steel line, and about 100 to 120 million cans for a three-piece soldered can production line, depending on the number of shifts in operation.[4]

Labor savings also result from mechanized material handling. The two-piece can line is a continuous process system from start to finish with elaborate automated conveyors between operations, monitored by solid-state sensing devices. By contrast, the three-piece line may consist of several noncontiguous components. Materials handling (as by forklift truck operator, for example) would be required between these operations.

[4] "Cans: Dynamic Technology Continues," *Beverage World*, July 1976, p. 52.

Of major importance is the labor saved in the decorating process of the two-piece beverage can. The application of the exterior decoration becomes an integral on-line component of the two-piece system and is a simplified process. There are two basic decorating steps: The already formed body is first coated with an enamel undercoat; the design is then applied using a dry offset process. All colors are transferred from a blanket cylinder to the can at the same time. A single mechanic may be responsible for this work station. By contrast, most three-piece lines use lithography to apply the exterior decoration at a work station usually separated from bodymaking operations. The decoration is first applied to flat metal sheets before the can is formed. In addition to unskilled material handlers charged with bringing the sheets to and from the station, a "litho" feeder must supply the sheets to the lithograph equipment. The sheets must pass through a printing press, generally once for each color in the decorating scheme. The press is operated by a lithograph pressman, one of the most skilled and best paid positions in the plant. Each sheet is subsequently baked in an oven to cure the inks, then removed by an unskilled litho oven unloader. (The decorating processes described herein refer to beverage cans. Most food cans, which have beaded walls, are sold with a paper label.)

Aside from labor savings, several other features of the two-piece can help explain its rapid adoption by the industry. One principal benefit is associated with reduced unit material requirements. In 1962, for instance, the net weight of three-piece double reduced tinplate (itself a lightweight product introduced in 1961) cans was about 122 pounds per thousand. By 1976, the lightest D&I steel cans weighed 76 pounds per thousand. The average weight for D&I aluminum cans has fallen from 42 pounds per thousand for the first cans in 1964 to 29 pounds in 1979. Another benefit of the two-piece can is that since it has neither bottom nor side seams, it is less susceptible to leakage and not subject to testing for seam quality. Moreover, health considerations have also encouraged the adoption of the two-piece can. The Food and Drug Administration has proposed reducing the use of solder in food can seams because of its lead content.

Welded three-piece lines

As an alternative to the standard soldered side seam, welding was introduced in the late 1960's. Welding is currently used for an estimated 15 percent of food-can lines in place, and an additional 10 percent are expected to be changed over to this type of process in the near future. Major advantages of this process include its lead-free content, reduction in the weight of the metal and in the thickness of the sideseam, its ability to join cheaper tin-free steel (which solder cannot), and its low capital cost compared to the two-piece alternative.

The effect of welded seam technology on unit labor requirements depends on the extent of replacement. In the simplest conversion, in which the solder bodymaker machinery is replaced by a welding sequence, the labor effect is minimal. In this case, the solder bodymaker operator and mechanic may be retrained to operate the welding components. If a new line is installed, some work stations may be consolidated. In an example cited by a union official, one operator assumed the duties of both the slitter and double seamer operators. In addition, such a system may run at slightly faster speeds than conventional three-piece lines due to a reduction of several cooling, reheating, and chilling steps.

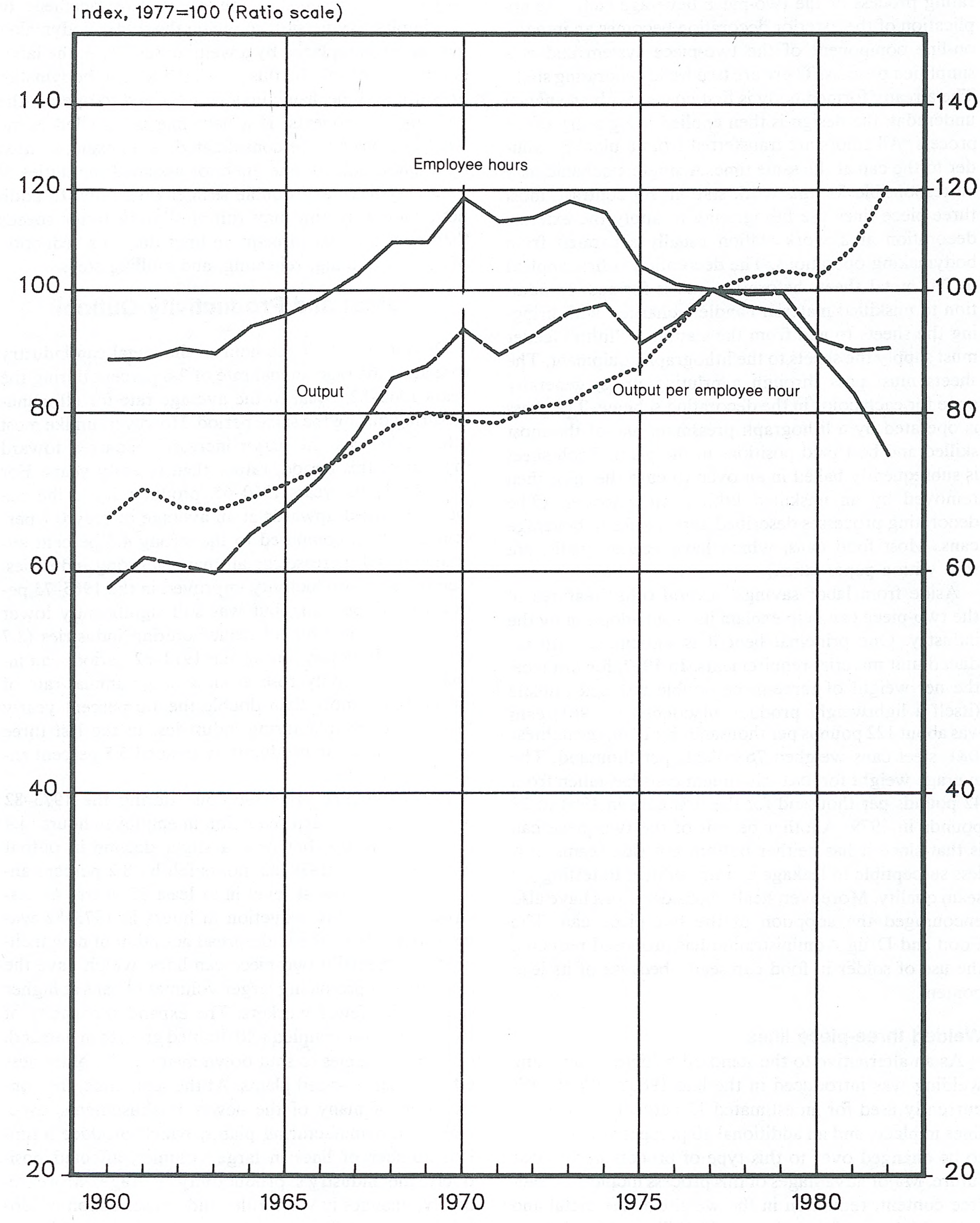
Output and Productivity Outlook

Output per employee hour in the metal can industry rose at an average annual rate of 2.6 percent during the years 1960–82, equal to the average rate for all manufacturing during the same period. However, unlike most other industries, the major increases occurred toward the end of this period, rather than in early years. For instance, in the years 1960–65, productivity in the can industry edged upwards at an average of only 0.7 percent per year, compared to the strong 4.8 percent average annual increase for all manufacturing industries. Can industry productivity improved in the 1965–73 period (to 1.8 percent), but was still significantly lower than the average for all manufacturing industries (2.7 percent). However, during the 1973–82 period, can industry productivity rose at an average annual rate of 4.0 percent—more than double the 1.6 percent yearly rate for all manufacturing industries. In the last three of those years, can productivity jumped 5.5 percent annually (chart 5).

The significant gains recorded during the 1973–82 period reflect a sharp reduction in employee hours (4.4 percent annually) but only a slight decline in output (0.6 percent). In 1979–82, hours fell by 8.2 percent annually, to the lowest level in at least 35 years. As discussed earlier, the reduction in hours in 1973–82 was made possible by the widespread adoption of new technology, especially two-piece can lines, which have the capability of producing larger volumes of cans at higher speeds with fewer workers. The expanded capacity of two-piece lines, coupled with limited growth in demand, caused companies to shut down many of the older, less efficient, larger-sized plants. At the same time, the construction of many of the newer establishments, especially self-manufacturing plants, which produce a limited number of lines in large volumes, affected positively the industry's productivity average. More recently, changes in work rules and consolidation of jobs have also contributed to the productivity growth.

Productivity has also been affected by the changing composition of output. The beverage can sector, which

Chart 5. Output per employee hour and related data, metal cans, 1960-82



has benefited from the greatest technological change, has grown rapidly, while the other less technologically advanced sectors (food and nonfood) have experienced no growth. Economies of scale are greatest for beverage cans because large volume runs are possible, requiring less downtime to change exterior decoration, labels, and can sizes. There are fewer sizes and larger markets for these products.

Although levels of output per employee differ widely within the industry, one can company reports that it has been able to increase its production of cans from 826,000 per employee per year in 1971 to 1,200,000 in 1980—a 56-percent increase. One of its most recently constructed plants produces at a rate of 6 million cans per employee per year.[5]

Data on another measure, payroll per unit of value added (i.e., value of shipments less materials and other costs), also indicate considerable improvement in efficiency in the can industry over the last two decades. In 1960, payroll per unit of value added was .50; by 1980, it had declined to .31.

