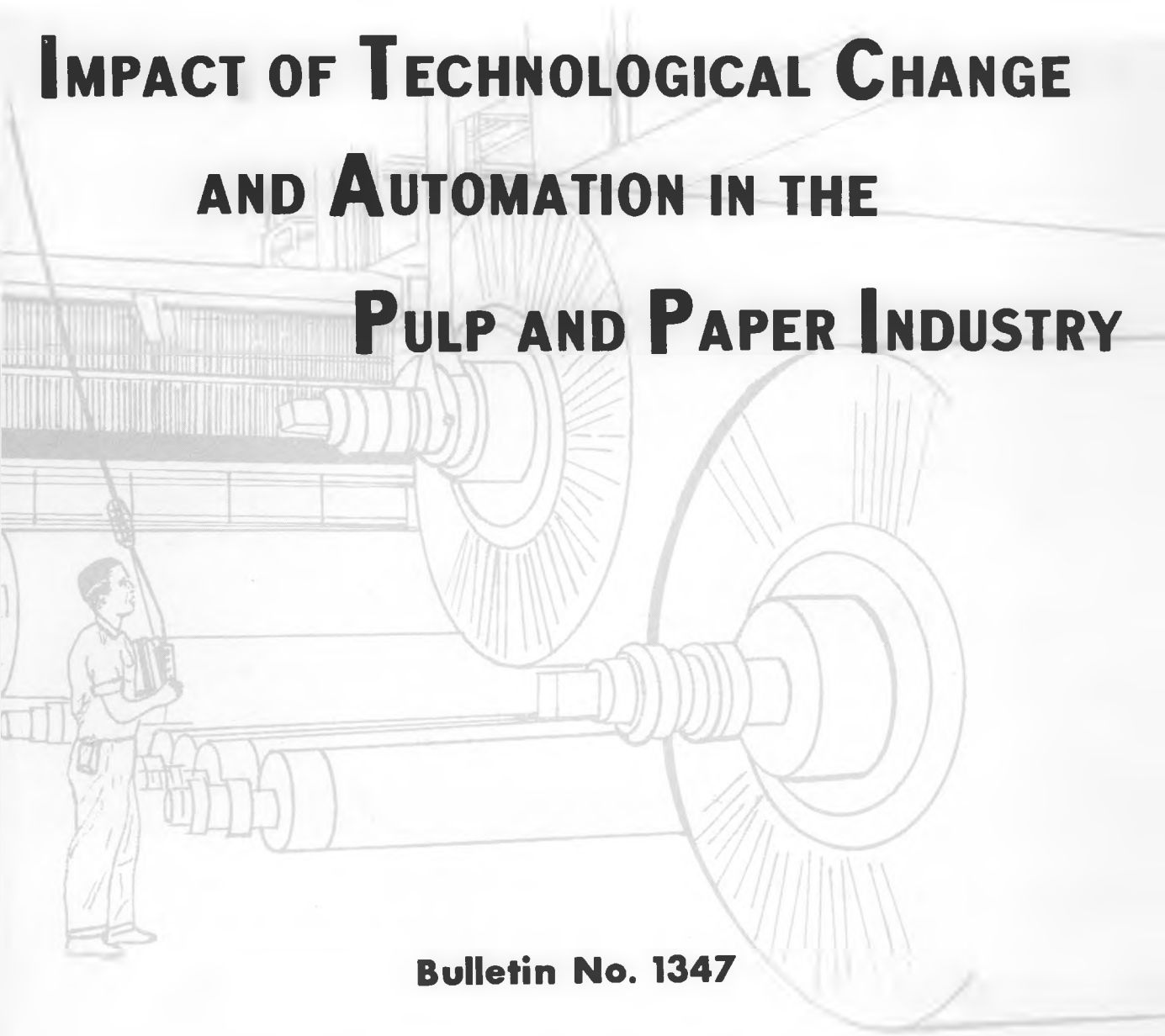
Impact of Technological Change and Automation in the Pulp and Paper Industry



Bulletin No. 1347

UNITED STATES DEPARTMENT OF LABOR
W. Willard Wirtz, Secretary

BUREAU OF LABOR STATISTICS
Ewan Clague, Commissioner

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IMPACT OF TECHNOLOGICAL CHANGE AND AUTOMATION IN THE PULP AND PAPER INDUSTRY

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Preface

The benefits and problems of automation and other technological changes have been described as one of the most urgent issues before the Nation. New equipment, processes, and products may open opportunities for investments, jobs, lower costs and prices, improved living standards, greater leisure, and a stronger national defense. On the other hand, technological advances may involve displacement of workers, requiring special measures to prevent layoffs and to retrain workers for new skills.

This study examines some implications for automation and other technological advances in the pulp and paper industry, a major industry undergoing extensive change. Historically, technological changes in the industry have been accompanied by expanded output and increased employment. Industry experts foresee further changes, with opportunities for growth and with new problems of adjustment.

The study is part of the Bureau of Labor Statistics program on the progress, outlook, and implications of technological change. Previous studies were generally confined to case studies of individual plants and offices. This bulletin presents a summary analysis of trends and outlook for the industry as a whole, in addition to illustrative case studies of adjustments to technological changes at three plants.

The study is based on published data from the Bureau of Labor Statistics, the Bureau of the Census, trade and technical publications, and information collected by the BLS directly from three plants through field visits. The generous cooperation of the officials of the companies, unions, and trade associations visited is deeply appreciated.

This bulletin was prepared in the Bureau's Division of Productivity and Technological Developments, by Edgar Weinberg, Chief, Branch of Analysis and Technological Studies, and Richard Riche. Bennett Moss participated in the detailed case studies.

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IMPACT OF TECHNOLOGICAL CHANGE AND AUTOMATION IN THE PULP AND PAPER INDUSTRY

Introduction

This survey covers the nature, status, and outlook of some important technological innovations and some implications for trends in productivity, production, employment, occupational requirements, and industrial relations practices in the pulp and paper industry. Part I covers the industry as a whole and is based on previously published data, the statistics covering mainly 1947-60. Part II presents case studies of adjustment to specific technological changes at three selected plants, based on data collected through field visits and interviews.

Industry Characteristics

In the text of this study, the term "pulp and paper" is used instead of the full title, "pulp, paper, paperboard, and building paper and building board." This term encompasses the 4 Standard Industrial Classification 1/ industries: pulp mills (SIC 261), which primarily manufacture various types of pulp from pulp wood and other cellulose fibers; paper mills, except building (SIC 262), which primarily produce various grades of paper, such as newsprint, book, fine, and sanitary tissue; paperboard mills (SIC 263), which primarily make various types of container board; and building paper and building board mills (SIC 266), which primarily produce different types of insulating board, construction paper and fiber boards. Some of the larger plants integrate the production of pulp, paper, and paperboard. In the appendix tables, the term, "pulp, paper, and board" has the same coverage.

The pulp and paper industry group excludes establishments (SIC 264-265) primarily engaged in converting paper and paperboard into finished products such as bags, boxes, and other containers. Although such plants are sometimes under the same ownership and at the same location as plants in the pulp and paper industry, they are classified in the paper products industry.

About 294,000 persons (BLS data) were employed in the industry in 1960. 1/ In 1958 there was a total of 802 pulp and paper establishments.

1/ U.S. Bureau of the Budget. Standard Industrial Classification Manual--1957 (Washington, U.S. Government Printing Office, 1957), pp. 70, 72. The employment figure for 1960 differs from earlier BLS employment data (275,300) because of recent comprehensive revisions in BLS employment and earnings statistics. These changes reflect such factors as introducing the 1957 Standard Industrial Classification, adjustment of data to new benchmarks, development of improved techniques, availability of more extensive basic data, and inclusion of Alaska and Hawaii. Except for the employment figure cited above (294,000 workers) and data on overtime hours (5.1), all other BLS data on employment and earnings in the pulp and paper industry used in this Bulletin are from an earlier series. Revised data for this industry are not available for years prior to 1958, and are not comparable with previously published data for 1958-60.

Plants are located in about 500 communities, in more than 40 States. More than 90 percent of the industry's production workers are covered by union agreements, the majority with the United Papermakers and Paperworkers and the International Brotherhood of Pulp, Sulphite and Paper Mill Workers.

The industry produces a wide variety of products, for both industrial and household uses. Most of the pulp produced by pulp mills is used by paper and paperboard mills; some pulp, however, is sold to producers of rayon, plastics, cellophane and related materials based on cellulose. Of the total tonnage of paper and paperboard produced, about one-half is used for packaging; nearly one-fourth for books, magazines and newspapers; about one-tenth for writing papers; about one-tenth for building; and about one-twentieth for sanitary purposes. Exports amounted to about 3 percent of total production in 1960.

Some Qualifications

In assessing the findings of this bulletin, it is helpful to keep in mind some difficulties of studying the implications of technological change. Emphasis is on the adjustments to changes made by plants within the pulp and paper industry. The data pertain primarily to the labor aspects of such adjustments.

Industries, however, are interdependent. Technical changes in papermaking, for example, result not only in savings of wood pulp, but also chemicals, power, water, and other materials and services purchased from other industries. The implications for employment in the supplying industries, as a result of such changes, are not readily determined through available statistics.

Moreover, the development of improved equipment, processes, and products increases the rate of technical obsolescence and affects the volume of investment in new plants and equipment. The volume of employment generated by purchases of new papermaking plants and equipment, however, is not readily estimated.

Finally, new, improved, and less costly pulp and paper products have an impact on competitive markets such as those for textiles, steel, and wood, and hence on employment in these industries. These effects also are difficult to isolate from the complex of competitive factors.

In short, not all implications of technological change in the pulp and paper industry can be covered in this study. A more complete description of the ramifications of such changes depends on the assembling of additional data on interindustry relationships and the interpretation of information on industries related to papermaking.

Highlights and Summary

Trends and Outlook

Trend Toward Automatic Production. The post-World War II period has been one of significant technological changes in many phases of pulp and paper manufacturing with important implications for employment and working conditions. Mechanized handling of pulpwood and paper rolls, continuous pulp processing, greater instrumentation, and semichemical pulp processing, reduce unit requirements for labor, capital, materials and fuel. The 1960's will probably see wider application of these innovations. The plant of the future will probably use more electronic equipment such as industrial television, radioisotope gages, and electronic computers to improve control of operations. Some industry experts see a new era of far-reaching changes, affecting producers of competitive materials as well as the industry, as more funds are channeled into research to improve processes and develop new and better products.

Increased Output per Man-Hour. Output per production worker man-hour in the pulp and paper industry increased at an average annual rate of 3.7 percent a year during the 1947-60 period. This rate was over 50 percent above the long-term trend (1919-60) after two decades of slow growth during the Depression and World War II. Technological advances will probably mean continued growth in the 1960's in output per man-hour at a rate above the long-term average. More emphasis will probably be placed on modernization and efforts to improve the efficiency of existing plants rather than on capacity expansion.

Production Growth. Physical output increased at an average annual rate of 4.5 percent during the 1947-60 period, only slightly above the long-term growth rate. The postwar advance in production exceeded the growth rate of output per production worker man-hour only by a small margin. Output is expected to rise over the next few years but at a slower annual rate than during the 1947-60 period. The 1960's may see output per man-hour rise at the same or a slightly faster rate than production.

Employment Implications. Employment in the pulp and paper industry increased by 41,300 between 1947 and 1960. The rate of increase was faster than that in manufacturing employment as a whole. Production worker employment during this period, however, rose relatively more slowly than administrative, professional, technical, and clerical employment, and between 1956 and 1960, declined.

The outlook for a significant increase in the level of employment over the next few years appears limited. Mechanization of materials handling operations and extension of continuous processing reduce the opportunities for semiskilled and unskilled workers. Administrative, technical, clerical, and supervisory employees, on the other hand, constitute a growing proportion of employment.

A slower growth of employment in the 1960's than in the 1950's may result in less flexibility in adjusting the work force of the industry to changing technology. Also, in communities where pulp and paper plants are located, this industry may not be as important a source of job opportunities for the expanding labor force of the 1960's as it was in the 1950's.

Adjustments in Three Selected Plants

The potentialities and problems of introducing some important technological changes that will probably be more widely used in the 1960's are illustrated by the experience of three plants: one had installed advanced materials handling equipment in woodroom operations; another, continuous pulping; and the third, automatic devices for paper roll handling. Although the study is limited to three plants, these case studies provide illustrative information on some types of labor problems that may be encountered in the future.

Introduction of Changes. Each innovation was part of a sequence of changes whereby capacity of the entire mill was enlarged. This expansion provided occasions for management to consider adoption of advanced technology that would reduce costs of labor, materials, fuel, and capital per unit of output. Improvements in the efficiency of one operation required improvements in others to achieve a balanced growth throughout the plant.

Increased Output per Man-Hour. The technological changes resulted in substantial increases in output per man-hour in particular operations. Because of initial operating difficulties, however, these gains were not always realized immediately. For each plant as a whole, the increase in output per man-hour was significantly less than in the particular operation mechanized. The rise in output per man-hour was accompanied by a sharp increase in the ratio of plant and equipment and of horsepower to worker. Changes in capital per unit of output varied; in one case, the ratio increased slightly; in another, the innovation produced a saving in capital.

Displacement and Reassignment. The immediate result of the changes studied in two of the three plants was the elimination of certain jobs and the reassignment of workers to other positions in the plant according to seniority procedures. The extent to which this caused serious dislocations of workers varied from plant to plant. Where the change involved only a moderate expansion of capacity and little increase in plant employment, reassignment of

workers to avoid layoffs required extensive advance planning, including supplementing normal attrition by encouraging retirement of eligible employees, opening up apprenticeship for an older worker, and hiring employees on a temporary basis. Where the change accompanied a substantial increase in capacity, displaced workers were absorbed by the need for additional workers, and reassignments were made with little dislocation.

Upgrading and Downgrading. The extent of upgrading and downgrading created by the change depended largely on special circumstances and the coverage and size of the seniority unit. Where additional employees were needed to handle a much greater output, former crews were promoted to better jobs. Severe downgrading occurred at one plant, however, where employees in an entire seniority line were "bumped-back" temporarily to the extra board (a central labor pool) at substantial reductions in wages. Because of the narrowness of the seniority unit, however, some employees with less seniority who were working in the line of progression where new jobs were created were promoted to better jobs.

Occupational Changes. Only a slight increase occurred in the average grade level of production workers in the plants studied by the case approach. The introduction of more conveyorization and continuous processing, however, produced a significant reduction in the proportion of laborers who moved materials or manipulated machinery by hand. The new jobs required workers to oversee a wider expanse of work flow, relate one processing step to another, and regulate operations by pushbutton control. Greater automation also increased the need for instrument repairmen. Despite the increase in automatic operations, however, some manual operations still remained. In the plant as a whole, the general trend in recent years has been toward an increasing proportion of administrative, technical, professional, and office workers. More formal education is now required for those entering the technical and engineering occupations.

Training and Retraining. Workers assigned to the newly created positions were retrained at company expense so that they could operate the new equipment. This training was given by company personnel and by representatives from the equipment supplier. Where the change involved mechanization of a materials handling operation, training was brief and was provided on the job. The introduction of a new continuous processing system required more elaborate training, lectures, classroom instruction, and training manuals in order to give the worker an understanding of the sequences of the steps that he was monitoring. Workers transferring to existing jobs within affected departments or elsewhere within the plant received little formal retraining, since they were generally able to acquire job proficiency on the job. At one plant, however, some displaced maintenance employees were assigned to a formal training program to upgrade maintenance skills.

Implications for Safety and Working Conditions. The technological changes appeared to offer significant opportunities for making the work environment safer. For example, some workers monitor instruments from an enclosed air-conditioned control room. Departments installing modern materials handling equipment reported a decline in incidence of certain handling injuries and strains. This evolved from a reduction in manual tasks and the removal of certain hazards associated with older equipment. At one plant, however, the frequency of injuries was higher until workers adjusted to new equipment and procedures. Moreover, more powerful moving conveyors and high-speed equipment constituted new hazards for severe injuries.

Older Worker and Changes. Employees age 45 and over generally benefited in the three plants from the reduction in heavy physical labor. They had no special difficulties in performing new tasks although the initial adjustment sometimes required a little time. The seniority system in general protected the older worker in transfer and reassignment, but the extent of protection in a particular case depended on the nature of the change and the definition of the unit for purposes of computing seniority. Some older workers encountered substantial downgrading in pay where the unit was defined narrowly.

Establishment of Wage Rates. An important phase of installing the new technology was establishing wage rates for new jobs. The union agreements generally contained a special provision for initiating rate changes. One mill used this period to make a systematic job analysis. Rates were generally negotiated on a tentative basis, and later revised on the basis of actual operating experiences. Another method was to set wage rates for the new jobs comparable with similar jobs in other mills.

Part I. Trends and Outlook for the Pulp and Paper Industry

Development of the Pulp and Paper Industry

Workers employed in pulp and paper mills are primarily engaged in operating, controlling, and maintaining large complexes of mechanical and chemical processing equipment. A modern integrated newsprint mill (600-ton daily capacity) costs over $72 million to construct. The buildings are sometimes spread out over several acres. According to Census data, investment per employee (i.e., gross value of depreciable assets) amounted to $22.6 thousand in 1957, or more than three times the investment per employee in all manufacturing.

Paper is made by first converting wood into pulp (a moist semisolid mass of vegetable matter) and processing this material into paper of a wide variety of types and grades. Except for some steps at the beginning and end of the production sequence, materials are moved from step to step in a semifluid state or as a continuous sheet by pumps, pipes, and moving conveyors, with little direct intervention by workers. Sheets are made from pulp on high-speed papermaking machines, some as large as three stories high and a block long, where the pulp is deposited continuously on the rapidly moving wire mesh screen to form a smooth wet sheet. This sheet is dried as it moves over a series of large drums at speeds up to 2,600 feet per minute.

This highly mechanized technology is the culmination of many decades of invention and research by scientists and inventors from many countries. Advances in the search for a more abundant raw material, for improvements in equipment and processes, and for the diversification of products were closely interrelated. The development of papermaking up to the end of World War II can be divided into two stages: the industrial revolution and the era of mass production in the 20th century. The era of automation and research since 1947 is discussed in later chapters.

Industrial Revolution

The industrial revolution in the 19th century in the paper industry was marked by five major developments: Substitution of mechanical power for hand labor; discovery of more abundant raw material; development of chemical pulping processes; development of special machinery; and a massive reduction in unit labor requirements.

Mechanical Power for Hand Labor. The first steps toward replacing hand labor by mechanical effort were the adoption first of the water wheel and later steam as sources of power for beating rags into pulp. These methods replaced extensive series of separate, time-consuming hand washing, beating, and pressing operations performed by small groups of workers.

Broadening of Raw Material Supply. With the market for paper expanding, an intensive search was initiated for new sources of cheap and abundant raw materials to replace rags which were becoming relatively scarce in relation to demand. An important step toward mass production occurred in 1844 when Friedrich Keller, a German, patented a practical mechanical method of obtaining fibers from wood, an abundant raw material hitherto unutilized. This discovery established a basis for further expansion.

Chemical Pulping Processes. The three basic chemical pulping methods (soda, sulphite, and sulphate) now in use, were developed in the second half of the 19th century by English, American, and German scientists. In all chemical pulping methods, the first step is the reduction of pulpwood logs to small chips. These chips are then cooked in a large, cylindrical steel tank called a "digester" where chemicals, steam, and pressure combine to remove lignin and other waste materials, leaving a residue of nearly pure cellulose. The search for more efficient methods of obtaining pulp on a mass scale was pursued at the same time that revolutionary changes in printing were expanding the mass market for paper.

