Productivity growth in the switchgear industry slows after 1973

During 1963–73, the industry experienced a period of high growth, but from 1973 to 1982 its rate of productivity increase fell sharply in response to cyclical downturns in output, the energy crisis, and an overall falloff in demand for switchgear

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Productivity, as measured by output per employee hour, in the switchgear industry grew at an average rate of 2.0 percent per year between 1963 and 1982.[1] This gain is below the corresponding 2.4-percent rate for all manufacturing. Productivity growth was aided by the introduction of new design and manufacturing technology, but moderated by the impact of cyclical downturns in output and an overall falloff in demand for the industry's products beginning in 1973.

This industry manufactures such products as high capacity switching units and circuit breakers. These are utilized by electric utilities as part of their transmission systems and by industry as components of control systems for much of the manufacturing equipment being used. In addition, switchgear, generally in the form of low-voltage circuit breakers and panelboards, is used in the construction of new buildings. There also is a replacement market for switchgear, mainly from electric utilities and industry, and to a lesser extent, from building renovation.

Demand for switchgear is closely tied to changes in power usage, particularly increases in demand for electric power, which in turn lead to expansion of the power generating and transmission network. New building construction requires additional switchgear. New subdivisions are particularly important sources of demand for switchgear, because they require new switchgear installed by electric power utilities as well as the equipment installed in individual new homes. Demand is also tied to growth in the installation of new capital equipment, because switchgear is installed along with most new manufacturing, mining, and other fixed equipment.

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Output and productivity affected by energy crisis

Because of its energy-related markets, the switchgear industry was particularly affected by the slowdown in demand for electricity, which began with the oil embargo of 1973–74. Because of sharply rising energy prices (the Consumer Price Index for electricity almost tripled between 1972 and 1982), the growth in electric power production slowed dramatically after 1973. Demand for electricity, which had been growing at the very high rate of 8.0 percent per year from 1958 to 1973 increased at less than half this rate, 3.1 percent, from 1973 to 1982. During the latter period, there were additional factors affecting demand for switchgear—economic slowdowns and a sharp drop in homebuilding caused by high mortgage interest rates toward the end of the period. As a consequence of this decrease in demand, both output and productivity growth can be divided into two distinct periods. (See table 1.)

A period of high growth, 1963–73. Fueled by the continuing expansion of electric utility systems and growth in new plant and equipment investment, as well as technological changes in key products, output in the switchgear industry grew at a rate of 6.1 percent per year, well above the all-manufacturing average over this period. The industry's 3.5-

percent rate of productivity advance also was significantly above the all-manufacturing rate of 2.6 percent per year. Despite 2 years of productivity decline, including the recession year of 1970, annual productivity gains in this period tended to be much above those occurring in the post-1973 period. For example, productivity grew 8.6 percent in 1969, 7.1 percent in 1971, and 8.0 percent in 1972, but gains did not exceed 5 percent in any year after 1973.

Slower growth, 1973–82. From 1973 to 1982, industry output growth fell sharply, averaging zero. The productivity trend paralleled the slowdown in output, increasing at the low rate of 0.3 percent per year. The long recession of 1974–75, in association with the rapid expansion in energy prices, resulted in two consecutive, steep declines in industry output. In 1974, output decreased 7.3 percent, then plummeted an additional 18.2 percent in 1975. In turn, productivity recorded the largest decline over the period, falling 4.3 percent in 1974, and dropping an additional 3.8 percent in 1975. At the end of the period, both output and productivity posted 3 more consecutive declining years, reflecting the energy crisis in 1979, the 1980 recession, and the economic slowdown beginning in 1981. Output fell 5.3 percent in 1980, 6.2 percent in 1981, and an additional 10.2 percent in 1982. Productivity dropped 0.1 percent in 1980, 4.1 percent in 1981, and 1.3 percent in 1982.

Table 1. Output per employee hour and related indexes in the switchgear industry, 1963–82

[1977 = 100]

Year	Output per hour			Output	Employee hours		
	All employees	Production workers	Nonproduction workers		All employees	Production workers	Nonproduction workers
1963	70.9	71.3	69.8	54.9	77.4	77.0	78.6
1964	70.2	72.4	64.8	57.5	81.9	79.4	88.8
1965	74.4	74.3	74.5	62.1	83.5	83.6	83.4
1966	78.7	76.8	84.5	74.4	94.5	96.9	88.0
1967	79.1	77.3	84.1	77.8	98.4	100.6	92.5
1968	79.1	78.8	79.7	73.7	93.2	93.5	92.5
1969	85.9	85.2	88.3	83.8	97.5	98.4	94.9
1970	83.3	84.1	81.0	80.6	96.8	95.8	99.5
1971	89.2	90.7	85.6	83.8	93.9	92.4	97.9
1972	96.3	97.1	94.4	94.4	98.0	97.2	100.0
1973	101.5	100.7	103.5	108.0	106.4	107.2	104.3
1974	97.1	96.2	99.8	100.1	103.1	104.1	100.3
1975	93.4	99.2	80.8	81.9	87.7	82.6	101.3
1976	95.3	99.1	86.5	84.9	89.1	85.7	98.1
1977	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1978	102.4	102.6	101.8	107.0	104.5	104.3	105.1
1979	102.7	104.2	98.9	109.8	106.9	105.4	111.0
1980	102.6	107.1	92.2	104.0	101.4	97.1	112.8
1981	98.4	102.2	89.5	97.6	99.2	95.5	109.1
1982	97.1	103.9	82.7	87.6	90.2	84.3	105.9
	Average annual percent change[1]						
1963–82	2.0	2.3	1.4	2.9	0.8	0.6	1.5
1963–73	3.5	3.5	3.6	6.1	2.5	2.5	2.4
1973–82	0.3	0.8	−1.0	([2])	−0.3	−0.8	1.0