During the remainder of the 1980's, productivity gains are expected to continue, but probably at a slower rate than during the past decade.

Output

After strong growth in the 1960's and early 1970's fueled by interest in convenience packaging, can output has been depressed by weaker demand in major markets, increased competition from alternative packaging forms, and generally less favorable economic conditions. During the years 1960 to 1965, output increased at an average annual rate of 2.4 percent, and significant gains of 4.4 percent were registered during the years 1965–73. In contrast, output edged down 0.6 percent annually during the 1973–82 period. In the last three of those years, output fell at an average rate of 3.1 percent annually (chart 5). Overall, during the years 1960–82, output increased at an average annual rate of 2.4 percent, less than the 3.3-percent increase recorded for all manufacturing industries.

Industry growth during the years 1965–82 is attributable solely to the relative strength of the beverage sector; both the food and general line sectors experienced declines. During the period of most rapid industry expansion (1965–73), beverage can output increased more than 12 percent annually; the other two sectors rose slightly. During the years 1973-82, the industry output decline occurred as the market for food and general line containers fell, while beverage can output leveled off.

Consequently, the beverage can sector increased to 61 percent of total can output in 1982, compared with only 26 percent in 1965. Shipments to the soft drink market increased from 8 million base boxes[6] to 53 million and shipments to the beer market more than doubled to 63 million base boxes in that period.

The strong growth in the beverage sector during most of this period can be attributed to consumer preference for disposable packaging, new product innovations, such as the development of the ring-pull opener, and a significant increase in per capita consumption of beverages, which is a function of rising real incomes and favorable changes in demography. Annual per capita consumption of all types of packaged soft drinks increased from approximately 151 12-ounce units in 1965 to 420 12-ounce units in 1982.

Because of consumer preference for disposable packaging, the soft drink industry has been able to expand its market share at the expense of returnable bottles. While can shipments increased from 13 percent of total packaged soft drink shipments (in equivalent 12-ounce units) in 1965 to 37 percent in 1982, the share of returnable bottles decreased from 82 percent to only 16 percent. Nonreturnable soft drink bottles have also increased from 5 percent to 26 percent of the market. However, plastic containers now constitute about one-fifth of the soft drink market.

Similarly, beer can shipments demonstrated significant growth during this period as beer consumption grew. Annual per capita consumption of beer in all forms increased from 15.9 gallons in 1965 to 24.3 gallons in 1982. The share of this expanding market packaged in metal cans increased from 40 percent in 1965 to 60 percent during the mid-1970's and stood at 62 percent in 1982.

Since the mid-1970's, the leveling off of output growth in the beverage can sector is in large part a result of increased competition from substitutes, particularly the smaller-size beer bottle and the 2-liter plastic bottle for soft drinks, as well as some weakness in the total soft drink market. Because soft drinks are discretionary purchases, sales tend to fall during economic slowdowns. For example, beverage can production increased only marginally during the 1971 recession after several years of robust growth, and declined during the 1975 (higher sugar prices were also a factor that year) and 1980 recessions.

Another cause for the recent slowdown in beverage can output growth has been the enactment of anti-litter laws requiring mandatory deposits on beer and soft drink containers, in effect in seven States in 1982. In the case of the beer market, packaged sales in those States declined initially or the rate of increase in consumption slowed after implementation of the laws.

[5] Address by Alan W. Larson. *Reshaping the Can Business: A Proud Industry Looks Ahead* (American Can Company, May 1981), p. 6.

[6] A base box is a measurement of the surface area of metal used in production, totaling 31,360 square inches, equivalent to 112 sheets, 14 in. x 20 in. in size.

Moreover, the can industry has generally lost market share to both refillable bottles and draught beer, although the extent has varied considerably from State to State. The extension of similar laws to major industrial States (two highly populated States will implement container deposit laws in 1983) will likely reduce can sales temporarily. The long-term effect of the anti-litter laws is unclear, but the can industry expects to expand its market share.

Projections for the beverage sector suggest modest long-term growth. However, introduction of the half-liter plastic bottle may pose a threat to the single-service soft drink market once technological problems are resolved.

Food and general line. Output of the second largest can sector, food, was lower in 1982 than in 1965. It remained relatively stable during the early part of this period but has gradually fallen since 1974. Consequently, food can shipments declined from 60 percent of total can shipments in 1965 to 33 percent in 1982.

Changing consumer tastes, such as a preference for fresh fruit and vegetables, have adversely affected the can market. Similarly, consumers have demonstrated a strong preference for the convenience of specialty frozen foods. Nor has the can industry benefited from increasing commercial demand for packaged foods since restaurants generally require large volume containers rather than cans.

Food can production tends to be less susceptible to cyclical changes in demand than either the beverage or general line sectors. However, output is often affected by weather and crop conditions. Droughts contributed to packing declines in both 1979 and 1980. After a good harvest year (as in 1974, for example), packing may decline because of excessive inventory accumulation.

An impending competitive threat to the canned food market is the "retort pouch," a flexible, laminated polyester container with packaging qualities considered by many to be superior to metal cans. At least one major can company and one aluminum company, as well as food processors, have been instrumental in the development of this competitive product. However, because present pouch packaging speeds are still comparatively slow and the pouch continues to meet some resistance from consumers, it appears unlikely that the retort pouch will become a serious competitor before the middle of the decade. A more immediate challenge is coming from the manufacturers of the plastic bottle and aseptic container (a flexible laminated container with sterilized contents requiring no refrigeration) for packaging such products as sauces and fruit drinks.

The third can sector, general line containers, has, like the food can sector, contracted in recent years. Sales of aerosol cans have been hurt by environmental concerns and, more recently, by lower discretionary spending. The paint and varnish can market, which had experienced the greatest growth in this sector, has recently been weakened by recession and increased usage of plastic containers. Overall, shipments of general line containers declined from almost 18 million base boxes in 1965 (15 percent of all can shipments) to about 12 million base boxes in 1982 (7 percent of the total). The peak year was 1972, when 21 million base boxes were produced.

Because of high transportation costs, foreign trade is not significant in the can industry. Exports accounted for less than 1 percent of all can product shipments in 1982. Rather than ship cans overseas, the major can companies have established subsidiaries abroad to serve foreign markets. The import penetration ratio is also very low—less than 1 percent.

Investment

Capital expenditures

Real capital expenditures[7] peaked in 1975, then fell by almost 50 percent in 1976 to the lowest level since the early 1960's. Although they fluctuated somewhat during the period 1976–80, real expenditures averaged 27 percent less than in the preceding 5-year period (1971–75). Because of the significant decline in employment, outlays per production worker fell 15 percent between these two periods.

The industry decreased its investment due to weaker demand in major markets, low profitability, projections indicating modest output growth, and current overcapacity. In addition, the major can companies have been diversifying into other nonpackaging industries.

In current dollars, can industry investment rose to $205 million in 1980 (latest available data), a nearly threefold increase over 1960, but well below the $232 million spent in 1975, the peak year. An average of 90 percent of new expenditures has been used to purchase machinery and equipment.

Although can industry expenditures per production worker exceeded the manufacturing average in the 1960's and early 1970's, the reverse has been true in recent years. In the 5 years 1963–67, current-dollar expenditures per production worker were 36 percent higher in the can industry than in all manufacturing; by 1976–80, they had fallen 2 percent below the manufacturing average.

Employment and Occupational Trends

Employment

In the 1960–82 period, can manufacturing employment data showed two distinct trends: a steady rise from

[7] Deflated Bureau of Census data.

the mid-1960's to a peak in 1970 and a gradual decline in the 1970's with cyclical fluctuations in the 1970 and 1975 recessions. By 1982, employment was down to 52,200—about 16 percent less than in 1960 and 30 percent below its 1970 peak (chart 6).

Employment was relatively stable in the first half of the 1960's following the 1961 recession. Employment then rose sharply as output increased more rapidly than productivity. To accommodate the growing demand for beverage cans, many new establishments were added, including a number of larger-sized plants.

In contrast, the employment decline in the 1970's occurred as productivity growth outstripped demand. Many forces came into play, including the impact of new technology on unit labor requirements, the change in composition of output (expansion of the technologically advanced beverage sector, with some contraction in the more labor-intensive food and general-line sectors), and less favorable economic conditions. In addition, as cited earlier, smaller, more efficient dedicated and self-manufacturing plants have been replacing larger, less specialized, labor-intensive facilities. In 1972, 43 percent (30,000) of workers were employed in establishments with more than 500 employees; 5 years later, this figure had dropped to only 24 percent (15,000).

The trend of plant closings and job consolidations, the continued diffusion of new and improved machinery, and modest output growth are likely to further depress employment in the 1980's.

Occupations

Changes in the can manufacturing processes have had a significant impact on skill requirements.

As mentioned in the technology section, the introduction of the major new innovation—the two-piece can line—has eliminated certain manufacturing steps and changed others. For example, because the decorating process is simplified on a two-piece line, several unskilled positions in the lithography shop can be eliminated, including the litho feeder and oven unloader. Also, because the line is a fully automated, continuous process system, requirements are reduced for the unskilled workers (e.g., forklift truckdrivers) who transport the material between work stations. In addition, because the respective job requirements for the three-piece and two-piece can lines are so different, many skills are virtually nontransferable. Press and part manufacture skills do have some crossover value, however.