Special Machinery. Along with the development of pulp making technology, important steps in mechanizing papermaking itself were taking place. The introduction of the Fourdrinier papermaking machine proved to be a revolutionary contribution to mass production of paper. Continuous papermaking on this machine contrasted sharply with early manufacturing methods which involved a sequence of hand dipping and pressing operations. Sheets of paper were made one at a time. By 1850, nearly every papermill in this country was using Fourdrinier machines, which were developed in England in 1803 by the Fourdrinier brothers. This machine consisted essentially of a rapidly moving wire screen on which pulp was formed into a sheet and carried to a press for drying. Improvements were made so that manual handling of sheets was virtually eliminated.

Reduction in Unit Labor Requirements. The Industrial Revolution brought about a massive reduction in labor requirements per unit of output. Although there are no overall measures of this shift from hand to machine labor, the comments of Carroll D. Wright, the first Commissioner of Labor, are enlightening:

> It is very difficult to get at the exact displacement of labor in the manufacture of paper, but a machine now used for drying and cutting, run by 4 men and 6 girls, will do the work formerly done by 100 persons, and do it very much better. . . . Six men can now produce as much per day on a given sample as 100 men could produce in 1800 of an approximate grade. A well-known firm in New Hampshire states that by the aid of machinery it produces three times the quantity, with the same number of employees,

that it did 20 years ago. In the manufacture of wallpaper the best evidence puts the displacement in the proportion of 100 to 1. 2/

Era of Mass Production

The first half of the 20th century may be described as an era of mass production in the pulp and paper industry. Output and employment were substantially increased as greater literacy, improved health and living standards, and a larger population expanded the demand for paper products. Major changes during this period encompassed more powerful and larger capacity machinery, broadening of the sources of raw materials, and changes in the industry's organization and structure.

More Powerful and Larger Capacity Equipment. A key factor which enabled the industry to supply the mass demand for paper was the development of more powerful and larger capacity equipment without a significant increase in number of operators required. One overall indicator of this trend was the tripling of horsepower per production worker between 1919 and 1954. 3/

An example of this trend was the fivefold increase in the horsepower of chippers. By the 1950's, chippers were being used to reduce logs to chips for chemical pulping without first sawing them into pieces. Much larger chipper discs, the large revolving face plate which holds the cutting knives, were used. These large chippers were often used with hydraulic barkers, which strip the bark off trees mechanically.

Another example of the trend was the introduction of larger and more powerful grinders to produce mechanical pulp (groundwood). Until the introduction of the artificial grinding stone in the middle twenties, the most powerful grinder was rated at about 2,400 horsepower; modern grinders are rated as high as 5,000 horsepower. The artificial stone allowed higher operating pressures of wood against the stone, and increased machine speeds. 4/

Although the basic process remained unchanged, significant design improvements in Fourdrinier papermaking machines were made after World War I. The sectionalized machine drive, involving a separate motor drive for each

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2/ Industrial Depressions. The First Annual Report of the Commissioner of Labor. March 1886. U.S. Department of the Interior, Bureau of Labor. (Washington, U.S. Government Printing Office, 1886), p. 85.

3/ Derived from Census of Manufactures data.

4/ George S. Witham, Modern Pulp and Papermaking, 3d ed. Revised and edited by John B. Calkin (New York, Reinhold Publishing Corp., 1957), pp. 202-203.

section of the paper machine, made possible substantially higher machine speeds. As a result, average capacity of Fourdrinier machines more than tripled between 1919 and 1947. 5/

Shifts in Sources of Raw Materials. One key change in papermaking was the improvement and spread of the sulphate pulping process which made possible the use of southern longleaf pine. Plants and jobs were expanded in Southern States. By 1939, sulphate pulp accounted for 42 percent of all pulp produced.

Research by the U.S. Department of Agriculture's Forest Products Laboratory and by Dr. Charles H. Herty, a noted chemist, contributed to this growth. Another key step was the discovery by American chemists, building on the work of European scientists, of ways of eliminating objectionable chemical odors in this process.

Changes in the Industry's Organization and Structure. Important changes in the organization and structure of pulp and paper companies accompanied the introduction of mass production. Some of the largest corporations manufacturing paper today were founded during the era of growth between 1890 and 1920.

The beginning of the 20th century also saw the growth in unionism. Although skilled workers had been organized prior to this period, the turn of the century marked the beginning of the organization of the bulk of the industry's workers. The extension of unionism throughout the industry continued during the 1930's.

Formal organizations were started to carry out research into the chemistry and other aspects of papermaking. The Technical Association of the Pulp and Paper Industry (TAPPI), established in 1915, and the Institute of Paper Chemistry, established in 1929, conducted research that led to improvements in the quality and diversity of paper. Scientific methods began to supplant the craftsmanship of papermakers of the 19th century.

5/ Derived from Census of Manufactures data.

Post-World War II Trends in Output per Man-Hour, Production, Employment, Hours and Earnings, and Labor Turnover

Statistical trends on output per man-hour, production, and employment afford a basis for gaging overall effects of post World War II technological changes. This chapter therefore reviews trends since 1947 in relation to long-term trends in the industry. Trends in technology and the outlook for the 1960's are discussed in the following chapters.

Increasing Output Per Man-Hour

A partial, though useful, indicator of the pace of technological change is the rise in output per man-hour. A rise in this ratio reflects not only technical improvements, but also such factors as shifts of production from low to high productivity plants, the exit of less efficient firms, and changes in capacity utilization, technology, capital investment per worker, layout and flow of material, skill of the work force, efficiency of management, and labor-management relations. Although output is related to the input of labor, the ratio does not measure the specific contribution of labor, capital, or any other factor to production.

Output per production worker man-hour increased by 66 percent between 1947 and 1960. The increase in output per production worker was somewhat less, 59 percent. Output per employee increased by 48 percent, reflecting the growing proportion of nonproduction workers in the industry. (See chart 1 and table A-4.) Output per all employee man-hour increased by 56 percent.

The average annual rate of increase in output per production worker man-hour for the 1947-60 period--3.7 percent per year--was substantially higher than the 2.4-percent rate for the long-term period, 1919-60. (See table 1.) This rate of increase during the 1947-60 period was only slightly above the rate of 3.5 percent for all manufacturing industries during the same period.

Table 1. Average annual percent change in output per production worker man-hour, selected periods, 1919-60

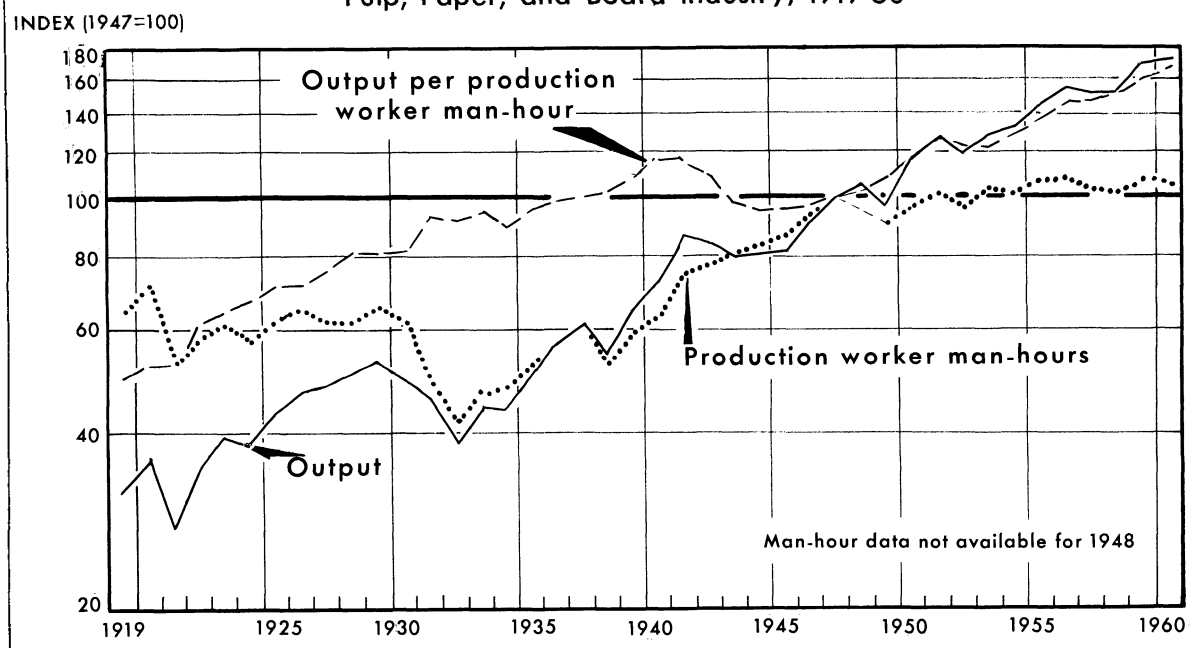
Period	Average annual percent change 1/
Long-term rate, 1919-60	2.4
Post-World War I decade, 1919-29	5.5
Depression decade, 1929-39	2.6
World War II period, 1939-47	-2.2
Post-World War II period, 1947-60	3.7

1/ Average annual rates are based on the least squares trend of the logarithms of the index numbers.

It is noteworthy that the rate of increase in the post-World War II period was below the 1919-29 rate when output per production worker man-hour rose 5.5 percent a year. This was a period of intensive mechanization and modernization of plant and equipment. During the depression decade of the 1930's, output per man-hour continued to increase but at a lower rate. Shortages of equipment and of skilled labor and management underlie the World War II decline.

Except for 1952, output per production worker man-hour increased in every year since 1947. In 1950, 1955, and 1959, following recession periods, the increases were substantially above the average for the entire period. In 1953 and 1957, however, the increases were substantially below average.

Chart 1. Indexes of Output, Man-Hours, and Output Per Man-Hour, Pulp, Paper, and Board Industry, 1919-60



Production Trends

Production of pulp and paper (BLS weighted index) increased by 73 percent between 1947 and 1960. The rate of increase for the post-World War II period--4.5 percent a year--was only slightly above the long-term (1919-60) average rate of 4.3 percent. Moreover, the postwar rate of production growth was only slightly higher than the rate of increase in output per production worker man-hour. Over the entire 1919-60 period, however, production expanded at a rate almost twice that of output per man-hour.

The industry's output growth rate was slightly higher than the growth rate of total industrial output. The postwar rate of increase--4.5 percent--compares with the annual growth rate of 4.1 percent shown by the Federal Reserve Board index of total industrial output. Long-term rates for the 1919-60 period show a similar relationship, 4.3 percent a year compared with 4.1 percent for industrial production.

Growth of output over the post-World War II period, however, was uneven. In the 1949 recession output declined, then recovered sharply; in 1952, during the Korean war, output again declined. Following a 3-year period of substantial growth ending in 1956, production declined in 1957. The recovery in 1959 was sharp, with output exceeding the 1956 peak. Preliminary data indicate that expansion continued in 1960. (See table A-3.)

Output varied considerably, by type of paper and board. Between 1947 and 1960, the output of special food board, such as used in frozen food packages, containers, and cups, more than tripled, and newsprint and sanitary and tissue papers more than doubled. (See table 2.)

Table 2. Production of paper and board, and percent increases by grade, 1947 and 1960

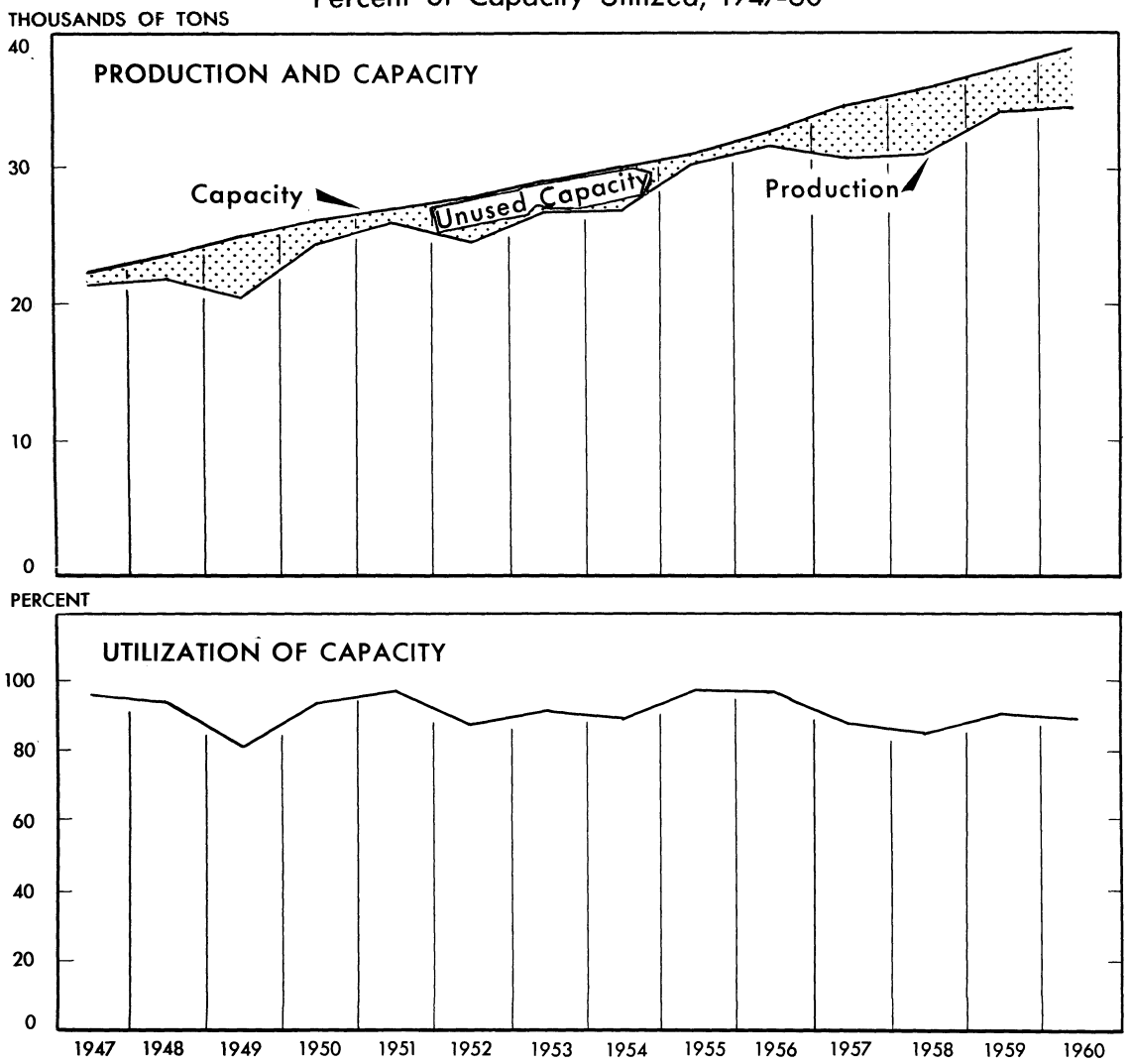
Grade	Production 1/ (in thousands of tons)		Percent increase
	1947	1960	
Newsprint	833	2,004	140.6
Printing paper	3,029	4,668	54.1
Fine papers	1,172	1,771	51.1
Coarse and special industrial papers	3,293	4,753	44.3
Sanitary and tissue papers	1,089	2,217	103.6
Container board	4,944	8,649	74.9
Bending board (except special food board)	2,298	2,905	26.4
Special food board	460	1,478	221.3
Nonbending and other paperboard	1,635	2,804	71.5
Construction paper	1,289	1,422	10.3
Construction board	1,072	1,789	66.9

1/ Unweighted aggregate tonnage. An output index for this industry based on these data would differ from the output indexes shown in tables A-3 and A-4 which include pulp, and are based on weighted averages for 24 product classes.

Source: U.S. Department of Commerce, Bureau of the Census.

Postwar gains in production, however, did not keep pace with expansion in capacity. Between 1957 and 1960, rate of capacity utilization in paper and board mills (according to American Paper and Pulp Association data) averaged only 88 percent; well below the rate of nearly 100 percent preferred by the industry, and the actual operating rates of over 96 percent during 1955 and 1956. (See chart 2 and table A-2.) A high rate of capacity utilization is considered desirable by the industry because of substantial fixed costs.

Chart 2. Production and Capacity of Paper and Board and Percent of Capacity Utilized, 1947-60

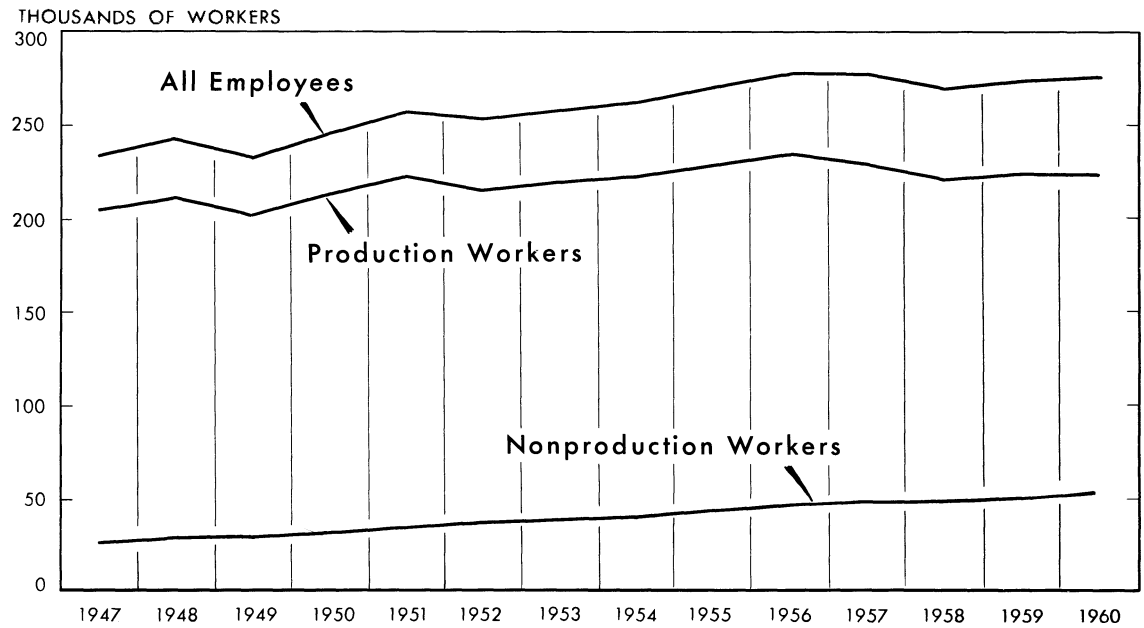


Source: Capacity, American Paper and Pulp Association Production, U.S. Department of Commerce, Bureau of the Census.

Employment, Hours, and Earnings

Although output in the pulp and paper industry increased by 73 percent between 1947 and 1960, production worker employment rose by only 8 percent. Nonproduction workers (i.e., administrative, professional, technical, and clerical) increased by 93 percent so that the total number of employees rose by 18 percent (from 234,000 in 1947 to 275,300 in 1960). In 1960, nonproduction workers constituted 19 percent of all employees; in 1947, they comprised only 12 percent. (See chart 3 and table A-5.) The employment increase in the pulp and paper industry was significantly greater than the rise in employment in all manufacturing industries between 1947 and 1960.