[1]Based on the least squares trend of the logarithms of the index numbers.

[2]Less than 0.05 percent.

Employment and hours

Employee hours in the switchgear industry grew 0.8 percent per year from 1963 to 1982. Changes in employee hours reflect both changes in the number of employees and in the average annual hours per employee. Employment grew 1.1 percent per year while annual hours per employee fell 0.3 percent per year.

The employment growth was similar for production workers and nonproduction workers, so that the proportion of production workers to total employment remained about the same, 70 percent, over the period measured. However, the average hours for the two groups of workers moved at different rates—for production workers, they fell 0.5 percent per year while for nonproduction workers, they rose 0.1 percent per year. Therefore, the slower growth in total hours as compared with employment can be traced to declines in the annual hours of production workers.

In this industry, year-to-year changes in employee hours and output tend to move in the same direction. However, the changes in employee hours are generally not as great as the changes in output, resulting in productivity changes. For example, in every year that output recorded a decline, employee hours fell also. With the exception of one year, the declines in employee hours did not match the drops in output, and productivity recorded declines. Conversely, in every year that output grew, except one, employee hours increased also. However, the gains in employee hours never were as great as the increases in output, and productivity posted gains.

This ability of the industry to adjust its employee hours fairly rapidly to shifts in demand can be attributed to the occupational makeup of the work force, which has a high percentage of operatives. For example, operatives tend to be more susceptible to layoffs, shortened workweeks, and other staff reductions than craftworkers, who tend to be retained when output slows because of the problem of replacing their higher skill levels.

Occupational data exactly matching this industry are not available. However, data on occupations are available at a somewhat broader level of aggregation for electric transmission and distribution equipment, which includes transformer as well as switchgear manufacturing.[2] These aggregate data should be representative of the switchgear industry which is similar to the broader category in many respects.

Operatives make up a large proportion of total employment in this group, accounting for 51 percent of total employment in 1980, compared with 43 percent for all manufacturing. The comparison is even more striking for assemblers, who make up 27 percent of employment in electric transmission and distribution, compared with only 8 percent for the all-manufacturing average. Although the proportion of engineers in these two industries is higher than the all-manufacturing average, craftworkers, at about 15 percent, are a somewhat smaller proportion than the 19-percent average for all manufacturing.

Capital expenditures tend to be low

The level of capital expenditures in the switchgear industry over the study period has been low. New capital expenditures per employee rarely exceeded half the average for all manufacturing industries from 1963 to 1981. While expenditures for new plant and equipment in this industry have grown over time, they fell off sharply after 1973 as demand for switchgear slumped. For example, while average capital expenditures per employee for all manufacturing industries increased in every year during 1973–81, expenditures in switchgear manufacturing posted a significant drop from 1974 to 1975. During that time, capital expenditures per employee fell to a level less than a quarter of the all-manufacturing average, and remained at less than 40 percent of that average through 1977. However, in recent years, capital expenditures in the industry began to expand somewhat more rapidly.

Industry structure dominated by large firms

Many establishments in this industry are owned by companies that manufacture many lines of electrical equipment. The proportion of shipments accounted for by the four largest companies remained at about 50 percent from 1963 to 1977.[3] Despite a recent trend to new facilities, many plants in the industry tend to be old. In some cases, they are housed in multistory buildings which have been refurbished by the addition of new manufacturing equipment. While there are a significant number of small establishments in the industry, on the whole, plants are large. The average number of employees per establishment in 1977 was 108, more than double the average for all manufacturing industries. In recent years, a number of foreign manufacturers have formed joint ventures with American firms or have purchased existing facilities and are producing switchgear in the United States. Plants in the industry tend to be concentrated along the eastern seaboard and in the Midwest. However, there are a significant number of plants located on the west coast, and California has the largest number of establishments in the United States.

Technology changes

Variety of products. Technological change in the switchgear industry is affected by the diverse variety of products manufactured. The small, simple items, such as panelboards and low-voltage circuit breakers, can be made in long runs and are amenable to assembly line equipment for manufacture. The larger units, such as transmission line circuit breakers and power and industrial switchgear, tend to require semi-custom production techniques. Generally, these units are designed to fit specific needs and are built to order. For example, a switchgear unit can contain such components as gauges, relays, capacitors, fuses, transformers, and switches all enclosed in a cabinet, which is generally made of steel and can be as large as a room.[4] Therefore, the production facilities for these larger units are set up to accommodate short runs of large, heavy, complicated units requiring a significant amount of manual assembly work.