The adoption of the new welded seam processes has generally had less impact on job content than did the two-piece line. The extent of the labor adjustment depends on whether the new welding machinery merely replaces the soldering sequence in an existing line or an entirely new welding system is installed. In the first case, the mechanic responsible for the soldering equipment could be retrained to maintain the new welding machinery. In an entirely new system, the labor adjustments can be more significant, because job consolidations down the line are possible.

Duty or skill consolidation increases the flexibility of the work force and, thereby, could result in the reduction of the number of workers required per processing unit. In the can industry, a major industrywide effort is currently underway to review, and where necessary, combine and reclassify jobs in recognition that "changes in business or equipment may create conditions which will not justify the (existing) pure classification. During such circumstances, nonskilled functions may be added to a trade, craft, or skilled job ...".[8] One example of the type of job combination is the case in which the production mechanic assumes some quality control responsibilities; i.e., examining, testing, and measuring equipment for quality specifications, and visually checking the product for defects. Similarly, the skilled mechanics may be assigned to duties normally the responsibility of maintainers. Some unskilled jobs, such as production checker and compound mixer, have also been combined.

A typical plant has more than 20 job classes. In one of the highest classes is the electronic repairman who is responsible for using electrical testing devices to ensure proper operation of electronic control components. Also highly skilled are the mechanics, who ensure that the components are properly functioning. Least skilled are the workers responsible for packing and shipping cans, such as the palletizer operators, packers, sorters, wrappers, and strappers.

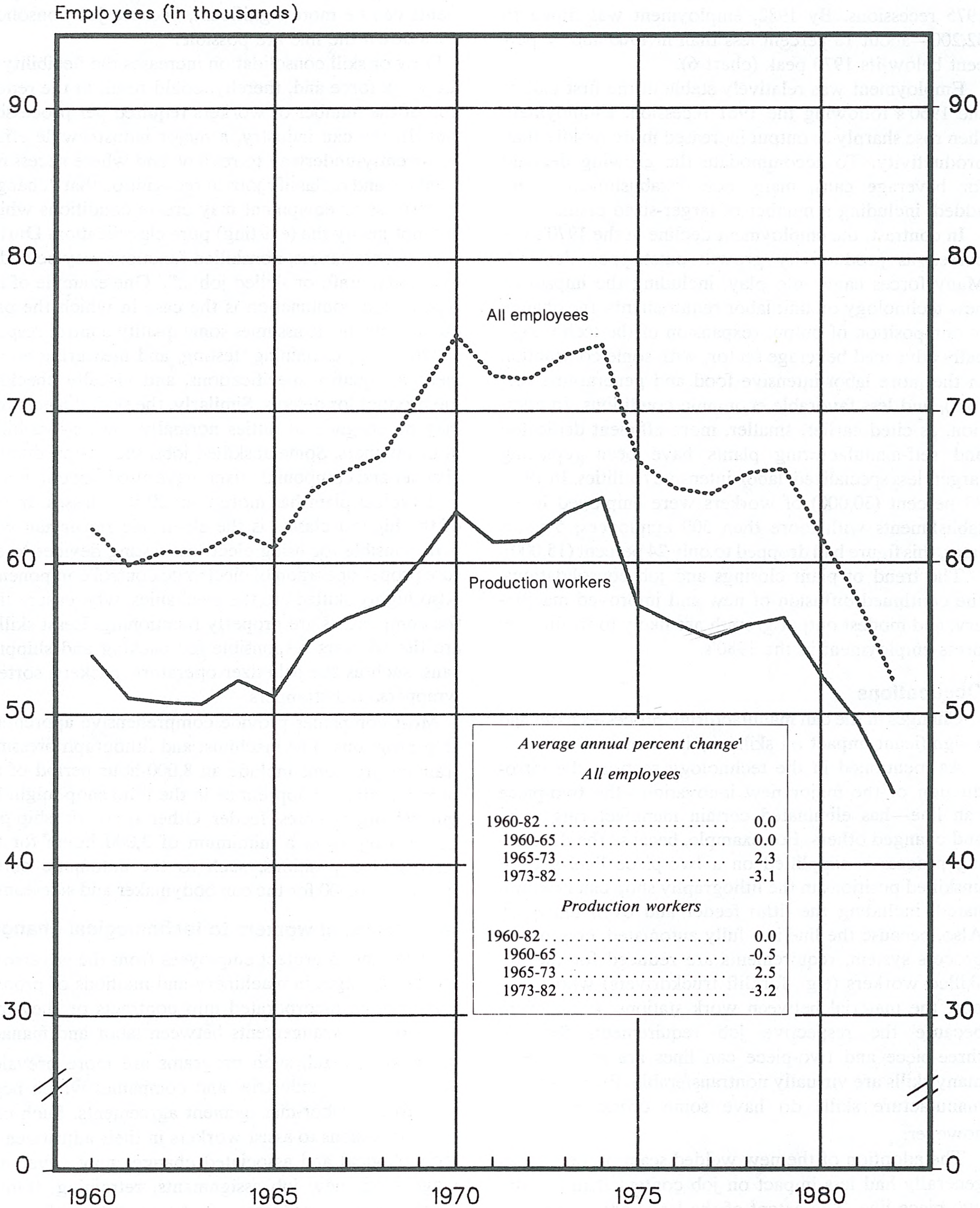
Most companies provide comprehensive apprenticeship programs. The machinist and lithograph pressman training programs include an 8,000-hour period of apprenticeship. An apprentice in the litho shop might begin training as a press feeder. Other apprenticeship programs vary from a mimimum of 3,000 hours for the least skilled positions, such as the automatic carton packer, to 6,000 for the can bodymaker and sideseamer.

Adjustment of workers to technological change

Programs to protect employees from the adverse effects of changes in machinery and methods of production may be incorporated into contracts or they may be informal arrangements between labor and management. In general, such programs are more prevalent and detailed in industries and companies which negotiate formal labor-management agreements. Such contract provisions to assist workers in their adjustment to technological and associated changes may cover new wage rates, new job assignments, retraining, transfer rights, layoff procedures, and advance notice of changes

[8] Master Agreement between Continental Can Company and United Steel Workers of America, p. 170.

Chart 6. Employment in metal cans, 1960-82



Average annual percent change[1]	
All employees	
1960-82	0.0
1960-65	0.0
1965-73	2.3
1973-82	-3.1
Production workers	
1960-82	0.0
1960-65	-0.5
1965-73	2.5
1973-82	-3.2

[1] Least squares trends method.

SOURCE: Bureau of Labor Statistics.

planned by management, e.g., machine changes or plant closings. They may include various types of income maintenance programs such as supplementary unemployment benefits (SUB) or severance pay.

The can industry has long been highly unionized. According to one 1981 estimate, substantially more than half of the production workers were covered by collective bargaining agreements, well above the 40-percent average of all manufacturing. The United Steelworkers of America (USW) and the International Association of Machinists and Aerospace Workers (IAM) are the principal unions in the industry. The Teamsters, Sheetmetal Workers, and Food and Allied Service Workers represent a smaller number of workers.

It seems likely that the proportion of can industry workers covered by union agreements is declining. Membership in the two largest unions has fallen faster than the overall decline in production worker employment. Many older, unionized plants have closed; at the same time, workers in some plants which have recently begun operations are not represented by unions.

In the "for-sale" sector of the industry, master agreements are established for the large multiplant companies, and bargaining is conducted on an industrywide basis. Wage and benefit settlements for these companies have followed the pattern of other basic-metal industries. In the self-manufacturing sector, negotiations are conducted on an establishment or companywide basis.

Hourly wages of workers in plants owned by the four large can companies—the so-called "core" companies—may not be substantially higher than those paid in self-manufacturing plants. Benefits, however, are more comprehensive. For instance, short week benefits and supplementary unemployment benefits are available to nearly all core company workers; comparatively few workers in the self-manufacturing sector are shielded by such provisions. Demography also plays an important role in the relative costs of the two sectors. The average age of the core company worker is more than 40, and many workers have years of seniority. In contrast, the newer companies generally employ a younger age group which reduces pension, severance, and SUB liabilities substantially. It is believed that the high unit labor costs of the core companies are a contributing cause to their loss of market share to the self-manufacturers.

Major industry contracts provide for severance payments, interplant transfer rights, and seniority regulations governing layoff and recall to protect workers against the negative effects of technological change. One contract states, "employees laid off because of a reduction in force arising out of the closing of their department or unit of the plant as a result of technological change, will be paid a severance payment."[9]

Retraining rights are a provision of some union contracts. One example in a contract for a large bargaining unit specifies that employees (in this case, the clerical work force) whose jobs are or will be displaced because of automation or economic conditions may qualify for training expenses to enable them to qualify for other jobs in the bargaining unit.[10]

Provisions are also included in the same contract for advance notice of actions affecting clerical workers—"When mechanical or electrical office equipment will have effect on the job status of employees ... where possible, management will notify the Local Grievance Committee one year in advance of such installation."[11] A second major agreement specifies, without reference to technological change, that the union will be notified of any layoffs as far in advance as is practical.[12]

Strengthening income protection and job security has for some years been an important objective of union negotiations because of employment shrinkage. Income protection plans specified in two master contracts entitle a worker to supplemental benefits if, for any calendar quarter, average (straight time hourly) earnings fall below 95 percent of the average (straight time hourly) earnings during a previous base year.[13] Also, SUB payments are available to a large number of workers.

[9] Collective Bargaining Agreement between Campbell Soup Company and the Food and Allied Service Workers, p. 77.

[10] USW Master Agreement-Continental Can, February 16, 1981, to February 19, 1984, pp. 134–35.

[11] Ibid., p. 135.