Chart 3. Employment in the Pulp, Paper, and Board Industry, 1947-60



Following a peak in 1956, the number of all employees declined by 2,700. The decline in production worker employment between 1956 and 1960 amounted to 7,500, while nonproduction workers increased 4,800, from 47,600 to 52,400.

The decline in production worker employment reflected the slow rate of increase in output relative to that of output per man-hour. Output per production worker man-hour increased at a rate of 3.5 percent a year (compounded) while total output increased somewhat less (2.7 percent). Production worker employment declined by 0.8 percent per year.

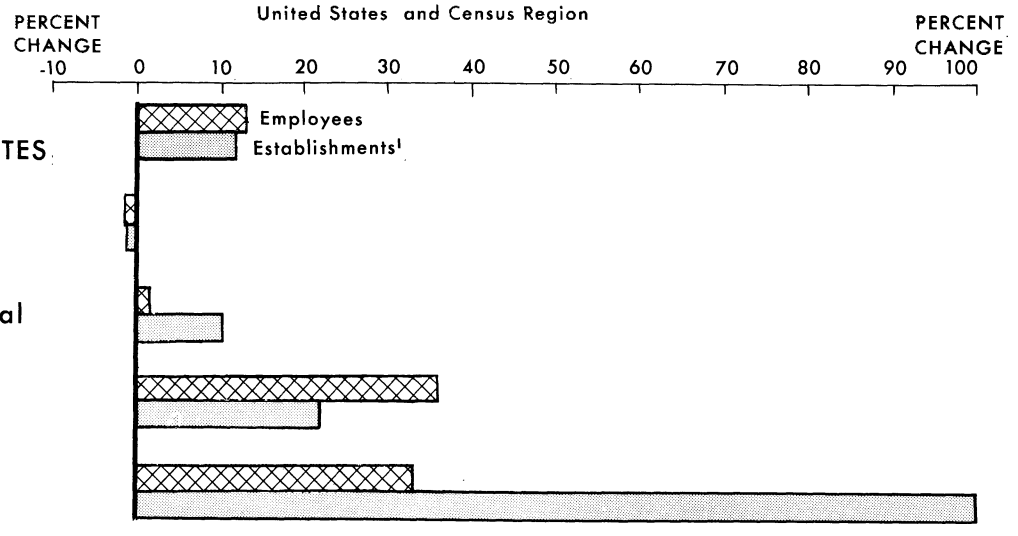
Average weekly hours for production workers in the industry varied only slightly between 1947 and 1960, declining from 44.2 to 43.4 hours. (See table A-6.) Compared with average weekly hours in manufacturing (39.7 in 1960), the average in the pulp and paper industry is relatively high. Production workers in pulp and paper averaged 5.1 hours overtime per week in 1960, compared with 2.4 overtime hours for production workers in manufacturing.

Compared with manufacturing earnings, the average hourly earnings of production workers in pulp and paper increased at a greater rate between 1947 and 1960. Production workers in both industries averaged about $1.22 per hour in 1947, but by 1960, the average hourly rate in pulp and paper had reached $2.42, compared with $2.26 in manufacturing. Average weekly earnings of production workers in pulp and paper were also well above manufacturing in 1960 ($105.03 compared to $89.72) because of the longer workweek and the higher hourly rate. These data exclude gains in certain supplementary benefits such as pensions and related benefits. (See table A-6.)

Shifts in Location of Jobs

One of the most significant employment developments (based on Census data) between 1947 and 1958 was the shift in the regional distribution of jobs. The Northeast and North Central regions lost in proportion of workers: total employment in the Northeast declined, and the increase in employment in the North Central region was below the United States average. In contrast, the South and West experienced sharp gains in employment; both regions had approximately one-third more employees in 1958 than they had in 1947. (See chart 4 and table A-7.) The South in 1958 was the dominant region, with more than one-third of the total employment in the industry.

Chart 4. Percent Changes in the Distribution of Employees and Establishments
Pulp, Paper, and Board Industry, 1947 to 58



[1]Excludes pulp mills because data are not strictly comparable.
Source: U.S. Department of Commerce, Bureau of the Census.

The expansion of jobs in the South and West accompanied a significant increase in the number of paper and board establishments in these regions. Although the total number of establishments grew by only 12 percent between 1947 and 1958, the number in the South increased by 22 percent, and the number in the West doubled. In the North Central region, however, the net increase was slightly below the industry average, and in the Northeast, the number of plants declined by 1 percent. (See chart 4 and table A-8.)

Shifts in the location of plants relative to available raw materials have long characterized the industry. Until wood was substituted for rags and straw in the manufacture of pulp, the industry was concentrated in the populous States of New York and Pennsylvania. After the 1880's the industry shifted toward its new sources of raw materials, first, near the forests of the Northeast and then into the North Central States. Rapid expansion into the West began early in the 20th century, and into the South, in the middle twenties, with the discovery of new processes which made it economically feasible to manufacture pulp from southern pine, hemlock, Douglas fir, and other species found in these regions.

Labor Turnover

The specific impact of technological change on labor turnover trends cannot be readily isolated from various economic factors affecting the labor market. Changes in hiring and layoff rates reflect the expansion and contraction of business activity and the opening and closing of plants because of competitive or other conditions as well as the effect of laborsaving innovations. It should be recognized that workers whose jobs are abolished because of technological change possibly may not be laid off until periods of recession. Moreover, workers laid off during business declines may not be rehired during recovery because of laborsaving changes introduced in the interim. Finally, when opportunities are lacking generally, fewer workers quit their jobs and plants which have installed laborsaving machinery may not be able to reduce employment by means of attrition to the extent possible when jobs are generally abundant.

The changing demand for labor in the pulp and paper industry is reflected in the sharp reduction in hiring rates and the rise in layoffs since 1949. The total accession rate was reduced from an average of 23 employees per 1,000 in 1949-51, to 16 per 1,000 in 1958-60. The number of new hires declined substantially. The layoff rate rose from an average of 6 employees per 1,000 in 1949-51, to 7 employees per 1,000 in 1958-60. The quit rate declined from an average of 13 employees per 1,000 to 7 per 1,000 during the same period. **(See table A-9.)**

Trends in Technology and Research

Technological developments in the 1950's marked the beginning of automation as well as the continuation of earlier developments. Along with changes in technology came a substantial increase in expenditures for research. According to one expert, "It is no exaggeration to state that in the past 5 years we have progressed as far as in the previous 20 years. . . ." 6/

Relatively large postwar expenditures for new plant and equipment provided mills with opportunities to install these latest improvements in papermaking technology. Between 1947 and 1960, close to $5 billion was spent for new machinery and equipment and for new structures and additions to plant. Consequently, between 1947 and 1960, paper and paperboard capacity increased by 76 percent. (See tables A-1 and A-2.)

Looking to the future, one expert concluded: "The paper industry is in the midst of a period of growth and evolution from which it may emerge quite changed from its traditional character." 7/ Technological changes in this era of automation are described under four major headings: trend toward continuous automatic production; development of improved measurement, inspection, and control devices; development of new sources of raw materials; and growth of research and development.

Trend Toward Continuous Automatic Production

A significant postwar trend has been the linking together of separate production steps and the elimination of labor involved in direct production. This trend is particularly important in wood handling, pulping, and shipping operations.

Materials Handling. One of the most important steps toward continuous automatic production involves the mechanization of materials handling. These changes encompass improving and expanding conveyor systems, merging separate conveyor lines into unified systems, and centralizing control units so that materials move from step to step with a minimum of labor.

Woodyard operations offer particularly challenging materials handling problems. Unloading pulpwood in the woodyard from railroad cars, trucks, or barges, and transporting it to storage prior to barking and chipping,

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6/ Lee Eberhardt. "Economic Impact of New Processes on the Pulp and Paper Industry," The Paper Industry (Fritz Publications, Inc., Chicago), March 1958, p. 982.

7/ McGraw-Hill Encyclopedia of Science and Technology, Vol. 9 (New York, McGraw-Hill Book Co., 1960), p. 541.

require extensive manual effort. Some pulpmills have developed unique side-dumping rail cars and other mobile devices which either rake or shove pulpwood off cars and into conveyors or flumes. These changes greatly reduce the need for manual labor.

A few mills have installed automatic paper roll handling systems in their shipping departments. These systems utilize conveyors to transport paper rolls automatically through banding machines and scales, and then to loading platforms or storage areas with a minimum of handling. The worker monitors these shipping operations from a central control panel, and memory devices and electric eye mechanisms are used to actuate an operation at a specific location.

Continuous Pulping. Another significant development toward continuous automatic production is the growing use of continuous pulping systems. These systems differ from conventional batch pulping methods because of the continuous flow of the input of wood chips and of the output of pulp.

Automatic controls, involving instruments to measure and control temperature and pressure in the pulping process, are an important feature of these systems, and they eliminate the need for manual starting and stopping of each batch. 8/

Continuous pulping offers important economies in capital through a reduction in physical plant required per ton of pulp produced, laborsavings resulting from a reduction in manual operations, and steam savings owing to a reduction in the liquor (cooking agent) to wood ratio.

Installations of continuous pulping systems increased significantly after 1945. Three continuous systems were in operation in North America in 1945; by 1958, 50 were in use (principally in the United States). Continuous systems, however, still comprise only a small proportion of the more than 1,000 pulping systems in operation. 9/

8/ James P. Casey. Pulp and Paper: Vol. 1, Pulping and Bleaching, 2d ed. (New York, Interscience Publishers, Inc., 1960), p. 104.

9/ John O. McCutcheon. "Continuous Pulping," Paper Mill News (L. D. Post, Inc., Philadelphia), March 28, 1960, pp. 46, 48.

Improved Measurement, Inspection, and Control

An important aspect of automation is the introduction of instrumentation and automatic control. Paper mills have adapted new developments arising out of advances in electronics to their own special production technology.

Instrumentation. Since manufacturing pulp and paper involves processing with large quantities of steam, water, and chemicals, instruments for measuring and regulating temperature, pressure, liquid flow rates, levels, and consistencies, are used extensively. The increasing emphasis on quality control has alerted management to the importance of instrumentation which offers more accurate and reliable control of these variables, than is possible with human operators.

One example of an important advance in instrument technology is the magnetic flowmeter. First introduced in 1955, this instrument is being widely adopted to measure and control the flow of pulp through refining equipment. The magnetic flowmeter makes use of a magnetic field and an electrical current to measure continuously and accurately the velocity of the pulp flowing through a pipe, regardless of variations in pulp consistency, temperature, and pressure. No obstructions interfere with the flow of pulp. An important advantage of magnetic flowmeters over other measuring instruments is their low maintenance requirements. 10/

Another important development is the installation of controls for several processes at central control stations. These stations are generally clean, air-conditioned rooms where an operator and an assistant read, monitor, and log instruments for an entire operation. A key advantage is that all motors and pumps can be started, regulated, and stopped, quickly and efficiently. Warning systems which utilize light and sound signals enable an operator to pinpoint quickly an equipment malfunction. When a breakdown in one unit occurs, the interlocking control systems automatically close down other units to prevent further damage. In some systems, adjustments are made automatically in other parts of the system to ensure a continuous flow rate. 11/

Graphic control panels are being used increasingly. One expert defines this innovation as: ". . . a central control panel, on which appear devices for maintaining control and obtaining records, in addition to a process flow diagram illustrating the most important process equipment; all panel instruments being located on the flow diagram relative to their actual point of

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10/ R. F. Barber. "Process Instrumentation for Continuous Refining," Paper Trade Journal (Lockwood Trade Journal Co., Inc., New York, October 31, 1960), p. 24.

11/ M. C. Boyd. "Automation for Insulating Board at Barrett's New Sunbury Mill," Taylor Technology (Taylor Instrument Companies, Rochester 1, New York, Fall Issue, 1957), pp. 16-17.

control in the process." 12/ An important element of these systems is that an operator can readily scan the panel and make necessary adjustments with minimum delay.

Computers. Paper companies are also exploring the feasibility of applying computer technology to their production operations. For example, one company is testing a computerized process control system on a large paperboard machine. The system provides operating personnel with detailed data on such items as stock flow, composition, and temperature. With a computer, it is possible to analyze data that could not heretofore be collected and to improve the operator's control of the entire process. The company expects to realize savings of $600,000 annually by reducing downtime and offgrade time by 75 percent. Besides expanding the system on the paperboard machine, the company plans to apply computer control systems to pulp digesters, caustic and bleach plants, and coating operations. In the opinion of some experts, however, widespread application of computer technology to papermaking depends first on the adoption of more sensitive measuring instruments. 13/

Radioisotope Gages. An important peacetime application of atomic energy in the paper industry is the growing use of radioisotope (beta) gages on paper machines. These gages are used primarily to measure and control the basis weight (weight per unit area) of paper and paperboard, and thickness of coated, laminated, and impregnated paper products. They consist of radioisotopes which emit beta rays and electronic detection devices which measure the amount of beta rays absorbed by the paper. Changes in paper density or thickness are reflected by variations in gage readings. Since measurement is continuous and the instrument does not touch the product, this equipment is particularly useful in paper manufacture. (See Fig. 1.)

The use of radioisotopes has yielded substantial operating economies. According to a study by the National Industrial Conference Board 14/ for the Atomic Energy Commission, 99 companies in the paper industry were using beta

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12/ J. Newell Stephenson, editor. Pulp & Paper Manufacture: Vol. 4, Auxiliary Paper Mill Equipment (New York, McGraw-Hill Book Co., 1955), p. 165.

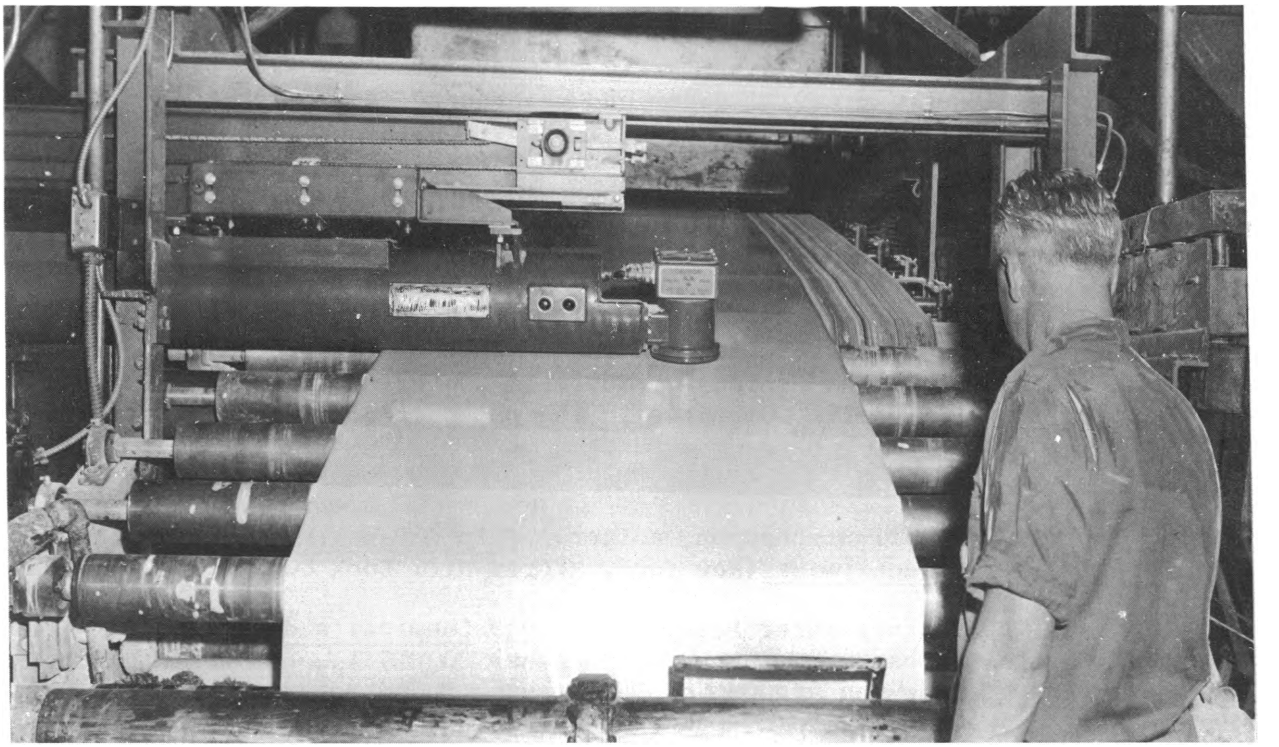
13/ "Computers Enter Paper Industry," Chemical and Engineering News (American Chemical Society, Washington, November 20, 1961), pp. 58 and 60. S. S. Livers. "Taking the Art Out of Papermaking," Control Engineering (McGraw-Hill Book Co., New York, December 1961), pp. 20-21.

14/ Although the NICB study refers to the paper and allied products industry, operations on which beta gages are used were in the pulp and papermaking branches of the industry.

gages in 1957-58. Of these, 93 companies invested a total of $369,000 in radioisotope equipment and facilities during a 12-month period, and realized an estimated net saving of $2,818,000, or nearly $8 for every $1 invested. 15/

Of the $2.8 million saved, 80 percent resulted from the use of radioisotope thickness gages. A manufacturer of coated papers, for example, achieved net savings of $183,000 in 12 months from a $10,000 investment in radioisotope gages to monitor and control coating thickness. Included in these savings were the annual wages of a paper tester for each of three shifts, which amounted to $18,400, and scrap savings of $175,000 attributable to a reduction in off-specification production. 16/

An important though intangible benefit, according to some paper producers, was the improvement in customer relations which resulted from closer quality control and improved quality products. The prospect of substantial savings, with increasing emphasis on quality control, is believed to be leading to wider adoption of radioisotope gages.



Automatic beta gage measuring the coating applied to the paper base; speed is approximately 1,000 feet per minute.

15/ John J. McMahon and Arnold Berman. Radioisotopes in Industry (New York, National Industrial Conference Board, Inc., 1959), p. 77.

16/ Ibid, pp. 77, 80.

Industrial Television. The use of closed circuit television for inspection purposes is another postwar application of electronics. A basic closed circuit television system consists of a camera, a receiver, and a transmission link, such as a coaxial cable or a microwave linkage. These units are said to be reliable and easy to operate and maintain. 17/

Operating experience, so far limited to a few installations, suggests potentialities for cost savings through more efficient utilization of manpower and more efficient inspection methods. A pulp washing installation, for example, currently uses a television camera to permit a worker to inspect pulp washing operations from a distance. This continuous inspection system is used to warn an attendant of improper pulp formation or vat overflow so that costly production delays can be prevented.

Although currently used on a limited basis, television units are expected to become more widely adopted as new applications become feasible. Experts see potential uses, for example, in controlling and inspecting conveyor operations in the woodyard and in the shipping department. The use of television to read instruments in certain recovery operations is expected to reduce accidents.

Development of New Sources of Raw Materials

The search for low-cost raw materials and the adaptation of manufacturing processes to them have long been dominant features of technological developments in the paper industry. The direction of current trends in pulping, according to one expert, ". . . is to use whatever species are available and to adapt the cooking process to those species. The development of new pulping processes has been a necessary accompaniment of the broadening in the number of wood species used." 18/

Semichemical Pulping. One of the most important postwar trends is the increased use of semichemical pulping systems which can utilize low cost Southern hardwoods. Because of the decline in softwood reserves, this new source of raw material has been particularly valuable. Like other changes in raw material utilization, this has important implications for location of plants and jobs.

17/ G. I. Burner. The Use of Closed Circuit Television in the Paper and Pulp Industry (Conference paper presented at A.I.E.E. Paper and Pulp Conference, Gainsville, Fla., March 8-9, 1956). 18 pp.

18/ James P. Casey. Op. cit., p. 102.

This process involves a relatively brief chemical treatment of chips, followed by mechanical separation of the fibers. Semichemical systems permit higher yields from pulp wood than can be achieved in full chemical systems. Semichemical pulp combines well with regular chemical and groundwood pulps, resulting in improved forming characteristics. 19/

First developed in 1925 by the Forest Products Laboratory, semichemical pulping was adopted slowly until the end of World War II. Even in 1952, only 22 semichemical pulping mills were in use. By 1961, however, 48 such mills were in operation. 20/ Although semichemical pulp comprised only 8 percent of total pulp output in 1960, semichemical grades are expected to increase in importance. In 1950, semichemical pulp comprised 5 percent of total output. 21/ Some experts predict that in total tonnage produced, semichemical pulps will eventually rank second in importance to regular kraft sulphate pulp. 22/

Use of Wood Residue Pulping. A significant postwar development in Pacific Coast pulpmills is the growing use of sawmill residue such as slabs and edgings as raw material in pulping. Wood chips from sawmill wastes now account for about 40 percent of all pulpwood consumed in these mills. Some new mills report using purchased wood chips almost exclusively, thereby achieving labor and capital savings in woodyard and woodroom operations. Although experts foresee further expansion in use of sawmill residue, they predict that even faster growth would occur if an economical, portable chipper and barker could be developed capable of processing western woods. This would enable sawmills to convert waste to chips economically and thereby increase the supply of chips for sale to pulp mills. Moreover, this equipment could efficiently process logging wastes such as limbs and small trees which are customarily left in the forests. 23/

19/ George S. Witham. Op. cit., pp. 157-158.

20/ Lockwood's Directory of Paper and Allied Trades (Lockwood Trade Journal Co., Inc., New York), 1952 and 1961 eds.

21/ Pulp, Paper and Board. (U.S. Department of Commerce, Business and Defense Services Administration. Annual Review issues, March 1961 and March 1960).

22/ George S. Witham. Op. cit., p. 185.

23/ John A. Guthrie and George R. Armstrong. "The Pulp and Paper Industry," Western Forest Industry: An Economic Outlook. Published for Resources for the Future, Inc. (Baltimore, Johns Hopkins Press, 1961), pp. 121-123.

Future Advances. Research may introduce some departures from the processes followed over the past 100 years. For example, some experts see the need for research in breeding trees free of bark and impurities, so that many operations and jobs in the pulp mill would be eliminated. 24/

A new development under study, the "bush mill pulping concept" could have far-reaching implications for the location of the industry and its employment. This may involve locating pulp mills near the source of wood supply, partially pulping the wood and shipping semiconverted pulp to a central mill for further processing. If feasible, this method would yield economies in transportation. In addition, some experts see the possibility of using the bush mill concept in connection with a small, semiportable paper machine, recently developed, which could be located at the market rather than at the raw material source. 25/

Research and New Products

A key factor in postwar technological change is the increased expenditures for research and development activities to broaden raw materials utilization, improve production processes, and to develop new products. According to a National Science Foundation survey, the paper and allied products industry in 1960 spent $66 million on research and development. This amount was 50 percent greater than was spent in 1956. 26/ A portion of this increase resulted from increased salaries and other costs, as well as from more workers engaged in R&D activities. 27/

24/ "Searching the Sixties . . . for Future Growth," Paper Mill News, February 29, 1960, p. 31.

25/ Lee Eberhardt. Op. cit., pp. 983 and 996-997.

26/ Funds for Performance of Research and Development in American Industry, 1960 (Preliminary Report). National Science Foundation, Reviews of Data on Research and Development (Washington, U.S. Government Printing Office, 1961), pp. 3 and 5.

27/ The data on research and development activities presented in this report are for the paper and allied products industry (SIC 26), and consequently includes plants engaged in converting activities. Data on research and development expenditures in the pulp, paper, and paperboard segment are not shown separately.

About 98 percent of these expenditures were for applied research. For example, one field of applied research is the development of new uses for lignin, now a waste substance from the pulping process. However, $1 million was spent in 1960 for basic research. One large diversified paper company, for example, reports carrying on a continuing program in fundamental research on the chemical and physical structure of cellulose and lignin molecules. The objective is to gain an understanding of materials worked with and to provide support for future research.

The development of new paper products and processes is one of the goals of research and development. A recent McGraw-Hill report, for example, estimates that 8 percent of the sales of the paper and pulp industry in 1963 will consist of products that were not on the market in 1959. 28/

Stretchable kraft paper is an outstanding example of a product recently introduced. Some of its useful properties are its great toughness, flexibility, good printability, and excellent folding qualities. The use of stretchable paper has thus far been primarily in the field of packaging, such as multiwall and grocery checkout bags.

One important trend is the development of new products by combining paper with products from other industries, especially plastics and metals, to produce end products with desirable features of both materials. For example, a low cost paper that conducts electricity has been manufactured by combining aluminum and wood fibers, and is reported well suited for many industrial electronics applications. Another firm is marketing inexpensive paper baking dishes coated with polyethylene plastic to withstand high oven temperatures. 29/ New types of plastic coated paper for cartons is being sold with unique properties to protect contents from damage from moisture, grease, etc. According to some experts, an even wider range of new products may be feasible if the industry can develop a technique for blending plastics with pulp prior to reaching the paper machine. 30/

28/ The American Economy--Prospects for Growth Through 1975 (New York, McGraw-Hill Book Co., 1961), p. 13.

29/ David G. Smith. "Promoting Paper . . .," the Wall Street Journal, Dec. 1, 1961, p. 1.

30/ Charles W. Heckroth. "Significant for the Sixties . . .," Paper Mill News, Dec. 26, 1960, pp. 29-30.

An important research goal in this industry is the development of low cost paper products as substitutes for textiles. One large firm, for example, has developed a bonded web, nonwoven fabric from cellulose, with certain characteristics of cloth, which can be made water repellant and fire resistant. Relatively inexpensive and easily disposable, industry experts claim that it is suitable for many applications in medical care. Examples of similar paper products now in use include shop aprons and towels for use in industrial plants, and paper pillow cases, operating table covers, and slippers for hospital use.

Looking further ahead, paper firms are undertaking research (in one case with a textile concern) to develop a variety of fabric substitutes. For example, a disposable paper fabric is being developed, which can be produced on conventional papermaking machines, using as a raw material cellulose wadding (a wood pulp product) and synthetic fibers. This material is reported to cost a fifth of the cost of conventional fabrics. Several firms report plans to market low cost paper clothing manufactured from materials of this type, which can be discarded when soiled. One firm is experimenting with a paper fabric that can even withstand laundering. 31/

31/ David G. Smith. Op. cit., pp. 1 and 8.

Outlook for the 1960's

The outlook for changes in production, output per man-hour, and employment over the next few years is presented in the following sections on the basis of a review of trends in the industry since 1947 and a weighing of some factors that would tend to alter these trends in the immediate future. Since the industry's growth is affected by economywide factors, significant departures from the overall economic pattern of the 1950's will necessarily influence the outlook for the industry.

Output per production worker man-hour is expected to continue to increase at an annual rate above the long-term average of 2.4 percent a year. In view of the expected rise in production and changes in technology, the rate of increase may be roughly in line with post-World War II changes in output per man-hour. The effect of newly constructed plants on higher levels of output per man-hour will probably be smaller in the 1960's than during the 1950's when the industry substantially enlarged capacity to meet expanding demand and to overcome obsolescence accumulated during World War II.

Paper plants are placing more emphasis on modernization of existing facilities than on the building of new plant capacity. 32/ Greater mechanization of materials handling in woodroom and finishing operations, improved instrumentation, and the introduction of continuous instead of batch processing will probably be important sources of laborsavings. Continued efforts by management and labor to improve efficiency and reduce waste should also contribute to greater productivity. Since technological improvements depend on management's investment decisions, trends in sales, costs, interest rates, taxes, depreciation allowances, and profits necessarily have an important bearing on the outlook for productivity increases.

Output of pulp and paper is expected to continue to increase, but at a slower rate than the average 4.5 percent annual rise during the 1947-60 period. According to 1957 estimates by the U.S. Department of Commerce (based largely on historic relationships to indicators of the economy's growth), by 1965, net demand for paper and board (unweighted tonnage) may increase by about 40 percent over 1956 or at an average rate (compounded) of 3.8 percent per year. 33/ The increase in the output of pulp would be somewhat higher.

32/ The U.S. Industrial Outlook for 1961--91 Selected Industries. U.S. Department of Commerce, Business and Defense Services Administration. (Washington, U.S. Government Printing Office, 1961), p. 145. Business Plans for New Plants and Equipment--1961/1964. (New York, McGraw-Hill Book Co., 1961.) p. 7.

33/ Pulp, Paper and Board Supply-Demand. U.S. House of Representatives, Committee on Interstate and Foreign Commerce, 85th Cong., 1st sess. (Washington, U.S. Government Printing Office, 1957), p. 20. David L. Luke. "Pulp and Paper," American Enterprise: The Next Ten Years, Martin R. Gainsbrugh, editor. (New York, The Macmillan Co., 1961), p. 217.

The outlook for demand for special food board, sanitary and tissue papers, and building board is considered especially favorable. Continued growth of population and gross national product and more intensive marketing and production of new paper products contribute to increased demand. Improvements in plastics and other competitive materials, on the other hand, may limit increases in sales.

The prospects for a significant increase in the level of production worker employment over the next few years (implied by the changes discussed above) appear to be limited. If output per production worker man-hour increases at the same rate as during the 1947-60 period, the estimated increase in output by 1965 could be achieved with about the same number of production workers as of 1960. This prospect is based on a continuation of the average weekly hours of about 43, which includes on the average about 5 hours overtime.

Widespread modernization, higher rates of capacity utilization, and successful cost reduction programs may increase output per production worker man-hour at a faster rate than during the 1950's. In that event, production-worker employment would decline unless production increases at a faster rate than expected. A continuation of the 1947-60 rate of increase in production, on the other hand, could increase production worker employment.

The outlook for certain occupations within the industry is more favorable than for others. Installation and maintenance of complex equipment as a result of changing technology and accelerated research and development activities will require more skilled workers and additional engineers and scientists, especially those with specialized training in paper technology. Specific skilled occupations expected to show above average growth include electricians, machinery repairmen, carpenters, pipefitters, and millwrights. During the decade of the 1960's, administrative and clerical occupations may increase faster than production jobs. The demand for semiskilled and unskilled workers, however, will probably decline significantly as more materials handling, continuous processing, and other laborsaving equipment is introduced.

Part II. Selected Case Studies

Part II of this bulletin presents case studies of the implications of the introduction of technological changes at three pulp and paper plants. The studies cover the background, main objectives, and the impact of specific technological changes on labor requirements, displacement and transfer of workers, occupational requirements, working conditions, and industrial relations.

The plants were selected after review of technical literature describing specific installations of new technology in the pulp and paper industry. Each of the three plants was highly advanced in some particular phase of paper technology: two had made important advances in materials handling; and one had introduced continuous processing. Only plants which replaced preexisting systems were selected so that the results of changes could be traced conveniently. The three plants are located in different geographic areas and vary in size.

The data which formed the basis for the detailed case studies were collected by BLS representatives during plant visits. This involved interviewing both labor and management officials who had a direct knowledge of the change, and extracting pertinent data from plant records.

In assessing the findings, it is essential to keep in mind certain qualifications of the case study approach. First, the plants selected are not necessarily representative or typical of all plants in the industry or of all plants making changes. The case studies are illustrative only and do not imply that the experiences described are necessarily widespread.

Also, the study was not designed to cover the impact of technological advances at competitive plants which could not or did not make the changes and therefore may have been adversely affected. The data for the industry as a whole discussed in part I reflect the net effects of such changes.

Finally, the case studies cover primarily the objective, formal aspects of the changes. No attempt was made to survey the subjective attitudes of workers and managers. However, managers, supervisors, foremen, and union officials were interviewed concerning various aspects of the changes.

Each case study begins with a brief description of the technological change, and then discusses such topics as changes in capital requirements, output per man-hour, extent of displacement and reassignment, occupational changes, training and retraining, safety, implications for older workers, labor-management relations, and setting of wage rates.

Case Study of Mechanization of Materials Handling

Summary

This study concerns the problems that arose when a relatively old mill with a large proportion of older workers mechanized materials handling operations in its woodroom. The change provided additional wood processing capacity needed for future expansions in mill output. Many manual tasks were eliminated and a larger amount of wood was processed with fewer workers. Since production was increased only moderately during the change, extensive planning was undertaken so that layoffs could be averted. This involved use of normal attrition supplemented by encouragement of retirement of eligible workers. There was considerable reassignment of workers to jobs elsewhere within the mill. The new equipment required fewer laborers and more machine operators and tenders, but the overall grade level remained relatively unchanged. The use of electronic devices to stop conveyors and machinery was a factor in reducing the hazard of serious accidents. Establishing wage rates for new jobs provided management with an opportunity to devise a systematic method of describing jobs. Extensive negotiations between management and unions took place before the final wage rates were established.

Description of Plant

Plant A, a relatively large pulp and paper mill, employs about 1,500 workers and is a major employer in its community. Approximately 80 percent of its annual production is enamel printing paper for use mainly in magazines. The remaining output consists of a variety of paperboard products such as shipping containers and folding cartons. Annual production is approximately 130,000 tons, and annual sales exceed $20 million.

The parent company, of which plant A is a major division, has been one of the pioneers in papermaking technology. Since World War II, the company has spent more than $62 million for new facilities and plant improvements. A new research and development center has been built to coordinate research and development with engineering, marketing, and manufacturing activities.

Plant A's new woodroom, its most important postwar laborsaving innovation, is considered one of the most completely integrated and highly mechanized wood processing installations in the industry. According to some industry experts, it is "the forerunner of woodrooms of the future."

The plant also installed beta gages and automatic controls on paper machines, conveyors, control instruments, improved pulp refining equipment, and new equipment to prepare paper coating materials. Specific projects planned for the future include the development of new paper coating techniques, and more efficient methods of recovering chemicals from manufacturing operations.

Converting logs into chips is the first step of papermaking in this plant. The basic process consists of sawing pulpwood logs to proper length, removing the bark, and converting them into chips. In the old woodroom, this process required an extensive series of manual operations. Although sawing, barking, and chipping operations were done on special purpose machinery, a considerable number of men stationed adjacent to the conveyors were still required to break up log jams, manually remove inadequately barked logs from conveyors, and perform numerous other heavy tasks by hand.

Several important limitations of the old system motivated management to plan for a new woodroom. The old system had too little capacity to sustain additional output; most of the equipment was in need of replacement, and labor costs were relatively high. A planning group consisting of the plant superintendent, a foreman, and several company engineers drew up specifications for a new woodroom.

Company A's new $1.8 million woodroom began operations in August 1955. Company construction crews under the supervision of company civil engineers installed the equipment. Six different companies supplied equipment, conveyors, motors, control units, and pumps.

Major Technological Changes

More machinery and expanded conveyor systems sharply reduced the number of manual operations. Capacity was increased by nearly 60 percent. The new system is flexible and can process a variety of softwoods and hardwoods. Major technological innovations in the new woodroom are described in the following paragraphs.

Faster Transportation System. The efficiency of transporting logs from storage to the woodroom entrance was substantially improved by a new pumping system which induces a faster current in the wood pond. The number of employees who formerly propelled logs by using long spiked poles has been greatly reduced.

More Extensive Conveyorization. An extensive integrated conveyor system which transports logs through a sequence of processing operations also helped to increase efficiency. This conveyor system consists of a main sorting belt and several auxiliary conveyors. The system permits the return of improperly barked logs to the barkers, diversion of groundwood logs to special saws, and routing of logs to one of two chippers. Since log jams along the new conveyor system occur less frequently than before, important laborsavings were derived from a substantial cutback in standby inspection personnel.

More Powerful Equipment. More powerful wood processing equipment is used. The barking drums now remove a greater percentage of the total bark and hence eliminate manual debarking operations. Reduction in employment also resulted from substituting mechanical for manual methods of loading and positioning logs in the splitters and chippers.

Increased Equipment Capacity. An important change was the enlargement of the capacity of the chippers, a key step in the woodroom operations. The chippers in the new woodroom can accommodate 8-foot logs, whereas the older equipment could process only logs less than 2 feet long. The total combined horsepower of the two chippers in the old system was 650, while the main chipper in the new system alone is rated over 1,000 hp. The amount of sawing required was reduced with significant decreases in material and labor.

Centralized Control Systems. An outstanding feature of the new woodroom is the centralized control system. Transporting logs efficiently through a sequence of processing operations by integrated conveyor systems requires more coordinated control of operations. Regulation of all operations is now centered in two locations. Pushbuttons on these control units supplant less efficient and less dependable manual control methods at a number of scattered locations.

Some overall measures of mechanization in the woodroom are shown in table 3. Total horsepower in the woodroom was increased nearly threefold. Because of reduction in employment, horsepower per worker was increased sevenfold.

Table 3. Woodroom of plant A: Horsepower installed and daily capacity, before and after modernization

Item	Before modernization	After modernization	Percent change
Total horsepower installed	1,130	3,160	179.6
Horsepower per worker	8.9	65.8	639.3
Daily (24 hour) capacity (cords)	450	713	58.4
Horsepower per cord of daily capacity	2.5	4.4	76.0

Source: Derived from data from plant records.

Effect on Output Per Man-Hour

Mechanization resulted in a sharp increase in output per man-hour in the woodroom. (See table 4.) Cords processed per man-hour increased more than 200 percent. Although actual volume of cords processed was only 14 percent higher, man-hours dropped sharply.

Table 4. Woodroom of plant A: Output per man-hour, and unit man-hour requirements, before and after modernization

Item	Year before modernization	Year after modernization	Percent change
Cords processed (annual)	119,853	136,754	14.1
Man-hours (annual)	264,160	99,840	-62.2
Cords per man-hour (average)	.454	1.370	201.8
Man-hours per cord (average)	2.20	.73	-66.8

Source: Derived from data from plant records.

These substantial output per man-hour gains, however, did not occur immediately. About 1 year was required to overcome operating difficulties, because of the breakdown of several conveyors.

Effect on Capital Requirements

The technical changes involved a substantial increase in the volume of capital installed per worker. In the new woodroom, capital investment per worker was about $37,000, compared with about $8,500 (estimated replacement cost) in the old woodroom, an increase of 336 percent. Total value of plant and equipment was 65 percent higher, but the number of workers was reduced sharply. (See table 5.) In terms of capacity, the ratio of capital per unit of capacity was only 4 percent greater than in the old woodroom.

Table 5. Woodroom of Plant A: Value of plant and equipment, before and after modernization

Item	Before modernization	After modernization	Percent change
Value of plant and equipment	1/ $1,077,504	$1,774,887	2/ 64.7
Value of plant and equipment per worker	8,484	36,977	335.8
Value of plant and equipment per 100 cords of capacity	239,445	248,932	4.0

1/ Estimated replacement cost at time of change.
2/ Affected by price changes as well as by amount of plant and equipment.

Source: Derived from data from plant records.