[12] Master Agreement-IAM and CCC, p. 28.

[13] Ibid., pp. 30-31; and USW and CCC, pp. 32-33.

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Chapter 4. Laundry and Cleaning

Summary

Technological changes associated with the laundry and cleaning industry (SIC 721) are achieving productivity gains in selected production operations, but the impact during the 1980's is expected to be moderate and confined mainly to the larger industrial launderers and linen supply firms. The small, owner-operated firms, which constitute a large segment of the industry, generally do not have the volume and capital to adopt new technology extensively.

New technologies in this major service industry share some similarity to those associated with manufacturing and include more automatic equipment and improved conveyors and related devices which transport items through cleaning, drying, and finishing operations. Major innovations in this industry include increased mechanization of washing equipment and related conveyor systems; mechanized steam tunnel finishing, and automated systems to hang, sort, and transport cleaned garments. In addition, improvements in other industries, such as improved detergents that save energy and time, and continued use of blended polyester/cotton fabrics which require less processing, are affecting operations in the laundry industry.

Output in the laundry and cleaning industry has been declining since the mid-1960's—particularly in the laundry services sector of the industry. Consumer expenditures for laundry and cleaning services have been falling as fabrics which are easier to clean and improved home laundry systems are used more extensively. In contrast, output in the industrial laundry and linen supply sector of the industry, which is highly mechanized, has been rising. For the two decades covering 1960–82, the Bureau of Labor Statistics measure of output in the laundry and cleaning industry declined at an average annual rate of 2.9 percent.[1] The pace and direction of output change over this period were uneven: During the early period 1960–67, output increased at an average annual rate of 2.3 percent; between 1967 and 1973, however, output declined at an annual rate of 5.0 percent and continued to decline at a rate of 3.7 percent between 1973 and 1982. Productivity (output per hour of all persons) increased at an annual rate of 0.5 percent between 1960-82. During 1973-82, however, productivity declined at an average annual rate of 1.7 percent, as output fell at a faster pace than employee hours.

Employment in the laundry and cleaning industry fell by one-third between 1960-82, from 523,000 to 347,300 workers, as demand slackened and improved technology was introduced. Employment declines have been greatest in the laundry and services sector; in contrast, employment in industrial laundry and linen supply establishments has been increasing, reflecting changes in industry structure. The outlook is for total industry employment to continue downward to 1990. Operatives, who make up nearly one-half of the work force, are projected to decline by more than one-third because of technological and other changes.

Industry Structure

The laundry and cleaning industry consists of over 75,000 establishments which employ 347,300 employees.[2] About half of the work force is located in establishments that launder and clean customer-owned items; most of the remainder work for the generally larger establishments which rent and clean uniforms, towels, diapers, and linens.

Most establishments in the laundry and cleaning industry are small, owner-operated enterprises. There is a trend toward some consolidation, as some larger firms purchase small, previously independent establishments. Only 1 out of 4 laundry and cleaning establishments are incorporated. They generally are larger and more highly mechanized, and they account for two-thirds of industry receipts, and employ a large segment of the work force.[3]

[1] Rates of change for historical data are based on the least squares trends method.

[2] Number of establishments, Bureau of the Census, *1977 Census of Service Industries, Subject Series—Establishment and Firm Size*; employment, Bureau of Labor Statistics, *Supplement to Employment and Earnings*, July 1983.

[3] Bureau of the Census, *1977 Census of Service Industries, Subject Series—Establishment and Firm Size.*

Major types of enterprises include laundries and drycleaning plants, (which serve many enterprises—retail, commercial, and industrial), linen suppliers, and industrial launderers. The drycleaning sector has the largest number of establishments with paid employees (47 percent) and accounts for just under one-third of the industry's receipts and annual payroll. But drycleaning plants—which cater primarily to retail customers—average only six employees per establishment, and few have the capital or volume of business to introduce significant new technology.

Most new technology is being installed by industrial laundering and linen supply establishments. Together, these establishments constitute only 3 percent of the total number of establishments within the industry; but they account for 30 percent of employment, 38 percent of receipts, and 40 percent of the industry's payroll. Moreover, employment per establishment averages 46 employees—well above the average in retail drycleaning plants. Industrial launderers (whose operations include drycleaning as well as laundering) and linen suppliers have the volume of work to justify large equipment investments. Also, the large quantities of identical items processed by these establishments (bedsheets, towels, rental uniforms, etc.) can be automated more readily than the wide variety of products handled by other industry sectors.

Technology in the 1980's

Technological changes in equipment, fabrics, and detergents and solvents are being introduced in the laundry and cleaning industry. Innovations such as polyester/cotton fabrics have been available for some time and are widely used; however, other developments, including electronic systems to mark and sort clothes, are in limited use and may be adopted more widely in the 1980's. Although the pace of change has been moderate, the technologies described below and summarized in table 3 have nonetheless had an impact on productivity and employment in a number of operations.

Improved washing equipment

The latest technology for washing and cleaning garments and other merchandise incorporates several features that reduce labor requirements for operators. Some

Table 3. Major technology changes in laundry, cleaning, and garment services

Technology	Description	Labor implications	Diffusion
Mechanization of the washing and cleaning processes	Washing and drycleaning machines that tilt backward to allow automatic loading from overhead slings or chutes. A few washing machines also can be unloaded automatically.	Automatic loading and unloading and automatic wash and cleaning systems reduce labor requirements for operators and raise productivity. Less manual handling of garments and linens; skill requirements largely unchanged.	Tilt machines used by 30 to 35 percent of industrial launderers and linen suppliers. Overhead loading by slings and chutes is deployed widely.
	Automatic systems that load, wash, and transport items with minimum handling.		Automatic wash systems are used by about 10 percent of industrial launderers and linen suppliers with further diffusion anticipated.
	Automatic and semi-automatic control of washing cycles and injection of chemical supplies—usually by electro-mechanical controls, but recently by solid-state controls in some establishments. Some fully automatic, continuous batch washers use computer controls.	Automatic controls reduce labor requirements for operators. Detergents and supplies added automatically rather than by hand. Increased requirements for maintenance skills.	About 90 percent of industrial launderers and linen suppliers use some form of automatic controls on washing equipment. Electronic control devices to be used more extensively. Continuous batch automatic washers are in only limited use at present, due to high costs.
Improved detergents	New and improved detergents allow laundry to be washed at lower water temperatures and with a shorter rinse cycle.	Reduced rinsing allows more washing loads per shift, increasing output per operator.	Widely used.
Blended polyester-cotton fabrics for uniforms and linens; and steam tunnel finishing	Blended fabrics are used for most industrial uniforms and linens. Steam tunnels are being used to dry and remove wrinkles from uniforms. This generally eliminates pressing.	Elimination of the need to press most industrial uniforms and linens has increased productivity and reduced employment of pressers. Skill changes involve a shift from pressing activities to tasks related to the loading and transport of items through the tunnel for finishing. Retraining minimal and on the job.	About 3 out of 4 industrial launderers and linen suppliers use blended fabrics and steam tunnel finishing.

Table 3. Major technology changes in laundry, cleaning, and garment services—Continued