Effect on Costs

Tangible savings in the cost of processing a cord of pulpwood through the woodroom were achieved. Although hourly wage rates rose by more than 20 percent in a 5-year period because of percentage wage increases, gross costs per cord remained virtually unchanged. The net cost per cord actually declined by 6 percent when the value of bark recoverable for use as fuel is deducted from gross costs.

Annual savings in payroll alone amounted to nearly $300,000 the year following the change, owing to the elimination of 79 jobs. More than $70,000 was also saved from the increased value of bark recovered for use as fuel. Based on these savings, the $1.8 million cost of the new woodroom would be amortized in less than 5 years.

Effect on Plantwide Output Per Man-Hour

Since employment in woodhandling comprised only about 13 percent of total plant employment, gains in output per man-hour for the plant as a whole were substantially less. Output per man-hour for the plant rose by about 15 percent. Total output increased by 19 percent, while total man-hours were up by 3 percent.

Displacement and Reassignment

The installation of new laborsaving equipment resulted in a sharp reduction in the number of jobs required in the woodroom, and in reassignment of a substantial number of workers directly affected to other jobs within the woodroom and throughout the mill.

Reduction of Jobs and Reassignment. The number of jobs required in the woodroom was reduced from 127 to 48, or 62 percent. (See table 6.) Of the 127 employees in the woodroom, 66 were transferred to other departments. Although none of the workers affected was laid off, 11 voluntarily retired, 1 quit, and 1 died.

Of the 66 workers transferred to other departments, a large proportion were initially reassigned to the yard, and subsequently reassigned as job openings developed in other departments of the plant. Fifteen months after startup of the new system, one-third of the 66 workers were still working in the yard.

Workers who were retained in the woodroom were also reassigned to other jobs. Only five were assigned to the same job they had before the change.

Downgrading and Upgrading. Approximately two-thirds of the workers affected by these changes experienced some change in grade status. (See table 7.) Forty-five workers were upgraded, and 30 were downgraded. Those who remained in the woodroom had about the same experience as those who were transferred. Although the hourly wage rate for some employees declined upon transfer from the new woodroom, percentage wage increases received by these employees in the next year more than offset most of these reductions.

Changes in Plant Employment. Total plant employment declined by 60 employees from December 1954 to December 1955, or 4.1 percent. This reflected quits, layoff of temporary workers and those with the least seniority in the mill, as well as retirements. Some retired because of management's program to encourage retirement of eligible workers in order to make positions available. Total employment in 1956 rose to nearly the 1954 level, the year preceding the change, and again declined in 1957. Although the employment increase in 1958 more than offset the 1957 decline, employment was still not as high as in 1953. Production in 1958 was about 2 percent below 1953.

Change in Occupational Structure

A major result of mechanization was the elimination of many jobs primarily done by hand. The job of hand barker was eliminated entirely. Other job classifications either abolished or substantially cut back included tail sawyer, sorting conveyor, and pond man. The number of job titles was reduced from 34 before modernization to 13 after modernization.

Table 6. Plant A: Job status of workers formerly assigned to the old woodroom 15 months after startup of the new system

Job status	Workers	
	Number	Percent
Total	127	100.0
Remained in woodroom	48	37.8
Assigned same job	5	3.9
Assigned different job	43	33.9
Transferred to other departments	66	52.0
Yard	22	17.3
Finishing room	10	7.9
Maintenance	6	4.7
Cleaning	5	3.9
Stock preparation	5	3.9
Screens and deckers	4	3.1
Shipping	3	2.4
Other (units receiving fewer than 3 employees)	11	8.7
Left the company	13	10.2
Laid off	--	----
Retired	11	8.7
Quit	1	.8
Died	1	.8

Note: Because of rounding, sums of individual items may not equal totals.

Source: Plant records.

Table 7. Plant A: Grade status of woodroom workers who remained in the unit, and of those who transferred to other plant departments

Grade status	Total		Workers remaining in woodroom		Workers transferring to other departments	
	Number	Percent	Number	Percent	Number	Percent
Total	114	100.0	48	100.0	66	100.0
Upgraded	45	39.5	18	37.5	27	40.9
No change in grade	39	34.2	18	37.5	21	31.8
Downgraded	30	26.3	12	25.0	18	27.3

Source: Plant records.

Another significant change was the shift of maintenance workers to the central plant maintenance pool. Seven maintenance occupations were used in the old system, compared with only two in the new woodroom. Since the new equipment is more complex than the old, it required more technical maintenance. For this reason, management centralized the maintenance function.

Although a number of jobs were abolished in the new woodroom, several new job classifications were created. The controller, a key job in the new system, controls a number of processing operations over a wide area. He stands near the main conveyor and oversees and regulates the speed of the conveyor and the flow of logs through processing stations by means of a central control board. He has responsibility for coordinating operations from the time the logs leave the barking drums until they are reduced to chips and transferred to storage. The controller communicates by phone with the sawyer and chip bin operator for purposes of production control.

Some jobs retained the same job title but were changed in content. The change in the sawyer's duties illustrates the extent to which some workers have been removed from direct manual participation in the production process. The sawyer in the old woodroom manually operated a lever to control the movement of a steam-powered carriage used to transport logs to the saws. He made his adjustments in operation of the equipment on the basis of sensations such as vibration and sound. The sawyer in the new system, however, controls this operation by pushbuttons located on a central control panel. He stops and starts the movement of the carriage without manual intervention.

Jobs at various stages of the production process now require less physical activity. The method of transporting logs through the pond, for example, has changed. Formerly, pond men utilizing long spiked poles manually pushed logs through the pond to the woodroom entrance. Now an electric pump produces a current of water which provides sufficient force to move these logs. Pond men are still required in the new woodroom, but their job duties require less physical activity.

Improved barking and pulp cleaning methods and a more efficient conveyor system also reduced physical demands of splitting and sorting jobs. The procedure for sorting logs is the same, but workers now have fewer logs to remove by hand from the conveyor for return to the drums for debarking. The splitting and sorting man is no longer required to manually position oversize logs in the splitter, since they are now transported to the chipper by conveyor and positioned automatically.

Table 8 summarizes the overall change. The new equipment reduced markedly the proportion of workers in hand occupations. In the old woodroom, more than half of all workers were hand laborers. After modernization, however, only about one-third of all workers were in this category, and more than half were machine operators or tenders. The proportion of supervisors was also higher after the change, although the actual number was less.

Table 8. Classification of woodroom occupations, by job content, before and after modernization

Job classification	Before modernization		After modernization	
	Number	Percent	Number	Percent
Total	127	100.0	48	100.0
Supervisors	5	3.9	2	4.2
Machine operators and tenders ..	34	26.8	27	56.2
Machine feeders	6	4.7	0	----
Maintenance workers	13	10.2	2	4.2
Hand laborers	69	54.3	17	35.4

Note: Because of rounding, sums of individual items may not equal totals.

Source: Derived from data from plant records.

Overall Change in Grade Level. One method of assessing the effect of new technology on skill requirements in the woodroom is to compare the average wage (or grade) level before and after the change. This method gives only an approximation, however, since wage rates are based not only on skill requirements, but also on such factors as working conditions and job responsibilities.

The average hourly wage (adjusted for percentage wage increases) increased only slightly--from $1.80 in 1954 to $1.82 in 1956; the overall labor grade thus remained practically unchanged. Significant shifts occurred, however, in the proportion of workers in high- and low-wage categories. For example, in the old woodroom only about 1 out of every 25 workers was in a job paying a wage equivalent to $2 an hour. After modernization, however, approximately 1 out of every 7 workers was making $2 or more. (See table 9.)

Table 9. Average hourly wage rate and percent distribution of woodroom employees by wage rate, before and after modernization 1/

	Before modernization		After modernization	
	Number of jobs or employees	Percent	Number of jobs or employees	Percent
Total	127	100.0	48	100.0
$2.20 and over	4	3.1	2	4.2
$2.10-$2.19	1	.8	1	2.1
$2.00-$2.09	0	--	4	8.3
$1.90-$1.99	10	7.9	2	4.2
$1.80-$1.89	17	13.4	5	10.4
$1.70-$1.79	95	74.8	34	70.8
Average hourly rate	$1.799		$1.817	

1/ In order to compare average rates affected by job changes only, rates before modernization were increased by an amount approximating percentage wage increases between the two periods.

Source: Derived from data from plant records.

Plantwide Changes. Important shifts in the job structure of the mill as a whole have taken place in recent years. Although not directly related to the changes in the woodroom, they are indicative of the effects of changing technology in the plant as a whole. Between 1953 and 1958, the proportion of employees in administrative, professional, and office occupations increased in importance relative to those in production and related jobs. Although total employment increased by only 2.0 percent, the number of administrative, professional, and office workers increased by 28.1 percent. The number of production and related workers, however, increased by only 0.3 percent. (See table 10.)

Table 10. Plant A: Composition of the work force by occupation or plant department, 1953 and 1958

Occupation or plant department	1953		1958	
	Number	Percent	Number	Percent
Total employment	1,454	100.0	1,483	100.0
Administrative, professional, and office employees	89	6.1	114	7.7
Administrative	3	0.2	3	0.2
Supervisors and foremen	41	2.8	54	3.6
Engineers, chemists, and draftsmen ..	4	0.3	3	0.2
Typists, stenographers, etc.	38	2.6	52	3.5
Miscellaneous office	3	0.2	2	0.1
Production and related workers	1,365	93.9	1,369	92.3
Wood preparation and handling	183	12.6	94	6.3
Pulp mill	154	10.6	161	10.9
Paper mill	297	20.4	290	19.6
Finishing and converting	230	15.8	275	18.5
Shipping and receiving	20	1.4	21	1.4
Maintenance and repair	171	11.8	214	14.4
Laboratory testing and research	24	1.6	25	1.7
Other 1/	286	19.7	289	19.5

1/ Includes powerhouse, storeroom, custodial, yard, timekeeping, etc.

Note: Because of rounding, sums of individual items may not equal totals.

Source: Plant records.

Several overhead occupational groups increased in relative importance during this 5-year period: supervisors and foremen, maintenance and repair workers, and typists and stenographers. Employees in the finishing and shipping activities also gained in relative importance.

Employment in wood preparation and handling activities declined sharply, owing to the installation of the new laborsaving equipment in the woodroom. In 1953, 2 years prior to modernization, 12.6 percent of all employees were engaged in wood preparation and handling tasks. By 1958, however, only 6.3 percent of all employees were in these activities.

A significant change has been a growing need for specialized employees to maintain more extensive and more complex instrument systems. Prior to World War II, plant A needed only one employee working on a part-time basis to service instruments. At present, however, a crew of six full-time instrument repairmen is employed.

The size and skill requirements of the parent company's plant engineering staff (those in charge of building new equipment and making major repairs) were also affected. In 1940, only seven employees were on its engineering staff--four engineers and three draftsmen. By 1959, the engineering staff had grown to 24 employees--15 engineers and 9 draftsmen.

Management at company A now seeks "engineers" with more formal training. It feels that modern papermaking equipment requires more skill and a broader education in engineering. Thus, the company will eventually hire only college graduates to fill these jobs. A graduate engineer is now in charge of the engineering group, replacing an employee who "had come up from the ranks."

Training and Retraining

Skill in operating the new woodroom equipment required only informal on-the-job training of workers assigned to new jobs. Representatives from the equipment manufacturer provided instruction. Since most of the job duties in the new system were not complex, the training period generally required only 1 month. The jobs of foremen, controller, and sawyer, the most responsible positions in the new woodroom, required the longest period of training. Employees received their regular wages during the training period.

Retraining Reassigned Employees. Workers assigned to jobs elsewhere in the mill were not given special retraining. During the 30-day probationary period provided for in the union agreement, these workers were able to learn their duties on the job. Four employees from the repair crew in the old woodroom, however, were assigned to formal training in the millwright

apprenticeship program. All of these employees became millwright journeymen within 15 months after the change, and consequently were upgraded in pay. Formerly, they were performing "handyman" type duties. This training program provided an opportunity to acquire new skills in equipment maintenance.

Educational Requirements for New Jobs. A significant result of installing new woodroom equipment was the requirement of formal education for employees entering the new jobs. No such requirements existed for jobs in the old woodroom. At first, management felt that the increased complexity of the new equipment, especially the new central control board, would require the foremen and controller be high school graduates, and that employees in the remaining positions have at least an eighth grade education. After the woodroom had been in operation for a time, however, management reduced entry level educational requirements for the foreman and controller jobs, from a high school to an eighth grade education.

Effect on Safety Conditions

The woodrooms are one of the most hazardous work areas in a paper mill. Workers are in danger of injury from falls on wet surfaces, from being caught in conveyors and other moving equipment, from being struck by logs and chips, and from incurring strains in lifting and positioning heavy logs.

The new equipment in plant A reduced the danger of cuts and puncture wounds from barking knives and long spiked poles, but increased the work hazards associated with more powerful and more extensive conveyor systems, and more powerful processing equipment.

The elimination of hand barking and hand knotting operations in the new woodroom removed a hazard from the sharp cutting knives, a particularly troublesome source of injury. Another source of injury eliminated was the use of long spiked poles to sort and route logs along the pond and the conveyors. Since the number of employees using these spiked poles has been substantially cut back, the number of injuries has fallen correspondingly.

The powerful main conveyor and the 1,000 hp., 360 r.p.m. chipper are considered potential sources of serious injuries in the new woodroom. An electric eye safety device has consequently been installed above the main conveyor belt and just ahead of the chipper. Should a workman or an oversize log inadvertently approach the entrance of the chipper, the beam of the electric eye is broken, the conveyor stops immediately, and the barking drum doors close automatically.

Statistics on the frequency of disabling injuries for the woodroom and for the total plant are shown in table 11. The high injury-frequency rate in 1955 was due primarily to the newness of the equipment. As workers became accustomed to the new equipment and work flow in the new systems, the rate of injuries declined sharply.

Table 11. Plant A: Frequency of disabling injuries 1/ (per million man-hours), total plant and woodroom, 1954-58

Area	Year				
	1954	1955	1956	1957	1958
Total plant	7.05	10.15	9.22	6.61	9.25
Woodroom	16.87	65.19	15.67	(2/)	19.62

1/ An injury which renders an employee unable to perform his regular job duties.

2/ Information not available.

Source: Plant records.

The Older Worker and the Changeover

The changeover to a more mechanized woodroom created factors both favorable and unfavorable for the utilization of employees age 45 and over. No arbitrary age barriers were imposed for new jobs. A provision in the union agreement which provides a 30-day trial period without loss of seniority for employees transferring to new positions proved a useful mechanism for reassigning older workers.

Older employees benefited from the seniority provisions in the union agreement to the extent that they were retained in their former workplace to a greater extent than were younger employees. In addition, 4 out of the 5 employees who retained the same job after modernization that they had held before the change were age 45 or over. (See table 12.)

Table 12. Plant A: Job status of woodroom workers 15 months after startup of new woodroom, by age group

Job status	Workers under age 45		Workers age 45 and over	
	Number	Percent of total	Number	Percent of total
Total	60	100.0	67	100.0
Remained in woodroom	21	35.0	27	40.3
Assigned same job	1	1.7	4	6.0
Assigned different job	20	33.3	23	34.3
Transferred to other departments	37	61.7	29	43.3
Left the company	2	3.3	11	16.4
Laid off	0	--	0	--
Retired	0	--	11	16.4
Quit	1	1.7	0	--
Died	1	1.7	0	--

Note: Because of rounding, sums of individual items may not equal totals.

Source: Plant records.

Some problems arose, however, in reassigning older employees to positions in the new woodroom. For example, a 66-year-old sawyer in the old woodroom with 40 years of company service was extremely reluctant to accept a job as sawyer in the new woodroom because of the increased responsibility. The company felt, however, that he could perform well in the new position on the basis of his prior work record. After a discussion with the foreman, the employee accepted the job and performed satisfactorily for nearly 3 years until he retired.

Special Problems of Retraining Older Workers. A special provision for the retraining of an older worker to avoid layoff was worked out through joint union-management negotiation. The union requested that the company permit an older relief repairman to enter the maintenance apprenticeship training program to avoid his being laid off after startup of the new system. The company acknowledged "that /this matter/ was something that could be discussed, although the company had taken a pretty definite stand /against this/ because of the employee's age (52). If the union has some new angles, we might explore them." A special program was finally worked out without establishing a precedent, and the employee became a millwright apprentice.

Labor-Management Practices Regarding Personnel Adjustments

About 18 months prior to the startup of the new woodroom, management informed employees in the old woodroom about the forthcoming technological changes. Notice was given that a sharp cutback in woodroom employment would occur. The woodroom foreman assured employees, however, that efforts would be made to reassign affected employees to other positions within the mill.

During the 12 months immediately preceding startup, the progress of the change was discussed with union representatives. Within management, plans for achieving an orderly transition were formulated. The Assistant Director of Industrial Relations, in a memorandum to the woodroom superintendent, wrote that:

> The new woodroom has been designed to do the necessary work of wood preparation with a minimum of manual labor . . . definite plans must be made for reducing the present woodroom crew so that the change can be made in an orderly manner with minimum hardship.

As planning progressed, management was able to determine its personnel requirements more precisely and concluded that all affected employees could be utilized somewhere in the plant and that there would be no layoffs. During one of the union-management meetings before the changeover, company officials set forth certain policies to reduce personnel displacements.

> As permanent openings occur in the mill, woodroom personnel will be studied to see if a qualified employee is available to fill such a vacancy. His place to be filled then with a yard employee with less seniority, or if no one is available, a man will be hired with the understanding that his woodroom job is only of a temporary nature.
>
> Encourage those of retirement age in the woodroom to retire when the new woodroom is in operation in order to move younger men up in the new woodroom.
>
> Encourage men throughout the mill who are of retirement age to retire so that more jobs are available throughout the whole plant.
>
> Inform woodroom men who will lose their jobs in the woodroom to come in and talk over with the woodroom superintendent, their qualifications and where they would like to work.

This statement of management's policy regarding the adjustments was received favorably by union representatives.

Practices Regarding Reassignment. Reassignments of workers were made according to the provisions regarding seniority in the union agreement. These provisions included:

> Seniority with ability and qualifications shall govern in promoting, demoting, transferring, filling vacancies and new positions, layoffs, and recalls after layoffs . . .
>
> If there should be any difference of opinion as to the ability and qualifications of an employee being considered for promotion, the Committee and the Management shall take the matter up for adjustment and settle such differences before promotion is allowed . . .
>
> An employee who is transferred or promoted shall be on probation for 30 days for determination as to whether or not he can meet the job requirements. This probationary period may be extended by mutual consent in cases requiring more than 30 days. If at the end of this period, he fails to qualify, or in case of discontinuance of his position during this qualifying period, he shall be returned to his former position without loss of seniority.
>
> Employees transferred from one division or department to another shall be identified as temporary or permanent, with a written notice of permanent transfers given the union . . . Permanently transferred employees will be considered new employees in the division or department to which transferred with their department or division seniority accumulative from the date of transfer . . .

The seniority provisions governed both the selection and assignment of former employees of the old woodroom who were retained in the new woodroom, and the transfer and reassignment of those who were no longer required. The latter constituted the bulk of the original group.

Management posted job openings as they developed throughout the mill, and interviewed woodroom workers whose jobs were affected to determine their job preferences. Efforts consistent with seniority and ability provisions of the union agreement were made to place these workers in jobs they desired. A number of workers were initially reassigned to the yard, and subsequently reassigned to other mill departments. As workers were gradually transferred out of the woodroom, temporary workers were hired to take their place to insure continuity of operations.