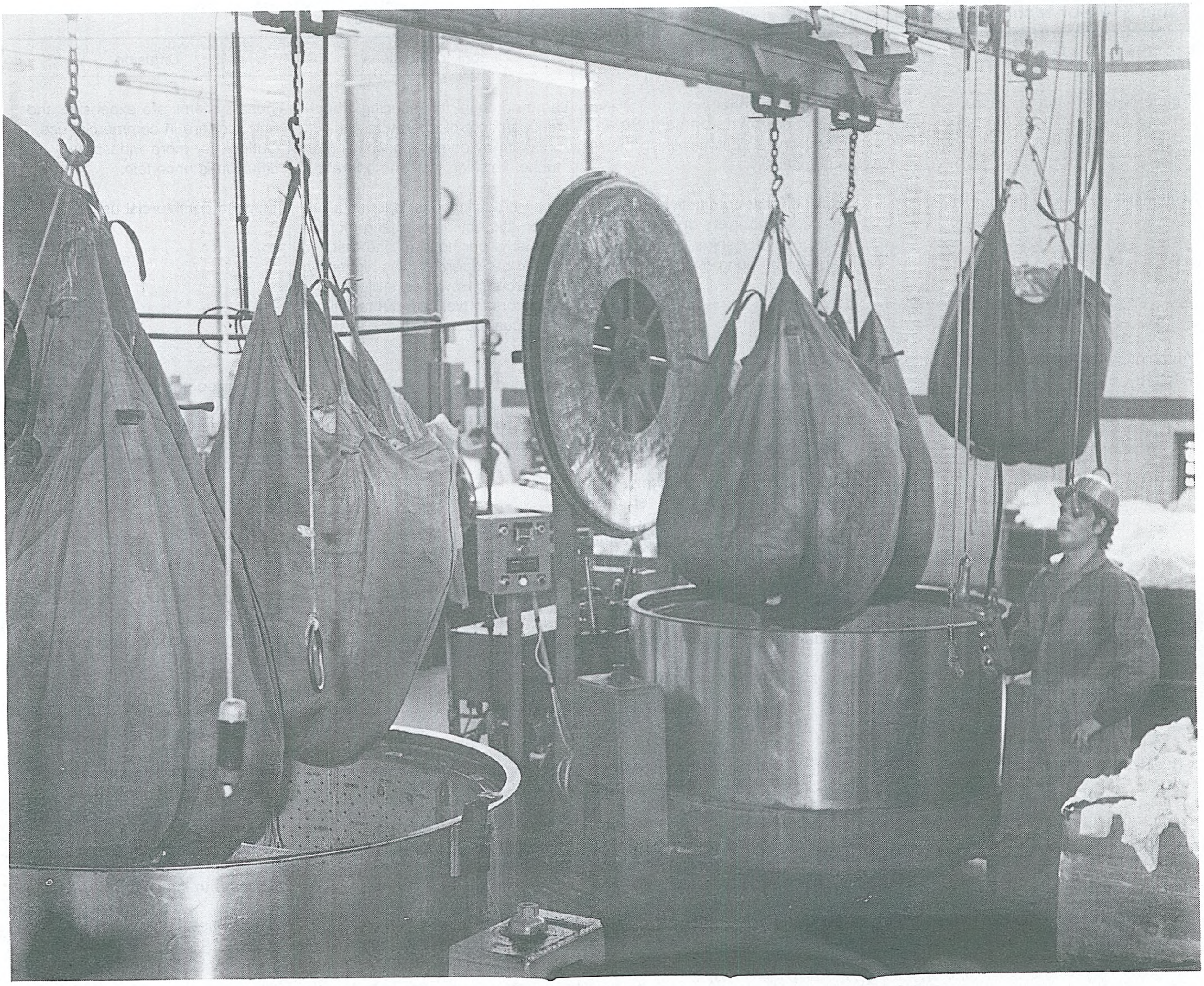
Technology	Description	Labor implications	Diffusion
Tunnel washing and finishing	New steam tunnel systems receive soiled garments on hangers and wash, dry, and steam finish them automatically.	Large potential for reducing labor requirements of operators and pressers by combining washing and tunnel finishing into one operation.	These systems are expensive and only four are in commercial use. Outlook for more widespread diffusion is uncertain.
Automatic devices to hang clothes	Machines that automatically dispense hangers on a clothing form ready for shirts, coats, or pants to be hung over them.	In some applications, operators of automatic equipment hang more garments per hour. In one test, output per operator was higher by 39 percent. However, skilled operators in well laid-out facilities can equal output of these systems.	In limited commercial use.
Automatic systems to sort and count clothes	A number of sorting systems are being used to get a specific garment to the proper customer. All systems incorporate conveyors and sensing and label-reading devices. Advanced systems use computer and electronic codes to keep track of garments. There are also some mechanized systems that sort and count soiled garments and linen coming into a cleaning establishment.	Advanced systems involve less manual tasks for operators and more involvement with equipment. Output per operator is higher.	Mechanized sorting systems are in general use; sophisticated computer sorting systems, now under development, will be placed in commercial use.
Flatwork finishing	Blended fabrics now used by many linen suppliers. Mechanical spreading and folding equipment is in use.	Manual handling of linens has been reduced by the spreaders and folders.	Widely used in linen supply firms.
Miscellaneous technological changes:			
Business computers	Small computers used for business purposes by small owner-operated establishments.	Little impact on employees.	Limited, but growing use.
Water reuse	Reuse of previously used wash water, to reduce consumption of water, energy, and chemicals.	Some increase in plant maintenance and engineering requirements.	Used be less than 10 percent of industry plants; but diffusion expected to increase.
Special purpose equipment	Cleaning equipment for floormats and roll towels.	Reduction in direct labor requirements, small increases in maintenance requirements.	In limited use.
Microprocessors	Electronic controls for machine operations, plant electrical energy needs.	Increased skill requirements for maintenance workers.	Limited, but growing use.

front-loading machines being introduced, for example, tilt backwards to permit automatic loading of soiled garments from overhead slings or chutes. This feature is used primarily with sling loading—a process in which the merchandise is loaded by hand or machine into slings and transported by overhead conveyors to the washing machines. This process is faster and requires less labor than does the older process of loading soiled garments into carts by hand and pushing the carts to the machines for manual loading. About one-third of all industrial launderers and linen suppliers use washing machines that tilt for loading and unloading.

Machines also can be loaded from chutes located directly overhead. These chutes are most often used with machines that load from the top—including washing wheels that have three or four pockets that wash several loads of similiar merchandise simultaneously. After a large quantity of soiled merchandise is loaded into the chutes, machine operators release part or all of the contents of a chute into the machine—again, a process that is faster and less labor intensive than placing each separate load into the machines by hand. Overhead loading chutes are used extensively.

Some washing machines also can be unloaded automatically, although this capability is less common than automatic loading. Some front-loading machines tilt forward to unload clean garments into slings that are carried by overhead conveyor to the finishing area. Although not in widespread use, automatic unloading processes reduce labor requirements of operators and raise productivity. Applications of automatic unloading are expected to increase.

Once the machines are loaded, washing and cleaning cycles can be controlled automatically. Some control



Operator loading cleaned linens into a modern centrifugal extractor to remove water

systems add soap, bleach, or other supplies automatically, while others alert the machine operator to add these supplies. Although most control systems are mechanical, solid state controls are being used on some of the newer equipment. About 90 percent of industrial launderers and linen suppliers use some form of automatic controls on washers.

Several manufacturers market continuous batch automatic systems that combine technologies described above. One washing system in commercial use, for example, incorporates overhead loading chutes, tilting washers with automatic control of the wash cycle and supply of soiled garments, and belt conveyors that remove cleaned garments. The process is automatic from loading soiled garments into the chute, to delivery of clean garments to the finishing area. Only about 10 percent of industrial launderers and linen suppliers use automatic washing systems, due to high costs, but more widespread diffusion is anticipated.

New detergents

New detergents that clean at lower water temperatures are being introduced. These improved products lower utility costs since water temperature in washing machines can be lowered from 180 F, to a range of 140 to 160 F. Thus, the amount of energy required to heat the water is less. Also, clothes washed at lower temperature with less detergents and other supplies require less rinsing, and, therefore, less water is used. The reduction in rinse cycles also increases output per operator since additional wash loads are carried out with no increase in labor requirements.

Blended fabrics and steam tunnel finishing

A significant change in industrial laundries and linen suppliers resulted from two innovations: The availability of blended polyester/cotton fabrics for industrial uniforms and commercially supplied linens; and the development of steam tunnels for finishing work on uniforms and linens. These innovations in combination almost entirely eliminate the need to press merchandise items after thay are washed, thereby reducing labor requirements for pressers.

Blended fabrics. Fabrics which are made from a blend of polyester and cotton are being used for rental uniforms and linens by over 75 percent of all industrial launderers and linen suppliers. Most of these fabrics are blended of 65-percent polyester and 35-percent cotton, although 80/20 blends and 100-percent polyester fabrics are also in use.

Garments made from these fabrics emerge from washing machines and drycleaning machines in wrinkled condition, but the polyester fabric smooths out when exposed to steam, and most wrinkles disappear. However, these fabrics must be pressed if a completely wrinkle-free finished is desired. Prior to the availability of the blended fabrics, most rental uniforms and linens were made of cotton, a fabric that did require pressing—which was very labor intensive.

Blended 65/35 fabrics became available in the mid-1960's, a period in which industrial launderers and linen suppliers were experiencing difficulty in finding experienced pressers. Pressing is not a particularly desirable job, and salary levels are low. During this period, when business activity was strong and labor mobility high, many people left pressing jobs. Thus, 65/35 fabrics were well received and the problems associated with labor shortages were eased.

The industry also is examining the characteristics of an 80/20 blend of polyester/cotton fabric and 100-percent polyester fabric developed by the textile industry for use in mills where cotton dust is a problem. Use of these fabrics for rental uniforms is growing, but is not yet widespead.

Steam tunnel finishing. Development of steam cabinets or tunnels provides the technology to economically clean blended fabrics. In steam tunnel finishing, garments that emerge from the wash cycle are shaken out by hand and placed on hangers. The hangered garments are placed on a conveyor and transported through the steam tunnel. In the steam chamber, steam relaxes the garment's fibers, and most wrinkles are removed. After the garments are dried by hot air in the second chamber, they leave the steam tunnel and are sorted for delivery.

Labor and skill requirements are both reduced when tunnel finishing procedures replace pressing operations. Steam tunnels finish 200 to 1,000 garments an hour (depending upon the particular machine and the amount of water still in the garment). Operators put garments on hangers, feed them into the tunnel, and operate the controls for the steam tunnel to maintain this production rate. If each item had to be pressed separately, a much larger number of pressers would be required to maintain the same output. Moreover, in conventional finishing, pressing garments and putting them on forms require considerable skill to ensure that wrinkles are not pressed in, creases occur in the correct places, and collars and cuffs look right. In tunnel finishing, less skill and effort are necessary to shake out wet garments, put them on hangers, and hang them on conveyors that carry the garments into the steam tunnel.

An example of the impact of polyester/cotton fabrics and tunnel finishing on productivity and labor was provided by an industrial launderer that changed from cotton to 65/35 fabrics for rental uniforms. Prior to the change, 35,000 to 40,000 cotton garments were laundered a week with pressing and repair work accomplished by a staff of 25.

Over a period of several years, this firm installed three steam tunnels and switched from cotton uniforms to 65/35 fabric uniforms. As the steam tunnels were brought in, pressers were retrained on the job to operate them. As the pressers became more skillful in operating the tunnels, labor requirements declined, and the number of people manning the steam tunnels was lowered through attrition.