The 34 men with the longest seniority were finally retained. In assigning these men to jobs, the woodroom foreman first drew up two alternative rosters which listed them by seniority. One list placed them according to age and physical condition, following the line of seniority as much as possible and utilizing their experience and skills by placing them in jobs comparable with their present duties. The second list considered seniority only, with the older men falling in line for the more important and physically demanding jobs. The foreman then sent these lists to the woodroom superintendent who forwarded them to the pulp mill superintendent with a recommendation that only the first list be considered. The woodroom superintendent subsequently talked individually to the 34 men to explain further the operation of the new woodroom, to tell them about the jobs to which they might eventually be assigned, and to learn of their individual job preferences. A summary of the interviews was also forwarded to the pulp mill superintendent.

Management then developed a tentative staffing pattern based on the recommendations and interviews and submitted it to the union for comment during a regularly scheduled union-management committee meeting. Several staffing changes were made as a result of these discussions.

Setting Wage Rates for New Jobs. One of the most important steps in planning for the changeover was establishing wage rates for new jobs. The general procedure was provided in the union agreement.

> Individual wage rates for new jobs or substantially changed jobs may be considered for special negotiations at any time during the term of the agreement . . .

Since the extensive technological changes resulted in a substantial change in the structure and content of woodroom jobs, management decided to initiate a more systematic procedure for describing jobs and establishing wage rates. The new method involved an intensive analysis of the new jobs on the basis of their educational requirements, responsibility, skill, and physical demands, learning time, and job hazards.

Tentative rates for new jobs were established, subject to revision after a 60- to 90-day equipment shakedown, and were then submitted to the union for review. The company and union met prior to startup to discuss these rates. Several revisions were made on the basis of the negotiations.

After the woodroom had been in operation 4 months, union and management officials met again to evaluate the tentative rates on the basis of actual operating experience. The union proposed that the hourly rate for six job classifications be revised upward on the basis of unanticipated changes in job skill and responsibility requirements. The company concurred on four jobs, felt no change was necessary for one job, and postponed action on another pending installation of additional equipment. New rates were made retroactive to the date of initial startup. Table 13 summarizes the union and company positions and the final disposition of rates.

Table 13. Plant A: Results of union-management negotiations over wage rates for selected woodroom occupations, based on operating experience

Job title	Union position	Company position	Results
Foreman	Job compares with a craft journeyman; rate should be increased.	Job carries increased equipment responsibility, but decreased employee responsibility.	Rate increased 4 cents an hour.
Controller	Job carries responsibility to keep production moving; rate should be increased.	Responsibility for keeping production moving is recognized.	Rate increased 5 cents an hour.
Pondman	Job duties require several sets of work clothing; rate should be increased.	Rate satisfactory.	No change.
Sawyer	Job content has changed; large saw requires full-time operator; rate initially set on basis of part time on large saw and part time on groundwood saw; rate should be increased.	Change in job content recognized.	Rate increased 6 cents an hour.
Chip bin operator	Rate should be increased.	Job responsibilities recognized.	Rate increased 3 cents an hour.
Bark handler	Rate should be increased.	Additional equipment to be installed; rate study should be postponed pending installation.	Postponed action.

Source: Plant records.

Case Study of the Introduction of Continuous Processing Equipment

Summary

This study describes the installation of a continuous digester to replace an obsolete batch system in manufacturing semichemical pulp. As a result, output per man-hour rose by one-fourth after conversion. Because of the narrowness of the seniority system, the elimination of an entire line of progression meant that some senior workers were downgraded while others with less seniority but in a different line of progression were promoted to better jobs created by the new technology. Management avoided layoffs by transferring employees whose jobs were eliminated temporarily to the extra board (a work pool from which temporary and permanent placements are made), and later to other mill departments. The new system required machine operators instead of the former manual labor occupations. The new operation entailed not only training workers on the job, but also providing some outside instruction.

Description of Plant

Plant B is the largest employer in its community, with over 3,500 employees and an annual payroll of about $18 million. It produces about 300,000 tons of paper, primarily bags and unbleached kraft papers. About one-third of the mill's output is converted into finished products by the plant's Container Division, located at the same site. The bulk of the remaining output is shipped to other plants within the parent company, a large, diversified pulp and paper manufacturer. Nearly 90 percent of pulp produced is sulphate pulp, and the remainder is semichemical pulp.

Plant B allocated considerable funds for new equipment during the postwar period. A major outlay was $1.1 million for a continuous digester and washing system to manufacture semichemical pulp from low-cost hardwoods. This shift to continuous digester operations in pulping is one of the important technical changes taking place in the industry.

Future installations in the plant will center on mechanized materials handling equipment to achieve economies in unloading pulpwood logs from railway cars and trucks and in handling paper rolls in shipping. The plant also plans to purchase more pulpwood in chip form.

Major Technological Changes

Plant B converts wood chips to pulp in large cylindrical steel tanks (digesters), cooking with chemicals under heat and pressure. This pulp is then washed and refined prior to being sent to the papermill for conversion into paper and paperboard.

Prior to installing new equipment, pulp was prepared by the batch method in four conventional digesters and subsequently transferred to a diffuser room where it was washed in eight diffuser tanks (large steel vats).

The batch method of preparing and washing pulp required employees to move and service heavy equipment manually. The sequence of operations was repeated for each digester in a rotating cycle.

Planning the Change. A major reason for installing the new system was that the conventional digesters were rapidly becoming corroded, owing to the action of the cooking liquor. Since operating efficiency was declining, management decided to install an alternative system for producing semichemical pulp.

A team of three company engineers was assigned responsibility for determining the economic possibility of a continuous digester. The team estimated that it would yield savings and greater yields sufficient to amortize the equipment cost in about 4 years, even though the cost of this new equipment was about four times greater than the cost of relining the old digesters.

The planning team selected the new equipment and developed instrumentation and controls with engineers from the equipment suppliers. The new system required not only the continuous digester itself, but also pulp washing equipment; chip storage silos; conveyors and elevators; a pulp storage tank with circulating pulp conveyor system; numerous control instruments; and graphic control panels, pumps, and compressors. More than 12 different companies supplied this new equipment.

The equipment was installed primarily by the company's regular maintenance crew. During construction and initial startup periods, representatives from equipment suppliers were on hand to assist company engineers. Complete installation required about 10 months.

The New System. The new continuous system began production in April 1957. Equipment ranging in age from 2 to 40 years was replaced. The old digesters were kept in place and can be put into service in the event of a prolonged breakdown of the new equipment. The two major differences between the old and new systems are summarized in the following paragraphs.

Continuous Production. An outstanding feature of the change is conversion from batch to continuous production. In the new system, chips are fed continuously and compacted by a screw conveyor; cooking liquor is added automatically and the pulp, under constant and uniform pressure and temperature, flows through the digester and then on to a continuous pulp discharger which automatically removes partially delignified chips from the digester and deposits them in a storage tank. A mechanism automatically draws the pulp through the tank and deposits it on moving conveyors, which transport it to the washing machinery.

The washing cycle is also continuous and automatic. Chips are forced through the washing equipment in two stages. During the first stage, cooking liquor is removed until the pulp reaches a specified consistency. Water is added, and the pulp is transferred to the second washing unit where the cycle is repeated. During these stages, the chips are being "defibered," a process which was not done in this cycle under the batch system.

More Extensive Instrumentation. The continuous flow of chips and liquor through successive processing stages required more instrumentation than was used in the batch system. A feature of the new system is the graphic control panel, located in an air-conditioned room, where the instruments are displayed.

The entire operation is now monitored and controlled by two men, one in the control room and the other in the pulp washing area. Since all instruments are clearly visible, the operator can quickly make required adjustments in operations such as changing steam and liquor flow rates, and conveyor speeds. An alarm mechanism is built into the system to quickly pinpoint the unit where an equipment breakdown has occurred. This unit automatically closes down until repairs are made.

The vast change in the extent of mechanization and its effect on plant capacity is shown in table 14.

Table 14. Plant B: Horsepower installed, and daily capacity, before and after technological change

Indicator	Former system	New system	Percent change
Total horsepower installed	120.0	1,135.0	845.8
Horsepower per worker	10.0	141.9	1,319.0
Daily capacity (tons)	175.0	150.0	-14.3
Horsepower per ton of capacity	.7	7.6	985.7

Source: Derived from data from plant records.

Effect on Output Per Man-Hour

The effect on output per man-hour of installing the new pulping equipment is shown in table 15.

Table 15. Plant B: Output per man-hour, and unit man-hour requirements, semichemical pulping, before and after technological change

Item	Year before change	Year after change	Percent change
Tons produced (daily average)	119.0	99.0	-16.8
Man-hours (daily)	96.0	64.0	-33.3
Tons per man-hour (average)	1.24	1.55	25.0
Man-hours per ton (average)	.81	.65	-19.8

Source: Derived from data from plant records.

Although output per man-hour increased significantly, production was not as great as management anticipated. Actual production fell substantially short of the 126 tons desired. One reason was that equipment downtime for maintenance was much greater than expected. The continuous system has a greater number of motors, pumps, conveyors, and other moving parts than the batch system. Foreign objects in the wood chips, and malfunctions in moving parts caused some costly shutdowns during the first few months of operation. However, improved operating techniques, more familiarity with equipment, and equipment modifications are expected to reduce sharply the frequency of breakdowns. As downtime declines, both production and output per man-hour are expected to increase significantly.

Other Savings

The new equipment yields 10 percent more pulp from the same quantity of wood through closer control of the cooking process. About a third less steam per ton of pulp produced is used: the former equipment used approximately 4,500 pounds per ton, the new system, 3,000 pounds. The new continuous system also has a potential for impressive savings in plant space. The system now occupies an area formerly occupied by eight diffusers.

Economies achieved in other parts of the mill comprised a significant, but not easily measured result of the new equipment. For example, the use of high consistency washing equipment, which leaves a greater amount of solids in the spent cooking liquor, led to economies in evaporator capacity required.

Effect on Capital Requirements

The comparative capital requirements for the new and old systems are shown in table 16.

Table 16. Plant B: Value of plant and equipment, old and new semichemical systems

Item	Old system	New system	Percent change
Value of plant and equipment	1/ $1,500,000	$1,085,000	2/ -27.7
Number of workers	12	8	-33.3
Value of plant and equipment per worker	$125,000	$135,625	8.5
Value of plant and equipment per ton of daily capcity	$8,571	$7,233	-15.6

1/ At time of purchase (estimated).
2/ Affected by price changes as well as amount of plant and equipment.

Source: Derived from data from plant records.

Effect on Costs

In the first year after installation of the new system, the cost of producing and washing a ton of pulp was greater than in the old system. Although significant savings were achieved, these economies were more than offset by unexpectedly high maintenance expenses as explained on p. 53. Table 17 gives a breakdown of unit costs, before and after the change.

Table 17. Plant B: Percent distribution of unit costs in semichemical pulping, before and after technological change

Item	Year before change	Year after change
Total	100.0	100.0
Wood	57.1	50.2
Chemicals	10.7	10.2
Conversion	32.2	39.6
Maintenance (labor and materials)	1/ 2.8	12.6
Operating labor	5.9	3.4
Other costs	23.5	23.6

1/ Estimated.

Source: Plant records.

Within the maintenance account, the composition of cost items has been changed significantly. Prior to the change, labor expenses amounted to 80 percent of total maintenance charges, and materials expenses were 20 percent. After the change, however, labor costs were about one-third, and parts expense amounted to about two-thirds of total costs.

Effect on Plantwide Output Per Man-Hour

The gains in output per man-hour which were achieved in the digester room had little effect on total plant output per man-hour. Over the same period that output per man-hour rose by 25 percent in the digester room (semichemical pulp), it increased by only 2.4 percent for the total plant.

Displacement and Reassignment

The change involved the elimination of 12 jobs and the creation of 8 new ones, but in the process 69 workers were affected because of shifting and bumping.

Of the 69 workers affected in the two seniority units (61 in the digester room and 8 in the diffuser room), the 61 digester room workers remained in their unit, and the 8 diffuser room workers were temporarily reassigned to the extra board. These eight workers were eventually assigned to permanent jobs elsewhere in the mill as positions became available. Four other workers (three from the extra board and one from the chip bin) were brought into the digester room to fill vacancies created when workers moved up to better jobs on the basis of their job seniority. (See table 18.)

Thus, the total number of jobs eliminated was small, but a considerable number of workers who remained in the unit were reassigned to new jobs. Twenty-six of the 61 digester room workers were assigned to a different job after the change.

Table 18. Plant B: Job status of digester room and diffuser room workers after technological change

Job status	Employees	
	Number	Percent
Total	69	100.0
Remained in digester room	61	88.4
Assigned same job	35	50.7
Assigned different job	26	37.7
Diffuser room employees transferred to extra board	8	11.6
Left the company	0	--

Source: Plant records.

Downgrading and Upgrading. Of the 69 workers in affected units, 26 were upgraded an average of 6 cents an hour, and 8 were downgraded an average of 48 cents an hour. The remainder experienced no change in grade. (See table 19.)

Table 19. Plant B: Grade status of workers in affected units immediately after technological change

Grade status	Number	Percent	Average increase or decrease (cents per hour)
Total	69	100.0	--
Upgraded	26	37.7	6.2
No change in grade	35	50.7	--
Downgraded	8	11.6	-47.5

Source:

From 7 to 16 months after assignment to the extra board, the eight workers who experienced sharp cutbacks in pay were reassigned to permanent jobs elsewhere in the mill. They were not able, however, to regain a wage level equivalent to that prior to the change. The average hourly wage rate for the eight workers was $2.15 per hour prior to the change, but was reduced to $1.67 per hour or 22 percent immediately after the change, and then rose to $1.89 an hour after reassignment to jobs elsewhere in the plant. However, this average hourly wage rate ($1.89) was still 12 percent below the average rate they received prior to the change. (See table 20.)

Change in Occupational Structure

The most significant occupational change resulting from the new equipment was a cutback in manual jobs involving physical, repetitive manipulation of machinery. Formerly, the workers whose jobs were eliminated manually unbolted and removed a heavy steel digester cover, lowered a chute into the digester to refill it with chips after each cook, and then replaced the digester cover and bolted it down. This sequence of manual operations was repeated for each of the four digesters in a rotating cycle. In the washing operation, the workers cleaned the diffuser tanks after each batch of chips was washed--a physically demanding task. Employees in these jobs worked in an atmosphere of wood dust, heat, and steam.

Table 20. Plant B: Changes in job assignments and hourly wage rates of the eight diffuser room employees whose jobs were eliminated

Employee	Job before change		Job after change		Subsequent change			
	Title	Hourly wage rate	Title	Hourly wage rate	Title	Hourly wage rate	Number of months after being assigned to extra board	Unit
A	Diffuser operator	$2.40	Extra board	$1.67	Second helper	$1.94	16	Brown stock washers.
B	Diffuser operator	2.40	Extra board	1.67	Filter man	2.27	12	Yard.
C	Diffuser operator	2.40	Extra board	1.67	Chip bin	1.91	11	Digester room.
D	Diffuser operator	2.40	Extra board	1.67	(1/)	(1/)	(1/)	(1/)
E	Diffuser dumper	1.89	Extra board	1.67	Utility man	1.73	10	Sulphate finishing room.
F	Diffuser dumper	1.89	Extra board	1.67	Salt cake roller	1.80	--	Recovery room.
G	Diffuser dumper	1.89	Extra board	1.67	Salt cake roller	1.80	8	Recovery room.
H	Diffuser dumper	1.89	Extra board	1.67	Salt cake roller	1.80	7	Recovery room.

1/ Information not available.

Source: Plant records.

The content of the new jobs contrasted sharply with that of the eliminated jobs. The operator (pandia cook) monitors a graphic control panel of dials located in an air-conditioned room. On the basis of his readings, he manually adjusts controls which vary digester pressure and temperature, steam and liquor flow, stock chest level, and conveyor speed. He also records certain instrument readings in a logbook every hour.

In addition to assisting the pandia cook, the assistant operator (pandia helper), occasionally leaves the control room to tour the pulping and washing area to check the condition of the equipment. He also records hourly data from instruments.

The impact of these changes on the digester room occupations is summarized in tables 21 and 22. Before the change, about 3 out of every 4 workers were hand laborers; after the change, about 2 out of every 3 workers were in this category. For the semichemical unit only--where the new technology was introduced--the occupational shift was more striking. All workers are now machine operators, whereas before they were all hand laborers.

Table 21. Plant B: Staffing pattern of digester room and No. 2 diffuser room, before and after technological change

Occupations	Number employed	
	Before change	After change
Total	69	65
Digester room	61	65
Digester cooks	8	8
Assistant cooks	4	4
Pandia cooks	--	4
Pandia helpers	--	4
Gas off men	12	12
Measuring tank men	4	4
Blow men	4	4
Blow men helpers	4	4
Cappers	25	21
No. 2 diffuser room	8	0
Diffuser operators	4	1/
Diffuser dumpers	4	1/

1/ Diffuser room closed down.

Source: Plant records.

Table 22. Plant B: Distribution of digester room and No. 2 diffuser room occupations by classification, before and after technological change

Job classification	Digester room and No. 2 diffuser room 2/				Semichemical unit only			
	Before change		After change		Before change		After change	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total	69	100.0	65	100.0	12	100.0	8	100.0
Supervisors	1/ 4	5.8	1/ 4	6.2	0	--	0	--
Machine operators..	12	17.4	17	26.2	0	--	8	100.0
Hand laborers	53	76.8	44	67.7	12	100.0	0	--

1/ A digester cook is a working foreman.
2/ After the change refers to digester room only; No. 2 diffuser room was closed down.

Note: Because of rounding, sums of individual items may not equal totals.

Source: Derived from data from plant records.

Overall Change in Grade Levels. Based on comparisons of average hourly rates, skill requirements in the new semichemical unit, where most of the job changes took place, increased slightly after the change: wages rose less than 2 percent--from $2.05 to $2.08 per ton. (See table 23.) In the digester room, the change had little impact on the overall skill level of the unit.

In comparing skill levels only on the basis of wage rates, however, it is important to keep in mind that wage rates are established not only on skill levels, but also on working conditions. For example, the unpleasant working conditions of the diffuser dumper were important considerations in establishing his wage rate.

Plantwide changes, 1953-58. From 1953 to 1958, total plant employment declined by 5.8 percent, but production increased by 2.6 percent. The reduction in employment was accomplished by not filling vacancies and not rehiring workers released because of a business decline. The increase in output per man-hour in the digester room was among the factors enabling the plant to increase production with fewer workers.

The relative importance of administrative, professional, and office employees increased from 10.2 percent of total plant employment in 1953, to 11.3 percent in 1958. (See table 24.)

Significant gains in the relative importance of specific occupational groups occurred. Supervisors and foremen, for example, rose from 3.8 to 4.5 percent of total employment. Engineers, chemists, and draftsmen also increased slightly in importance over the 5-year period.

Training Workers for New Jobs

Training employees to provide them with the skills needed to perform new jobs was especially important, since the content of the new jobs differed considerably from the old ones.

Workers selected for new jobs received training over a period of 6 months prior to startup of the new system. As a first step, company engineers prepared a detailed illustrated manual describing the new system's operation, a copy of which was given each worker to study. Next, a series of lectures on the subject was presented during working hours by company engineers and representatives of the equipment suppliers. Finally, practice runs were held to acquaint workers further with the procedure for starting up and shutting down the new system. When workers became proficient on the system's operation, the new equipment was put into regular production. The company now concludes, on the basis of operating experience, that a new worker can be trained completely in about 2 or 3 weeks.