During the period that new technology was introduced, the workload about doubled to 70,000 garments a week—but the number of people needed to operate steam tunnels and make repairs to damaged rental garments remained at 25. The mix of job tasks changed, however. Fewer people operate steam tunnels than did pressing work when cotton garments were used, but the number of workers who do repair work has grown to meet the needs of the 70,000 garment workload. The total volume of repairs has increased even though there are fewer repairs per 100 garments processed with 65/35 fabric than with cotton fabric.

Tunnel washing and finishing

Tunnel-type machines have been developed to wash, dry, and steam finish clothes in one continuous operation. This process has potential to reduce labor by combining the two basic production steps—washing and steam tunnel finishing—into a single operation. The process is labor intensive only at the first stage, where soiled garments are manually put on hangers and placed on a conveyor that goes into the washing tunnel. Garments are washed in the first part of the tunnel, then dried and steamed in the following section, in a manner similar to conventional steam tunnel finishing.

The outlook for diffusion of tunnel washing and finishing is uncertain. This system is expensive to install and must be used properly to be cost effective. The technology is considered experimental by most industrial launderers, and only four installations are currently in use in this sector of the industry.

Automatic hangering devices

The more widespread use of tunnel finishing and the potential use of tunnel washing have focused attention on the most labor-intensive aspect of garment laundering: Placing items of clothing on hangers,then placing the hangers onto conveyors that feed into the finishing tunnels.

Automatic devices to hang garments have been developed by several manufacturers but are in limited commercial use. Under some conditions, the speed at which garments can be placed on hangers is increased. Central to the success of this equipment is some method (which varies by manufacturer) to dispense hangers automatically and in a way that the operator need only reach out to hang a garment.

In conventional methods, the operator picks up a hanger, places it on a form, and hangs a garment on it. The hangered garment is placed on a conveyor that feeds into the steam tunnel. An operator can place from 200 to 300 garments an hour on hangers. Operator skill and motivation affect speed. Location of hangers, garments, and conveyors also affect output.

In tests where automatic hangering devices were compared to manual hangering of shirts, operators working with automatic devices usually increased the number of shirts placed on hangers per hour. In one test, operators using automatic equipment averaged 278 shirts per hour, compared to an average of 200 shirts an hour when they were placed on hangers entirely by hand—a productivity gain of 39 percent. In several plants, 300 shirts an hour were handled with automatic equipment. There were, however, a few instances where operators hung shirts by hand at a rate of 300 shirts an hour. These people were described as being particularly agile, and they worked on an incentive pay basis, in areas that were unusually well organized.[4]

Automated sorting systems

The laundry and cleaning industry makes extensive use of conveyor systems to sort garments. Some uniforms are rented to specific customers, and after washing, must be sorted in such a way that the proper uniform is returned to the customer. This also is required, on a smaller scale, for retail washing and drycleaning of garments.

Conveyor systems are becoming more mechanized, and, in some systems, hooks for the hangered garments are located at different levels. Operators read codes on labels attached to the garments and hang the garments on hooks at a particular level. As the garments are carried along the conveyor, each level of hooks feeds into branching conveyors that sort the garments into proper delivery areas. Skill and concentration are required by operators, who read the coded labels, and use the information to hang the garments on the proper level of hooks. Mechanized sorting systems of this type are used widely; and, without such a system, labor costs in large laundries would be prohibitively expensive.

Development work on more advanced sorting systems is underway. These systems feature computers, sophisticated marking and recognition devices, and coding systems similar to the universal product codes used in retail trade. With this technology, electronic reading wands and scanning devices read coded labels on uniforms and other customer items. These labels can be printed on high-speed, computer-controlled marking machines. Computer systems also track items and assist in inventory control. Computer-controlled sorting systems reduce the number of sorters and lower skill requirements. At present, however, this technology is experimental, and is being used on a large scale in only one plant.

There are also mechanized systems in use to count and sort soiled uniforms, linens, and other such merchandise that come into a plant for laundering and cleaning. These systems utilize operator work stations, conveyors, and electronic counting devices. The more advanced systems can be tied into computers which keep track of the merchandise and provide data for customer billings and deliveries.

Sorting operations are very labor intensive, and the skill requirements are low. Mechanized sorting and counting systems do reduce labor requirements; but this equipment is used primarily in the larger commercial establishments, so present diffusion is limited.

Flatwork finishing

Changes in fabrics and equipment technology have affected operations in flatwork finishing (which consists primarily of bedsheets and table linen, hospital operating room linen, aprons, and towels). The introduction of blended polyester-cotton fabrics may reduce the amount of ironing required for flatwork after the washing cycle. There have been improvements in materials handling technology that reduce manual handling of flatwork items to an extent: Mechanical spreaders and folders, for example.

Miscellaneous technological changes

Business computers. Small computers are being used by a growing number of smaller, owner-operated firms—primarily retail drycleaning and commercial laundries—for business operations such as payroll, and for customer inventory and billing. Computer operations are most likely to be handled by the owner of the firm, so labor implications will probably be limited.

Water reuse. Systems for reusing portions of previously used wash water have been developed for the

[4]"Garment Hangering for Tunnel Finishing," *Industrial Launderer*, July 1980, pp. 35-37.

purpose of reducing consumption of water, energy, and some chemicals. These systems increase requirements for maintenance workers and plant engineers, but should have little or no impact on other plant occupations. Less than 10 percent of industry plants have installed water reuse systems, but diffusion is expected to increase.

Special-purpose equipment. Equipment designed specifically for washing floormats, and a continuous processing system for cleaning roll towels (unrolling, washing, ironing, rerolling) are available. These special-purpose systems substantially reduce the amount of direct labor required for cleaning, while increasing—to a smaller extent—maintenance requirements. Special-purpose equipment of this nature is in limited use, as it is practical to use only in plants that process large volumes of the specialized merchandise.

Microprocessors. These electronic devices are in limited, but growing, use for controlling a variety of plant functions, such as control of machine operations and plant electrical energy demand. This sophisticated equipment increases the skill requirements for maintenance workers, but has little impact on other employees.

Output and Productivity

Output

Output (as defined by deflated value receipts) in the laundry and cleaning industry is down significantly (chart 7).[5] Between 1960 and 1982, the BLS measure of output declined at an average annual rate of 2.9 percent, with substantial variation in direction and rate of change over this period. Output grew during the early 1960's, reaching a peak in 1967, but has since declined fairly steadily. The average annual growth rate in output between 1960–67 was 2.3 percent a year. Between 1967 and 1973, however, output declined at an average annual rate of 5.0 percent, and continued to fall at a lower average annual rate of 3.7 percent between 1973 and 1982.

Shifts in demand for the various types of laundry and cleaning services have taken place over the period. Receipts from personal cleaning services have been declining, while those associated with commercial and industrial activities have been moving upward.

According to the U.S. Department of Commerce, receipts generated from traditional family laundry and drycleaning services continued a long-term trend, declining from 46 percent of total industry receipts in 1972, to 40 percent in 1977 (the latest year available). Individually, receipts for laundries declined in dollar terms as well as percentage terms; while receipts for retail drycleaners increased slightly in dollar amounts, but declined as a percentage of industry receipts (from 33 percent to 30 percent). Firms that provide drycleaning, garment pressing, and diaper services also have lost market shares.[6] These shifts result from the acceptance—in homes as well as working places—of the new, more easily cleaned polyester and knit frabrics, and the development of disposable diapers.

In contrast, industrial laundry and linen supply establishments, which provide rental and cleaning services to businesses and institutions, increased their share of total industry receipts from 32 percent in 1972, to 38 percent in 1977. Coin-operated laundry and drycleaning facilities accounted for 13 percent of industry receipts in both 1977 and 1972.

Productivity

Productivity (BLS output per hour of all persons) has grown at an average annual rate of 0.5 percent during 1960–82 (chart 7). The annual growth rate was highest—averaging 2.1 percent a year—between 1960 and 1967; and it continued to grow at an annual rate of 0.4 percent during 1967–73. Between 1973 and 1982, however, productivity declined at an annual rate of 1.7 percent a year.

During 1960–67, the growth of productivity reflected output increasing more rapidly than hours of all persons. However, both output and employee hours declined after 1967. Between 1967 and 1973, the reduction in hours was slightly greater than the decline in output, thus output per hour of all persons rose. After 1973, however, output fell more rapidly than hours, causing productivity to decline between 1973 and 1982.

Employment and Occupational Trends

Employment

Employment in the laundry and cleaning industry (BLS data) has declined as demand for services slackened and new technology achieved labor savings (chart 8). There were 347,300 people employed in the industry in 1982—a decline of 34 percent from the 1960 employment level of 522,700, and 38 percent below the 1966 peak employment of 559,300 people. Employment changes within the various sectors of the industry follow the pattern of output described earlier—declining in personal cleaning services, and increasing in the commercial and industrial sector.[7] With the exception of 2 years (1978 and 1979), employment declined steadily since 1966.

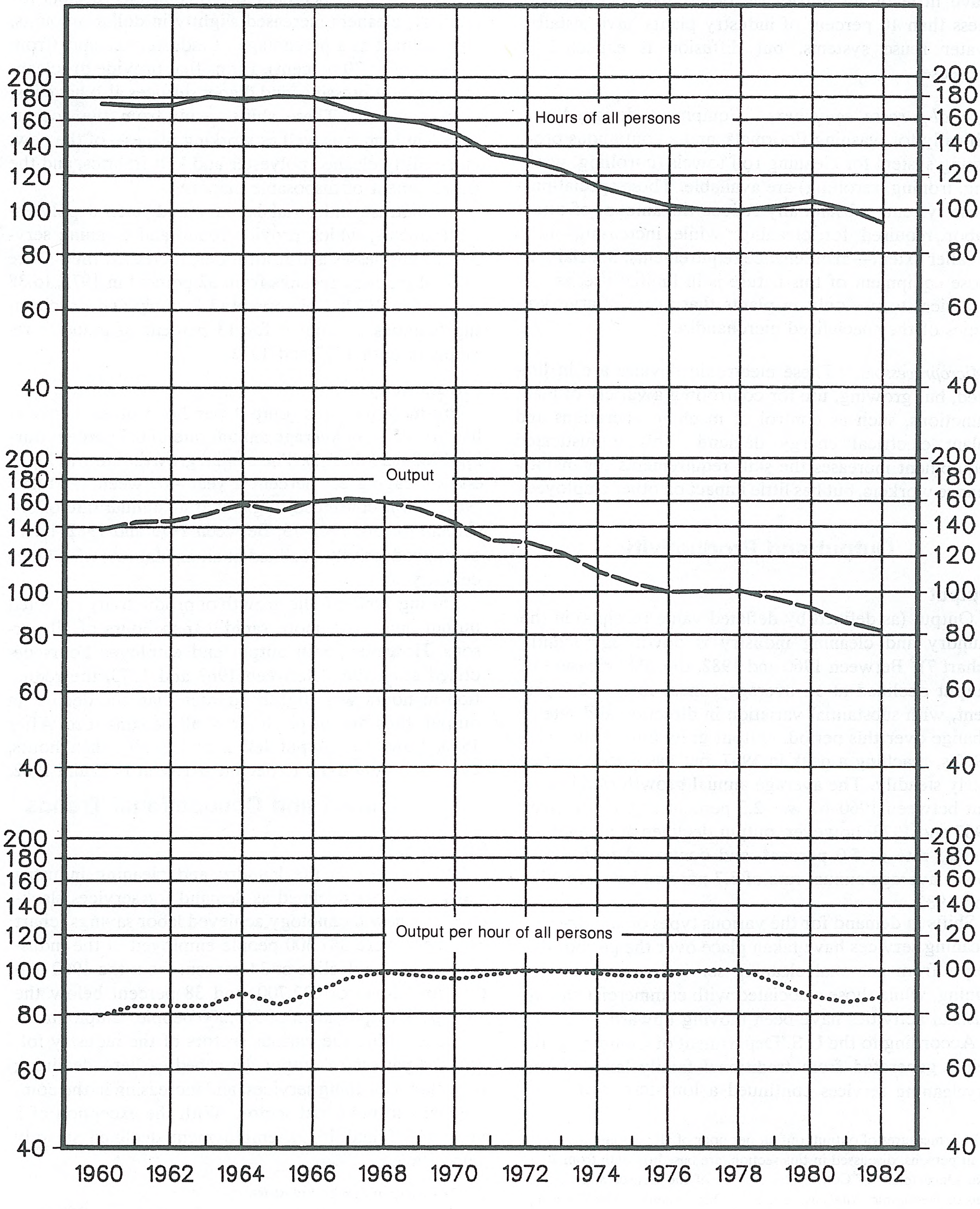
[5] BLS measures of output, output per hour of all persons, and hours of all persons, discussed in this section, are based on data from BLS; U.S. Department of Commerce, Bureau of the Census and the Bureau of Economic Analysis; and U.S. Department of the Treasury, the Internal Revenue Service. For additional detail, see *Productivity Measures for Selected Industries, 1954-81,* BLS Bulletin 2155 (1982).

[6] *1977 Census of Service Industries.*

[7] *1977 Census of Service Industries.* Bureau of the Census. BLS data for subsectors of the laundry and cleaning industry are not available.

Chart 7. Output per hour of all persons and related data; laundry, cleaning, and garment services, 1960-82

Index, 1977=100 (Ratio scale)



SOURCE: Bureau of Labor Statistics.

The rate of employment change varied over the past two decades. Between 1960–82, employment declined at an average annual rate of 2.5 percent. Within this period, however, employment grew at an annual rate of 1.2 percent from 1960 to 1967, declined at an annual rate of 4.9 percent in the 1967–73 period, then continued to decline at a lower annual rate of 1.6 percent from 1973 to 1982.

The industry is a major employer of women. In 1982, nearly 2 out of every 3 positions were filled by women. The proportion of women to total employment declined slightly between 1960 and 1982, as the number of women in the work force fell by 35 percent, compared to a 30 percent drop for men.

The outlook is for employment to decline between 1982 and 1990, according to BLS projections based on three versions of economic growth.[8] The number of employees is expected to change at an average annual rate ranging from an increase of 0.2 percent to a decline of 2.4 percent over the 1982–90 period. Nonsupervisory employees are expected to continue to make up a relatively large proportion (around 90 percent) of total employment.

Occupations

BLS projects a decline in employment, between 1980 and 1990, in each of the major occupational groups. Employment for professional and technical workers, one of the smallest occupational groups, is projected to decline by 14 percent. Declines for the remaining occupational groups are projected to be in the narrow range of 18.0 to 18.2 percent.

In terms of employment share, two occupations—operatives and clerical workers—account for about 4 out of 5 workers in the industry. Operatives, the largest occupational group, make up more than one-half of the total work force. Clerical workers, next in employment size, account for nearly one-fourth. The category of managers, officials, and proprietors and the category of craft workers make up 9 and 7 percent of the work force, respectively. Service workers, sales workers, laborers, and professional and technical workers are next in employment size, but, combined, account for less than 6 percent of those employed in the industry.

New technology introduced into this industry has had an impact on employment in several occupations. The impact, however, cannot be specifically measured, nor isolated from factors such as changes in output.

Blended polyester-cotton fabrics have probably had a greater impact on occupations and employment than any other technological change. Growing use of these fabrics since the mid-1960's has reduced demand for people involved in traditional laundry work, and for those employed in pressing occupations.

Washing operations are becoming increasingly mechanized and automated, which is reducing labor requirements for several occupations. Automatic loading and unloading of washing machines, along with greater use of conveyor systems to move garments, linens, and related items from one wash station to another, has reduced the amount of manual handling required to move items through the various cleaning steps. Automatic control of machine-operating cycles and automatic injection of supplies (soap, bleach, etc.) have reduced labor requirements for equipment operators.

Increasingly sophisticated and automated sorting systems are being introduced which reduce labor requirements in sorting operations. There also may be a reduction in skill requirements for some of the people performing marking, sorting, and assembly work.

The use of these new and improved technologies will continue to grow in the laundry and cleaning industry—but the growth will be confined primarily to the larger firms, such as industrial launderers, linen supply firms, and large general laundry and cleaning establishments. As indicated earlier, there are many small firms in this industry that can neither afford nor make efficient use of such equipment. No significant change in occupations, attributable to technology, is expected in these smaller establishments.

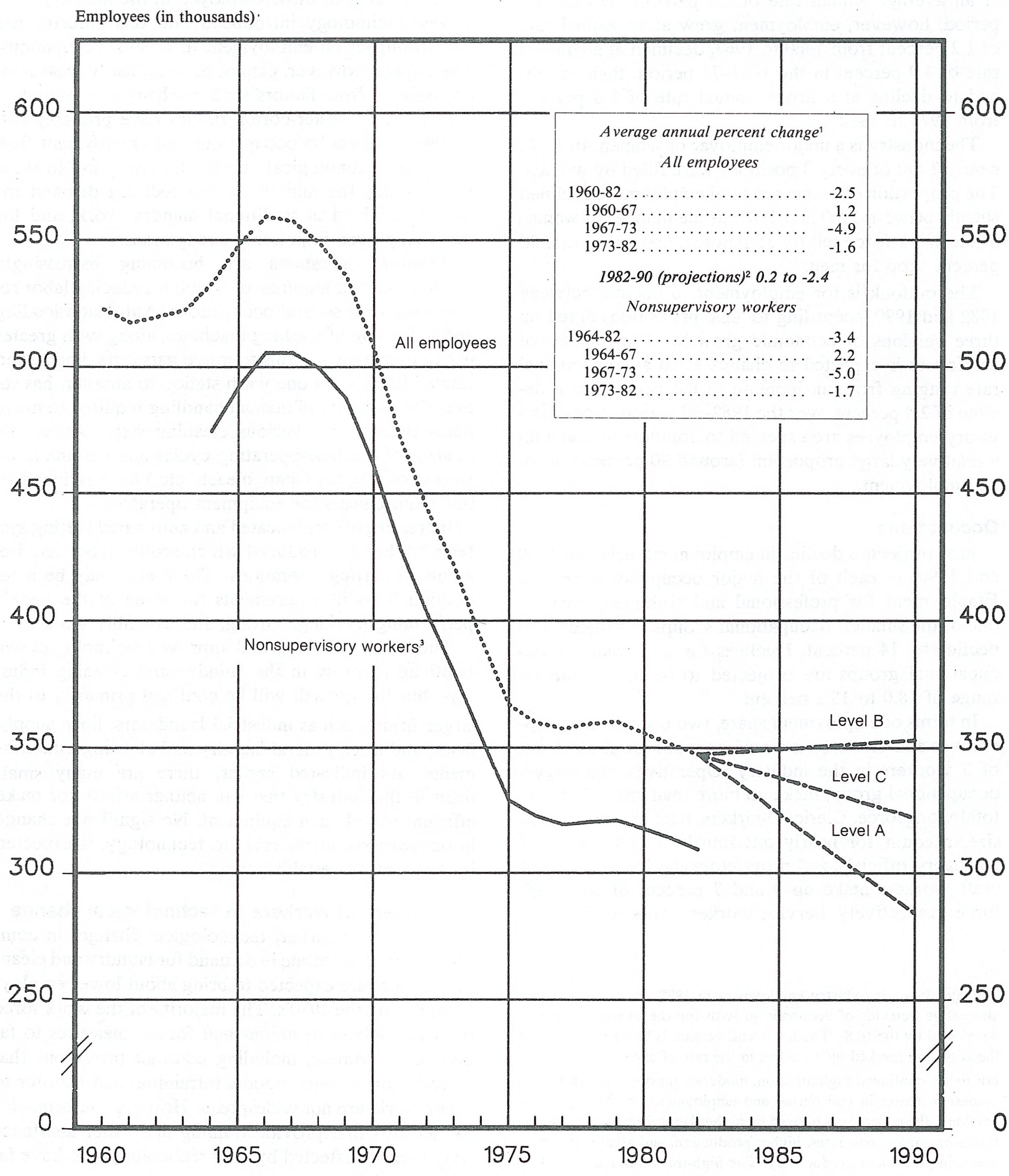
Adjustment of workers to technological change