Table 23. Plant B: Average hourly wage rate, and percent distribution of employees by wage rate, before and after technological change

	Digester room and No. 2 diffuser room				Semichemical unit only			
	Before technological change		After technological change		Before technological change		After technological change	
	Number of jobs or employees	Percent	Number of jobs or employees	Percent	Number of jobs or employees	Percent	Number of jobs or employees	Percent
Total	69	100.0	65	100.0	12	100.0	8	100.0
$2.60 and over	8	11.6	8	12.3	0	--	0	--
$2.50-$2.59	0	--	0	--	0	--	0	--
$2.40-$2.49	4	5.8	0	--	4	33.3	0	--
$2.30-$2.39	4	5.8	4	6.2	0	--	0	--
$2.20-$2.29	0	--	4	6.2	0	--	4	50.0
$2.10-$2.19	12	17.4	12	18.5	0	--	0	--
$2.00-$2.09	0	--	0	--	0	--	0	--
$1.90-$1.99	8	11.6	8	12.3	0	--	0	--
$1.80-$1.89	33	47.8	29	44.6	8	66.7	4	50.0
Average hourly rate	$2.075		$2.079		$2.053		$2.080	

Note: Because of rounding, sums of individual items may not equal totals.

Source: Derived from data from plant records.

Table 24. Plant B: Composition of the work force, by occupation or plant department, 1953 and 1958

Occupation or plant department	1953		1958	
	Number	Percent	Number	Percent
Total employment (yearend)	2,007	100.0	1,891	100.0
Administrative, professional, and office employees	204	10.2	214	11.3
Administrative	21	1.0	18	1.0
Supervisors and foremen	77	3.8	85	4.5
Engineers, chemists, and craftsmen..	20	1.0	26	1.4
Typists, stenographers, etc.	86	4.3	85	4.5
Production and related workers	1,803	89.8	1,677	88.7
Wood preparation and handling	81	4.0	69	3.6
Pulpmill	402	20.0	379	20.0
Papermill	317	15.8	315	16.7
Finishing and converting	93	4.6	78	4.1
Shipping and receiving	67	3.3	59	3.1
Maintenance and repair	428	21.3	404	21.4
Laboratory testing and research	96	4.8	92	4.9
Other 1/	319	15.9	281	14.9

1/ Includes powerhouse, storeroom, custodial, yard, timekeeping, etc.

Note: Because of rounding, sums of individual items may not equal totals.

Source: Plant records.

Retraining Reassigned Workers. Those who were assigned to different jobs were not formally retrained. Workers who moved into new jobs within the digester room on the basis of seniority were generally familiar with the duties of the next position to which they would be assigned within the job progression system. These workers were able to learn specific duties of the new jobs during the 30-day probationary period provided for in the union agreement. No training was given to the eight workers assigned to the extra board, since their next job assignment was not yet determined.

Effect on Safety Conditions

Compared with the batch system, the continuous pulping installation is a safer workplace. There is less danger of workers accidentally falling into the digesters, or of being injured by flying chips and wood dust. Since the work of the capper and diffuser dumper have been abolished, there has also been a reduction in muscle strains.

Labor Management Practices Regarding Personnel Adjustments

Affected workers were informed in advance concerning their reassignment. Since no layoffs were planned, those whose jobs were being abolished when the unit was closed down were informed, under terms of the union agreement, that they would be "bumped back" to the extra board. This information was given verbally by the tour foreman, but most workers were already aware of the proposed change, owing to informal discussion with members of the planning group.

Practices Regarding Reassignments. Reassignments of workers to different jobs were made according to provisions of the union agreement. These provisions include:

> The principles of departmental seniority, if the employees in question are equally capable and efficient, will be given every consideration by the management in all promotions and demotions . . . and layoffs and rehiring.
>
> In each line of promotion, seniority will be based on length of service in each position, rather than on total length of employment with the company.
>
> The management will consult with the departmental adjustment committee . . . in regard to layoffs and rehiring. Men will be hired in the reverse order in which they were laid off.

Since workers in the diffuser room whose jobs were abolished constituted a complete seniority unit, they were transferred to the extra board. At the same time, new jobs in the digester room were filled with workers from the extra board who had some previous seniority in the digester room. (See table 25.) These employees were given a 60-day trial period, according to provisions of the union agreement. The assignment of lower seniority workers

to digester room jobs over the displaced diffuser room workers with longer seniority was governed by a clause in the union agreement:

> Regular men whose jobs are abolished or who are cutback due to curtailment of operations, will have preference to extra work and vacancies in all parts of the mill based on qualifications and date of employment (except these employees will not supersede employees who acquired seniority in a unit prior to July 1, 1956, or who have established callback time in a department).

Although workers in jobs eliminated in the diffuser room averaged twice as much plant seniority as those who moved into new jobs in the digester room, they could not be assigned to the new jobs as long as others had some seniority within the digester room unit.

Table 25. Plant B: Average age, years of service, and wage rates of workers in new jobs and in jobs eliminated

Item	Workers in new jobs in the digester room	Workers in jobs eliminated in the diffuser room
Number of workers	1/ 8	8
Average age	39.0	48.4
Average years of company service	11.2	22.1
Average wage rate:		
Before the change	$2.02	$2.15
After the change	$2.08	$1.67

1/ Includes 4 digester room workers whose jobs were abolished.

Source: Plant records.

Setting Wage Rates for New Jobs. In establishing wage rates for the new jobs of pandia cook and pandia helper, management and union representatives met to negotiate according to a general provision in the union agreement

regarding changes in the schedule of rates:

> The wage rates . . . shall remain in effect during the term of this agreement, unless changed by mutual consent of the signatory parties at a meeting called on 30 days' written notice by either of the parties hereto.

Since both jobs were new to the company, management proposed that the hourly rates for these positions be made comparable with those set for similar jobs in plants in nearby states. Although the union representatives initially accepted rates established by this method, they now feel, on the basis of operating experience, that the rate for the pandia operator should be increased.

Case Study of an Automatic Paper Roll Handling System

Summary

The effect of installing an automatic paper roll handling system in a recently built and highly mechanized mill was to expand capacity and to reduce unit labor costs substantially in the shipping operations. The system is an example of the most advanced automation in this operation. The change involved moving conveyors with electronic devices that performed tasks formerly done by hand. Because of enormous increases in capacity and employment, the changes were made with minimum dislocation. Employees acquired the skills needed for operating and maintaining new equipment by attending a school operated by the equipment supplier. The new system required more supervisors and machine operators but fewer record keepers and hand laborers. The overall grade level, however, was not raised.

Description of Plant

Plant C employs over 800 workers to produce more than 425,000 tons of kraft paper and board annually. This highly mechanized mill was constructed in the early 1950's.

The high quality kraft paper and board produced is sold to bag and box manufacturers and converted into such items as corrugated boxes, shipping containers, bags, packages, and wrapping papers. About 50 percent of the annual output is retained for use within the parent company.

The plant is owned by one of the Nation's largest paper and packaging manufacturers. Since the end of World War II, net sales of the parent company have nearly tripled, largely as a result of the introduction of new products such as glassine and greaseproof papers; waxed paper products; and corrugated, folding, and setup boxes.

Plant C has had an equally impressive growth. In response to the strong postwar demand for kraft products, capacity was increased by more than 300 percent and employment nearly doubled since the plant began operations.

Management plans to place high priority on improved quality control procedures to meet increased competition among kraft producers. Beta gages and equipment to measure moisture content of paper may be installed on papermaking machines to give continuous and more accurate quality control.

Major Technological Changes

The major change described in this study concerned the finishing and shipping department, the final processing area. Most of the plant's production is shipped in large rolls each weighing as much as 3,000 pounds. Some output is processed through finishing operations where it is converted into sheets and rolls, according to customer specifications.

The Former System. Prior to the change, preparing rolls for shipment involved heavy manual operations. After leaving the winder at the end of the Fourdrinier papermaking machine, rolls were pushed by hand onto a scale where a worker recorded weight and hand stenciled information such as type of paper and order number, on the face of the roll. Loose ends of paper were glued down, plugs driven by hand into the center of rolls, and protective steel bands were applied. Next, rolls were transferred by elevator and conveyor to an area near the loading docks where they were inspected and moved by forklift truck to railway cars and trucks.

The primary drawback of the old system was its lack of capacity to handle additional output from a second papermaking machine installed in 1957. Since all output must pass through shipping operations, a larger system was felt to be necessary, with a capacity to process at least 1,300 tons of kraft paper and board daily, instead of only 300 tons.

The old materials handling operation was also relatively inefficient and time consuming. The rolls had to be transported a considerable distance from paper machine to loading dock by hand and by lift truck. Management therefore sought an alternative method, to achieve laborsavings and lower per ton costs.

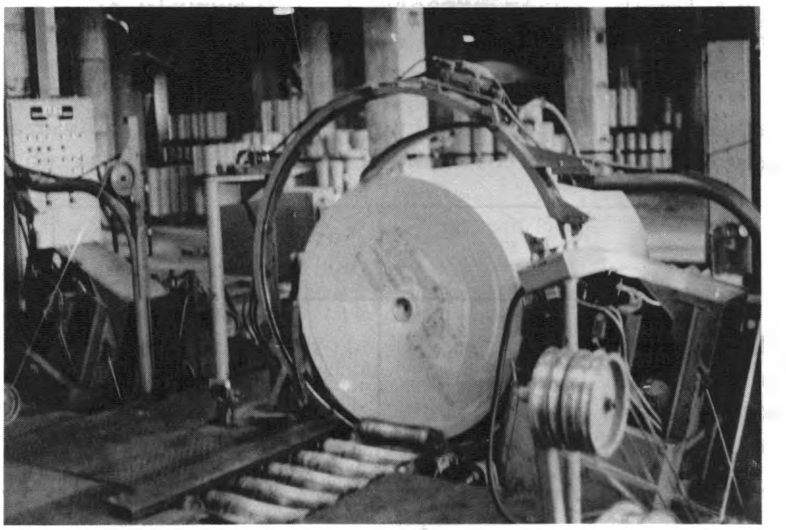
Planning the Change. To improve the system, the finishing and shipping superintendent and his staff, assisted by company engineers, began an intensive study to develop better handling methods. Equipment manufacturers were consulted and their systems studied in detail. Finally, on the basis of these studies, the planning group recommended the purchase of an automatic roll handling system. Installation of the equipment by the manufacturer required about 1 year.

The New System. The new automatic control and conveyor system began operation in the fall of 1957, simultaneously with startup of the new papermaking machine.

The new system resulted in virtually automatic transfer of paper rolls through shipping operations. It consists of a dual line of integrated conveyors (one to service each papermaking machine) over which rolls are mechanically transported to preselected loading areas. The control mechanisms include memory drums, photoelectric devices, switches, relays, and timers which automatically start the equipment in sequence. Although rolls are still stenciled, glued, and plugged by hand, significant laborsavings are derived from more extensive and integrated conveyor systems, and automatic banders. (See Fig. 2.)

Processing paper rolls through shipping operations by an automatic paper roll handling system

Worker controlling movement of paper roll along a conveyor line



Banding machine automatically applying steel straps to paper roll

Some Indicators of Change. The total installed horsepower of equipment used in shipping operations was nearly four times greater after modernization. (See table 26.) Employment increased by 170 percent, but horsepower per worker rose by only 44 percent. Horsepower per ton of capacity, however, declined by 22 percent after the change.

Table 26. Plant C: Horsepower installed and daily capacity, shipping operations, before and after technological change

Indicator	Former system	New system	Percent change
Total horsepower installed	207	807	289.9
Horsepower per worker	6.3	9.1	44.4
Daily capacity (tons)	300	1,500	400.0
Horsepower per ton of capacity	.69	.54	-21.7

Source: Derived from data from plant records.

Effect on Output Per Man-Hour

After modernization, output per man-hour was one-third higher, total output rose by 267 percent, and total man-hours increased by 170 percent. Man-hours per ton of paper processed consequently declined by 26 percent. (See table 27.)

Table 27. Plant C: Output per man-hour, and unit man-hour requirements, shipping operations, before and after technological change

Item	Former system	New system	Percent change
Tons processed (daily average)	300	1,100	266.7
Man-hours (daily)	264	712	169.7
Tons per man-hour (average)	1.14	1.54	35.1
Man-hours per ton (average)	.88	.65	-26.1

Source: Derived from data from plant records.

Effect on Maintenance Requirements

Maintenance requirements for the new equipment have been higher than anticipated. Most of the mechanical and electrical equipment used in operating the conveyors is located below floor level where inspection and maintenance is difficult and costly. For example, the new automatic banders have already been a source of difficulties with maintenance expense averaging as high as $2,000 per month.

On the basis of operating experience with the present system, management reported that it would strongly consider installing an overhead monorail system in future expansions of finishing facilities. This method would be easier to maintain and would offer more protection for rolls in transit. The economies possibly achieved through leasing this equipment rather than purchasing it outright are being explored.

Effect on Plantwide Output Per Man-Hour

Output per man-hour increased 112 percent between 1954 and 1958. Total output increased by 230 percent during this 4-year period, but total man-hours increased by 56 percent. The sharpest year-to-year change in output per man-hour occurred between 1957 and 1958, during which the plant underwent a major expansion. In addition to the automatic paper roll handling system, one of the world's largest kraft papermaking machines was installed. (See table 28.)

Table 28. Plant C: Indexes of man-hours worked, output, and output per man-hour, total plant, 1954-58

Year	Man-hours	Output 1/	Output per man-hour
1954	100.0	100.0	100.0
1955	95.1	107.3	112.8
1956	101.3	109.0	107.6
1957	133.9	170.4	127.3
1958	156.1	330.1	211.5

1/ Tons of unbleached kraft paper.

Source: Derived from data from plant records.

Displacement and Reassignment

Since total finishing and shipping department employment had to be expanded to handle the increased output, none of the original crew was laid off. Of the 33 employees in shipping jobs prior to the change, 32 remained in the department and 1 was transferred to the paper mill 2 months prior to startup of the new equipment. Most of the 32 employees who remained, however, were promoted to better jobs in the new system according to seniority provisions in the union agreement. Only 1 out of every 8 of these employees was working in the same job 1 year after the change. (See table 29.)

Table 29. Plant C: Job status of finishing and shipping department employees 1 year after technological change

Status	Finishing and shipping (total)		Shipping operations only	
	Employees		Employees	
	Number	Percent	Number	Percent
Total	44	100.0	33	100.0
Remained in unit	43	97.7	32	97.0
Assigned same job	9	20.5	4	12.1
Assigned different job	34	77.3	28	84.8
Transferred to another unit ..	1	2.3	1	3.0
Laid off	0	--	0	--

Note: Because of rounding, sums of individual items may not equal totals.

Source: Plant records.

Downgrading and Upgrading. The expansion in the number of finishing and shipping jobs resulted in extensive upgrading. Thirty-six out of 44 employees (82 percent of the total) were upgraded an average of 31 cents an hour. The remaining eight employees experienced no change in grade. No employee was downgraded. The eight employees promoted to tour foremen and shipping clerk jobs also received increases.

Change in Occupational Structure

Although only slight changes were made in the number and titles of job classifications used in shipping operations, the content of several jobs changed significantly. These changes resulted from the use of automatic equipment to perform certain operations which were done by hand in the former system, and from the introduction of improved materials handling machinery.

The content of the stenciler and production helper classifications, for example, was simplified, but not abolished, by the introduction of the automatic banding machines. One of the duties performed by the stenciler and production helpers in the old system was to apply, using hand tools, thin steel bands to each end of the paper roll. In the new system, however, rolls are automatically transported through banding machines by conveyors, and bands are applied mechanically.

The duties of the production weigher also changed significantly. In the old system, the production weigher recorded the weight of the roll after it had been pushed manually onto a scale, wrote certain information on the roll, and then pushed the roll off the scale by hand. Under the new system, the production weigher is now stationed at a control panel located between the conveyor lines. He controls by pushbutton the movement of conveyors which carry rolls into and out of the weighing stations. His job now involves surveillance of a wider expanse of the work area. Although information is still recorded and transcribed by hand, all material handling is accomplished by conveyors.

Table 30 summarizes the net effect of new equipment on the content of jobs. The decline in the relative importance of recordkeepers and hand laborers after the change, has been offset by the increase in the proportion of machine operators and supervisors.

Change in Overall Grade Levels

The introduction of the new materials handling equipment did not raise the overall skill level (measured by the wage rate) required to perform shipping jobs. The average hourly wage rate of shipping employees (excluding the tour foreman who is paid monthly) declined slightly after the change. (See table 31.)

Table 30. Plant C: Distribution of shipping occupations, by job classification, before and after technological change

Job classification	Before change		After change	
	Number	Percent	Number	Percent
Total 1/	35	100.0	95	100.0
Supervisors	2	5.7	6	6.3
Recordkeepers	4	11.4	8	8.4
Machine operators	5	14.3	25	26.3
Hand laborers	24	68.6	56	58.9

1/ Includes the finishing and shipping department superintendent and his assistant.

Note: Because of rounding, sums of individual items may not equal totals.

Source: Derived from data from plant records.

Table 31. Plant C: Average hourly wage rate, and percent distribution of employees by wage rate, before and after technological change

	Before technological change		After technological change	
	Number of jobs or employees 1/	Percent	Number of jobs or employees 2/	Percent
Total	33	100.0	89	100.0
$2.50 and over	4	12.1	16	18.0
$2.40-$2.49	0	--	0	--
$2.30-$2.39	0	--	0	--
$2.20-$2.29	0	--	0	--
$2.10-$2.19	4	12.1	0	--
$2.00-$2.09	1	3.0	1	1.1
$1.90-$1.99	6	18.2	28	31.5
$1.80-$1.89	12	36.4	16	18.0
$1.70-$1.79	6	18.2	28	31.5
Average hourly rate	$1.962		$1.923	

1/ Excludes the finishing and shipping department superintendent and his assistant.

2/ Excludes the finishing and shipping department superintendent and his assistant and 4 tour foremen.

Note: Because of rounding, sums of individual items may not equal totals.

Source: Derived from data from plant records.

Retraining for Changes

Several workers were sent to a school maintained by the equipment supplier where they received brief formal instruction in maintaining and operating the new banders. Immediately prior to startup, all workers were given a brief, informal orientation in operation by company personnel and by engineers from the equipment suppliers.

The 28 workers in shipping jobs who remained in the unit and were assigned to different jobs were not formally retrained, since their new duties were only slightly different from those previously performed. Specific requirements of the new jobs were learned on the job.

Effect of New Jobs on Safety Conditions

A significant result of the installation of the new equipment was the decline in frequency and severity rates of injuries in the finishing and shipping department, one of the most hazardous work areas in the mill. Although the absolute number of injuries increased along with the increased employment, the relative frequency of sprains, bruises, and other injuries per employee declined.

Labor-Management Practices Regarding Personnel Adjustments

Management's first step was to give advance notice of the impending changes to employees affected. Department foremen informally assured them that no one would be laid off owing to mechanization of shipping operations. Moreover, it was well known that more workers would be needed to handle the increased volume of work, and that those on the job would likely be promoted to better jobs under seniority provisions of the union agreement. Thus, a favorable climate existed before the actual personnel changes were made.