As indicated earlier, technological changes in combination with a decline in demand for laundry and cleaning services are expected to bring about lower employment during the 1980's. The majority of the work force does not belong to unions and formal measures to facilitate adjustment, including contract provisions that provide for advance notice, retraining, and transfer to other work, are not widespread. However, informal arrangements that provide training and other assistance to employees affected by new technology also have facilitated adjustment.

Improvements in technology are not expected to modify skill requirements to a significant extent, although some changes in job requirements are evident. As laundry and cleaning activities become more mecha-

[8] Projections for industry employment in 1990 are based on three alternative versions of economic growth for the overall economy, developed by the BLS. The low-trend version is based on a view of the economy marked by a decline in the rate of expansion of the labor force, continued high inflation, moderate productivity gains, and modest increases in real output and employment. In the high-trend version I, the economy is buoyed by higher labor force growth, much lower unemployment rates, higher production, and greater improvements in prices and productivity. The high-trend version II is characterized by the high GNP growth of high trend I, but assumes the same labor force as the low trend. Productivity gains are quite substantial in this alternative. On chart 8, level A is the low trend, level B is high trend I, and level C is high trend II. Greater detail on assumptions is available in the August 1981 issue of the *Monthly Labor Review*.

Chart 8. Employment in laundry, cleaning, and garment services, 1960-82 and projections for 1982-90



¹ Least squares trends method for historical data; compound interest method for projections.
² See footnote 8 in text.
³ Data for nonsupervisory employees not available prior to 1964.

SOURCE: Bureau of Labor Statistics.

nized, operators of washing machines and other production equipment increasingly are removed from direct involvement with machine operation. More time will be spent in loading and unloading clothes before and after processing, and monitoring equipment performance. Basic laundry and drycleaning skills will continue to be acquired on the job in a relatively short time—under a week for many positions. However, training can be longer for skilled occupations such as spotters, who must learn the characteristics of new types of fabrics and chemicals available to clean them.

Slightly over one-third of plant workers in the laundry and drycleaning industry are employed in establishments covered by collective bargaining agreements.[9] This proportion was reported to be higher than the average for all service industries. Major unions in the industry include the Laundry and Drycleaning International Union (AFL-CIO), the Amalgamated Clothing and Textile Workers Union (AFL-CIO), and the Textile Processors, Service Trades, Health Care, Professional and Technical Employees International Union.

[9] *Industry Wage Survey: Laundry and Cleaning Services, April 1967 and April 1968,* Bulletin 1645 (Bureau of Labor Statistics, 1969).

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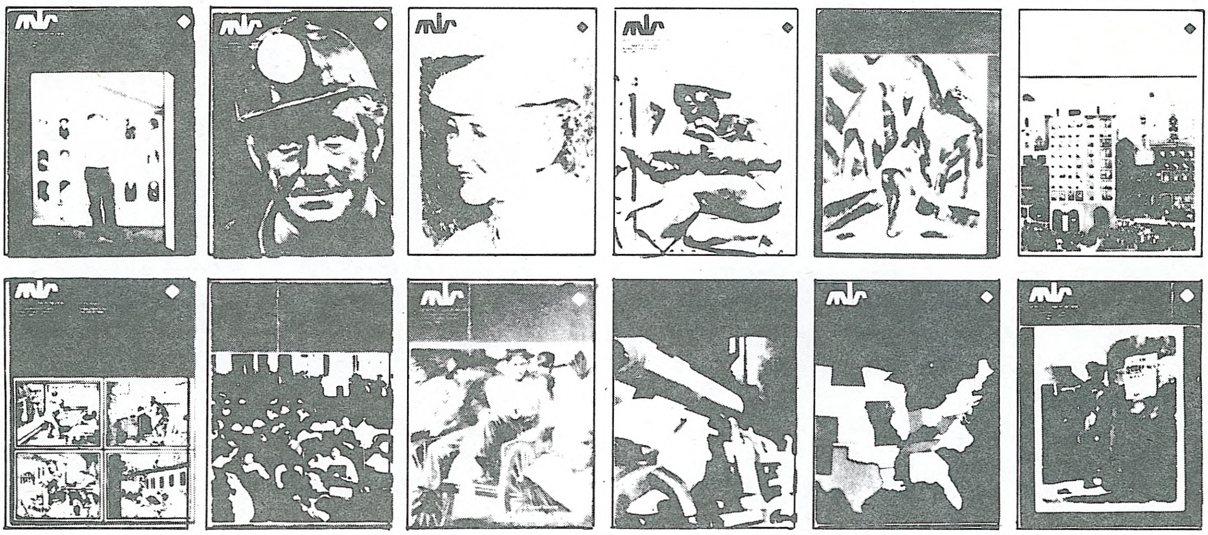

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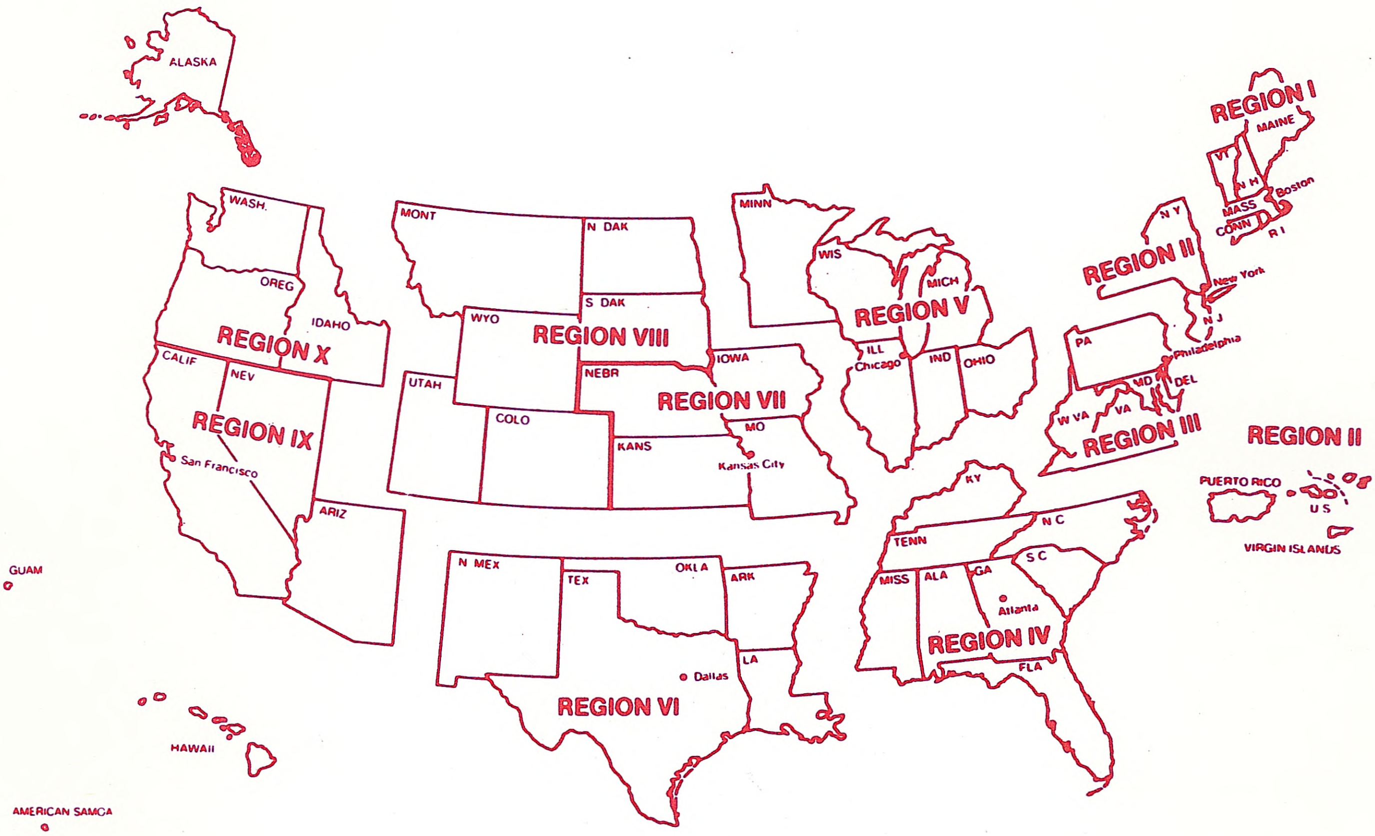

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