The changeover was discussed with union representatives at various times during the conversion. Suggestions were made by union representatives not only on labor aspects of the change, but also on methods of improving operations and installing the new equipment. Company officials adopted several of these suggestions. The union president reported that these advance negotiations by the local plant officials contributed to favorable relations during the changeover.

Practices Regarding Reassignment. Because of expansion in departmental employment, the principal problem of the changeover was assigning the former finishing and shipping crews to higher paid jobs according to seniority provisions in the union agreement. The provisions stated:

> The principles of seniority shall govern in promotions, layoffs, demotions, filling vacancies, vacations, transfers and rehiring, provided the employee has the necessary qualifications, dependability and ability to perform the work properly and efficiently.

> For the purpose of this agreement there shall be three types of seniority. Job seniority, departmental seniority, and mill seniority. Job seniority is defined as the length of service on a given job within a line of progression . . . Departmental seniority is defined as the length of service in line of progression. Mill seniority is defined as the length of service in the . . . mill.
>
> In the consideration of seniority in promotions and demotions, first preference shall be given job seniority. Where job seniority is equal, departmental seniority shall prevail. If job and departmental seniority are both equal then mill seniority shall determine the promotion or demotion.
>
> Seniority will operate according to lines of progression agreed upon between the local unions and the mill management. Such lines of progression shall be subject to change only by mutual agreement of the two parties.
>
> In filling subsequent vacancies in lines of progression, the senior qualified employee shall be promoted. Should a question arise as to whether or not the senior employee is qualified, and it cannot be resolved by agreement between the unions and management, the senior employee will be given a trial period up to thirty (30) days on the job in question.

Hiring New Workers. Management could, under provisions in the union agreement, employ new workers from outside the plant since the capacity of the department was increased substantially and experienced help was not available from within the mill. The specific provision states:

> Should the capacity of the mill or a department of the mill be increased it is understood management may hire experienced help where necessary.

Applicants for new jobs in the department were interviewed about 3 months prior to startup of the new system. Management sought high-school graduates with good employment records who were under age 30, and in good physical condition. Preference was given married persons who resided in the area. Those employed were brought into the department about a week before the new system was put into operation. Since most of the original workers in the department had moved into better jobs on the basis of seniority, new employees were used to fill the lower paid positions.

Special Problems During Reassignment. Some difficulties concerning seniority arose during assignment. According to union spokesmen, the "if qualified" clause in the seniority provisions of the union agreement permitted management to advance some employees into better jobs ahead of those with longer periods of service. The union also felt that an additional worker was needed to reduce the workload for the stencilers in the new system.

Establishing Wage Rates. The basis for negotiations over wage rates was a specific clause in the union agreement as follows:

> When major changes are made in the plant which create new jobs, or substantially change the duties of existing jobs, the management will meet with the unions concerned and receive from them their suggestions as to size of crew and appropriate rates of pay. If after discussion mutually satisfactory rates cannot be agreed upon, management will set rates but such rates may be subject to further negotiations at the next contract negotiations in a separate discussion from other adjustment requests, and any changes agreed upon at that time shall be retroactive to the date of the job changes which occasioned the rate adjustments.

It was agreed to apply the same wage rate after the change to most jobs because it was assumed that the content would remain substantially unchanged. The jobs of car bracer and car loader, however, were combined into a single classification (car loader and bracer), and the rate of the car bracer, the higher of the two rates, was assigned the new job.

Appendix A. Tables

Table A-1. Expenditures for new plant and equipment, pulp, paper, and board mills, 1947-60

Year	Expenditures for new plant and equipment (in millions)		
	Total	New structures and additions to plant	New machinery and equipment
1947	290.6	77.8	212.8
1948	(1/)	(1/)	(1/)
1949	212.4	36.8	175.6
1950	211.6	40.2	171.4
1951	262.8	46.1	216.7
1952	274.0	40.9	233.1
1953	276.3	41.3	235.0
1954	370.5	83.7	286.8
1955	388.9	68.7	320.2
1956	548.5	106.5	442.0
1957	584.4	98.3	486.1
1958	424.7	84.7	340.0
1959	449.8	(1/)	(1/)
1960	391.0	(1/)	(1/)

1/ Information not available.

Source: U.S. Department of Commerce, Bureau of the Census.

Table A-2. Capacity, and production of paper and board as a percent of capacity, 1947-60

Year	Capacity		Production as a percent of capacity
	Tons (in thousands)	Index (1947=100)	
1947	22,025	100.0	95.9
1948	23,389	106.2	93.6
1949	25,048	113.7	81.1
1950	26,059	118.3	93.5
1951	26,789	121.6	97.2
1952	27,854	126.5	87.7
1953	29,089	132.1	91.5
1954	30,025	136.3	89.5
1955	30,926	140.4	97.6
1956	32,579	147.9	96.5
1957	34,845	158.2	88.0
1958	36,025	163.6	85.6
1959	37,504	170.3	90.8
1960	38,847	176.4	88.7

Source: Capacity--American Paper and Pulp Association, year-end historic basis. The historical method assumes an annual capacity of 310 days' production-per-year for paper, and an annual capacity of 313 days' production-per-year for paperboard. Production--Bureau of the Census.

Table A-3. Indexes of output, production worker man-hours, and output per production worker man-hour in the pulp, paper, and board industry, 1919-60

/1947=100/

Year	Index			Year	Index		
	Output 1/	Production worker man-hours	Output per production worker man-hour		Output 1/	Production worker man-hours	Output per production worker man-hour
1919	31.7	64.7	49.0	1940	72.6	63.2	115.0
1920	36.2	70.6	51.3	1941	85.6	73.9	115.9
1921	27.4	53.1	51.5	1942	83.5	76.5	109.1
1922	35.1	58.1	60.5	1943	79.9	81.4	98.1
1923	39.2	61.0	64.2	1944	80.0	84.2	95.0
1924	38.2	57.5	66.5	1945	81.6	85.4	95.6
1925	43.3	61.8	70.2	1946	90.9	92.7	98.0
1926	46.6	64.9	71.8	1947	100.0	100.0	100.0
1927	47.2	62.0	76.1	1948	104.2	(2/)	(2/)
1928	49.2	61.3	80.2	1949	96.9	90.8	106.7
1929	52.8	65.4	80.8	1950	115.8	97.1	119.3
1930	49.6	61.0	81.3	1951	126.2	100.7	125.3
1931	45.5	48.8	93.1	1952	120.0	97.0	123.7
1932	38.7	41.8	92.7	1953	128.0	103.4	123.8
1933	43.9	46.3	94.9	1954	130.5	101.0	129.2
1934	43.3	48.2	90.0	1955	146.4	106.4	137.6
1935	49.9	52.3	95.5	1956	155.3	107.1	145.0
1936	56.8	56.9	99.9	1957	151.2	103.3	146.4
1937	60.9	60.3	101.1	1958	151.9	100.9	150.5
1938	54.3	52.6	103.2	1959	169.0	105.8	159.7
1939	64.4	59.0	109.2	3/ 1960	172.8	103.9	166.3

1/ Weighted average index for production of 24 product classes (since 1947); 8 pulp grades and 16 paper and paperboard categories. This index differs from an unweighted production index based on aggregate tonnage.

2/ Information not available.

3/ Preliminary.

Sources: Output based on data from the U.S. Department of Commerce, Bureau of the Census. Employment and hours based on data from the U.S. Department of Commerce, Bureau of the Census, and the U.S. Department of Labor, Bureau of Labor Statistics. Data prior to 1936 based on WPA National Research Project study.

Table A-4. Indexes of output, man-hours, output per man-hour, and unit labor requirements in the pulp, paper, and board industry, 1939 and 1947-60

/1947=100/

Year	Output	Production worker man-hours	Output per--			Labor requirements per unit		
			Employee	Production worker	Production worker man-hour	Employees	Production workers	Production worker man-hours
1939	64.4	59.0	(1/)	99.5	109.2	(1/)	100.5	91.6
1947	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1948	104.2	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)
1949	96.9	90.8	100.0	101.9	106.7	100.0	98.1	93.7
1950	115.8	97.1	116.1	118.0	119.3	86.1	84.7	83.9
1951	126.2	100.7	120.9	123.7	125.3	82.7	80.8	79.8
1952	120.0	97.0	116.5	120.0	123.7	85.8	83.3	80.8
1953	128.0	103.4	116.7	120.8	123.8	85.7	82.8	80.8
1954	130.5	101.0	119.4	124.2	129.2	83.8	80.5	77.4
1955	146.4	106.4	130.5	135.4	137.6	76.6	73.8	72.7
1956	155.3	107.1	135.5	142.0	145.0	73.8	70.4	69.0
1957	151.2	103.3	132.2	139.4	146.4	75.7	71.8	68.3
1958	151.9	100.9	134.7	142.4	150.5	74.3	70.2	66.4
1959	169.0	105.8	145.7	155.2	159.7	68.6	64.4	62.6
2/ 1960	172.8	103.9	148.3	159.4	166.3	67.4	62.7	60.1

1/ Information not available.
2/ Preliminary.

Sources: Output based on data from the U.S. Department of Commerce, Bureau of the Census. Employment and hours based on data from the U.S. Department of Commerce, Bureau of the Census; and the U.S. Department of Labor, Bureau of Labor Statistics.

Table A-5. Employment in the pulp, paper, and board industry, 1947-60

/Annual average--workers in thousands/

Year	All employees	Non-production workers	Production workers	
			Number	Percent of all employees
1947	234.0	27.1	206.9	88.4
1948	242.8	30.1	212.7	87.6
1949	232.6	30.1	202.5	87.1
1950	245.5	32.0	213.5	87.0
1951	257.6	35.1	222.5	86.4
1952	252.8	37.1	215.7	85.3
1953	258.3	38.7	219.6	85.0
1954	262.9	40.7	222.2	84.5
1955	271.2	43.8	227.4	83.8
1956	278.0	47.6	230.4	82.9
1957	277.4	48.3	229.1	82.6
1958	269.4	48.7	220.7	81.9
1959	273.8	50.7	223.1	81.5
1960	275.3	52.4	222.9	81.0

Table A-6. Average weekly hours and average hourly and weekly earnings of production workers in the pulp, paper, and board industry, 1947-60

/Annual average/

Year	Production workers		
	Average weekly hours	Average hourly earnings	Average weekly earnings
1947	44.2	$1.22	$54.10
1948	44.0	1.36	59.88
1949	42.4	1.41	59.83
1950	43.9	1.48	65.06
1951	44.4	1.60	71.04
1952	43.6	1.69	73.68
1953	44.0	1.79	78.76
1954	43.5	1.84	80.04
1955	44.3	1.94	85.94
1956	44.2	2.06	91.05
1957	43.4	2.17	94.18
1958	42.9	2.24	96.10
1959	43.9	2.34	102.73
1960	43.4	2.42	105.03

Table A-7. Employment in the pulp, paper, and board industry, by region, 1947 and 1958

/Workers in thousands/

Census regions 1/	1947		1958		Percent change
	Number of employees 2/	Percent of total employment	Number of employees 2/	Percent of total employment	
United States ...	197.9	100.0	223.2	100.0	12.8
Northeast	72.1	36.4	71.1	31.9	-1.4
North Central	55.1	27.8	56.2	25.2	1.8
South	54.5	27.5	74.4	33.3	36.5
West	16.2	8.2	21.6	9.7	33.3

1/ The regions in this table are: NORTHEAST--Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania; NORTH CENTRAL--Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas; SOUTH--Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas; and WEST--Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, and California.

2/ Employment data from the Bureau of the Census differs from the BLS series because of differences in collection methods and other factors.

Note: Because of rounding, sums of individual items may not equal totals.

Source: U.S. Department of Commerce, Bureau of the Census.

Table A-8. Establishments in the paper and board industry, by region, 1947 and 1958

Census regions	Number of establishments		Percent change
	1947	1958	
United States ...	665	1/ 743	11.7
Northeast	333	329	-1.2
North Central	198	219	10.6
South	94	115	22.3
West	40	80	100.0

1/ 44 establishments were misclassified in 1958 and included in industry SIC 2661, building paper and board mills, and excluded from industry SIC 2643, bags, except textile bags. The figures for each region were therefore adjusted downward in proportion to the regional distribution of establishments in industry SIC 2643 in 1958.

Source: U.S. Department of Commerce, Bureau of the Census.

Table A-9. Labor turnover, rates (per 1,000 employees), pulp, paper, and board industry, 1949-60

/Annual average/

Year	Accession rates		Separation rates		
	Total	New hires	Total	Quits	Layoffs
1949	17	(1/)	22	10	9
1950	24	(1/)	20	12	4
1951	28	23	28	17	4
1952	24	20	25	15	4
1953	24	20	23	14	4
1954	16	12	16	8	5
1955	18	14	16	9	4
1956	18	15	17	10	3
1957	16	12	19	9	7
1958	15	9	17	6	8
1959	18	13	17	8	6
1960	16	14	18	7	7

1/ Information not available on new hires in 1949 or 1950.

Appendix B. Selected Bibliography

I. U.S. Government Documents

A. U.S. Department of Labor Publications

The Coarse Paper Industry: Capital Requirements and Operating Ratios, 1949 and 1950, Bureau of Labor Statistics Report 24, Washington, May 1953. 45 pp. Prepared by the University of Pennsylvania, Wharton School of Finance and Commerce, for Mutual Security Agency, and Bureau of Labor Statistics.

"Occupations in the Pulp, Paper, and Paper Products Industry," Occupational Outlook Handbook, Bureau of Labor Statistics, Bulletin 1300 (Washington, U.S. Government Printing Office, 1961), pp. 682-690.

Pulp and Paper Mills: Case Study Data on Productivity and Factory Performance, Bureau of Labor Statistics, Washington, December 1951. 64 pp. Prepared for the Mutual Security Agency, Productivity and Technical Assistance Division.

B. Other

U.S. Department of Agriculture, Forest Service. Woodpulp Mills in the United States by State and Types of Products (Washington, U.S. Government Printing Office, June 1961). 23 pp.

U.S. Department of Commerce, Business and Defense Services Administration. The U.S. Industrial Outlook for 1961-91 Selected Industries (Washington, U.S. Government Printing Office, 1961), pp. 144-48.

U.S. Department of Commerce, Business and Defense Services Administration. Pulp, Paper, and Board, Annual review issues, March 1961, and prior years (Washington, U.S. Government Printing Office, 1961).

U.S. Congress, House of Representatives, Committee on Interstate and Foreign Commerce. Pulp, Paper, and Board Supply-Demand; Report, 85th Cong., 1st sess. (Washington, U.S. Government Printing Office, 1957). 218 pp.

U.S. Congress, Joint Economic Committee, Subcommittee on Economic Statistics. Measures of Productive Capacity; Hearings, 87th Cong., 2nd sess. (Washington, U.S. Government Printing Office, 1962). Statement on measuring capacity in the paper industry by Robert S. Shultz, 3d, pp. 148-165.

II. Books and Reports

American Paper and Pulp Association. The Statistics of Paper--1960 (New York, May 1961). 98 pp. See also The Statistics of Paper--1961 Supplement.

James P. Casey. Pulp and Paper--Chemistry and Technology, 2d ed., 3 vols. Pulping and bleaching, Papermaking, Paper testing and converting (New York, Interscience Publishers, Inc., 1960).

John A. Guthrie. The Economics of Pulp and Paper (Pullman, Washington, The State College of Washington Press, 1950). 194 pp.

John A. Guthrie and George R. Armstrong. "The Pulp and Paper Industry," Western Forest Industry: An Economic Outlook. Published for Resources for the Future, Inc. (Baltimore, Johns Hopkins Press, 1961), pp. 95-123.

International Brotherhood of Pulp, Sulphite and Paper Mill Workers. Report of the Proceedings of the 25th Convention, Montreal, Canada, August 31-September 4, 1959 (Fort Edward, N.Y., 1959). 288 pp.

Clark Kerr and Roger Randall. Causes of Industrial Peace, Case Study No. 1, Crown Zellerbach Corp., and the Pacific Coast Pulp and Paper Industry (Washington, National Planning Association, 1948). 78 pp.

David L. Luke. "Pulp and Paper," American Enterprise: The Next Ten Years, Martin R. Gainsbrugh, editor (New York, The Macmillan Co., 1961), pp. 217-222.

Robert M. Macdonald. "Pulp and Paper," The Evolution of Wage Structure by Lloyd G. Reynolds and Cynthia H. Taft (New Haven, Yale University Press, 1956), pp. 99-166.

John J. McMahon and Arnold Berman. Radioisotopes in Industry (New York, National Industrial Conference Board, Inc., 1959), pp. 77-82.

Organization for European Economic Cooperation. The Pulp and Paper Industry in the U.S.A. (Paris, 1951). 378 pp.

The Progress of Paper (New York, The Lockwood Trade Journal Co., Inc., 1947). 392 pp.

J. Newell Stephenson, editor. Pulp and Paper Manufacture, 4 vols. (New York, McGraw-Hill Book Co., 1950-1955).

United Papermakers and Paperworkers. Proceedings of the 2d Constitutional Convention, Washington, D.C., September 19-23, 1960 (Albany, N.Y., 1960). 346 pp.

George S. Witham. Modern Pulp and Papermaking, 3d ed., revised and edited by John B. Calkin (New York, Reinhold Publishing Corp., 1957). 549 pp.

Wood Pulp Statistics--26th Edition (New York, United States Pulp Producers Association, Inc., August 1961). 255 pp.

III. Periodicals and Articles

A. Periodicals

The Paper Industry, Fritz Publications, Inc., Chicago (Monthly).

Paper Mill News, L. D. Post, Inc., Philadelphia (Weekly).

Paper Trade Journal, Lockwood Trade Journal Co., Inc., New York (Weekly).

Pulp, Paper, and Board, U.S. Department of Commerce, Business and Defense Services Administration (Washington, U.S. Government Printing Office, Quarterly).

Southern Pulp and Paper Manufacture, E. A. Abernethy Publishing Co., Inc., Atlanta, Ga. (Monthly).

Tappi, Technical Association of the Pulp and Paper Industry, Easton, Pa. (Monthly).

B. Articles

George W. Brooks and Sara Gamm. "The Practice of Seniority in Southern Pulp Mills," Monthly Labor Review, July 1955, pp. 757-765.

"Computers Enter Paper Industry," Chemical and Engineering News, American Chemical Society, Washington, November 20, 1961, pp. 58-60.

Lee Eberhardt. "Economic Impact of New Processes on the Pulp and Paper Industry," The Paper Industry, Fritz Publications, Inc., Chicago, March 1958, pp. 982-983 ff.

Charles W. Heckroth. "Significant for the Sixties," Paper Mill News, L. D. Post, Inc., Philadelphia, December 26, 1960, pp. 29-30.

Helen Hunter. "Innovation, Competition, and Locational Changes in the Pulp and Paper Industry: 1880-1950." Land Economics (Madison, University of Wisconsin, November 1955), pp. 314-327.

Stephen S. Livers. "Taking the Art Out of Papermaking," Control Engineering, McGraw-Hill Publishing Co., New York, December 1961, pp. 20, 21.

John O. McCutcheon. "Continuous Pulping," Paper Mill News, Philadelphia, March 28, 1960, pp. 46 ff.

Paul L. Phillips. "Automation in Pulp and Paper," I.U.D. Digest, Industrial Union Department, AFL-CIO, Washington, D.C., Summer 1957, pp. 35-40.

Edward F. Thode. "What of Computers and the Paper Industry?--A 1959 View," Paper Trade Journal, Lockwood Trade Journal Co., Inc., New York, March 2, 1959, pp. 34-36.

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