Computer-assisted design. A key technological advance affecting the production of most of the larger types of switchgear is computer-assisted design. A large amount of design and engineering work is required to match the switchgear units to the customer's needs. Computer-assisted design cuts design and engineering effort drastically. A contract proposal, including engineering drawings and circuit diagrams, can be completed in minutes using computer-assisted design, compared with weeks without it. Therefore, this technique has greatly increased engineering and drafting productivity. It also has assisted overall manufacturing operations by making production scheduling more flexible.[5]

Numerical control. An innovation that has been widespread in the industry for some time is numerical control of machine tools. This technology was widely adapted because of the large number of complicated parts that must be built in order to assemble switchgear units. Many of these parts require a large amount of machining and are made in discrete batches adaptable to numerical control.

New plants. In recent years, a shift from old multistory plants to new single-story facilities has been underway. This has aided in the manufacture of larger-size units. Single-story plants result in much better workflow, cut materials handling greatly, and provide better work layouts. The new plants have also accelerated the impetus to install new, modernized production equipment.

Shift to sulphur hexafluoride. A significant change in one of the industry's major products has aided manufacturing techniques. Since the mid-1960's, there has been a shift from oil-type, air-blast circuit breakers for power transmission use to units using sulphur hexafluoride as the extinguishing medium. The new units are safer and much quieter and because they are significantly smaller in size and weight, they are easier to transport and install.[6] For example, some of the older, oil-based circuit breakers could be so large that they had to be shipped one to a flatbed freight car, but the new units are small enough to be shipped by truck. The smaller circuit breakers are also easier to manufacture, because they can be built by moving them from station to station on an assembly line rather than having them assembled largely in a single location, with workers and parts brought to them. Moreover, sulphur hexafluoride circuit breakers are being improved. In recent years, they have become even smaller and more modular. One plant, for example, is producing sulphur hexafluoride puffer circuit breakers, the capacity of which can be changed by the addition of breaker modules. Based on this design, the plant

is being completely revamped to introduce more automatic manufacturing equipment. For the first time in this plant, the circuit breaker modules will be built on a slowly moving assembly line using conveyorization, rather than being assembled at stationary locations and moved by forklift truck between work stations.[7]

Automatic computerized testing. An innovation that is becoming more widespread in the industry is automatic computerized testing, which is particularly important in the production of the large switchgear units and circuit breaker assemblies. Because switchgear is designed for protection or control of expensive equipment or large electric transmission systems, its failure could cause drastic problems. In addition, the larger types of switchgear tend to be very expensive. Therefore, they are extensively tested to meet specifications and operating conditions prior to shipment. In recent years, much of the manually operated electronic testing equipment has been replaced by automatic computerized testing, significantly reducing the number of inspectors and testers needed.

Productivity hindered. A factor retarding productivity is the industry's requirements for providing replacement parts for in-service units. In many cases, these parts are built to order, rather than kept in inventory. Currently, this is a relatively inefficient use of manufacturing capacity because a complicated machine tool may have to be set up to work on just a single item. Conversely, because switchgear units have long lives and have changed in design, it is difficult and expensive for producing firms to keep an adequate inventory of replacement parts on hand.

THE OUTLOOK FOR PRODUCTIVITY is unclear. In recent years, the industry has experienced very poor demand, and, as a result, output is currently at a level significantly below its peak in 1973. Although demand from the construction market is expected to pick up in the next few years from its current very low level, demand by utilities will probably remain low. While the shift to new, more efficient manufacturing facilities, computer-assisted design, advanced automatic equipment, and easier to manufacture products provides a basis for the industry to increase productivity, in the near future, changes in productivity are expected to be greatly affected by changes in demand, which are uncertain. □

FOOTNOTES

[1] Average annual rates of change are based on the linear least squares trends of the logarithms of the index numbers. The switchgear industry is designated as industry 3613 in the *Standard Industrial Classification Manual, 1972*, issued by the U.S. Office of Management and Budget. The industry is made up of establishments primarily engaged in manufacturing switchgear and switchboard apparatus. A technical note describing the indexes is available from the Office of Productivity and Technology, Bureau of Labor Statistics, Washington, D.C. 20212. The indexes for this industry will be updated and included in the Bureau of Labor Statistics annual bulletin, *Productivity Measures for Selected Industries*.

[2] "National Industry-Occupational Employment Matrix," 1980, Bureau of Labor Statistics, unpublished.

[3] *Concentration Ratios in Manufacturing, 1977 Census of Manufactures*, MC77-SR-1, 1981, p. 9-50.

[4] *Power Centers Including Type DS Switchgear*, Descriptive Bulletin 38-850 (Pittsburgh, Pa., Westinghouse Electric Corporation, 1978), pp. 1-55.

[5] Based on discussions with industry experts.

[6] *U.S. Industrial Outlook, 1973* (U.S. Department of Commerce, 1973), p. 273.

[7] Based on discussions with industry experts.

APPENDIX: Measurement techniques and limitations

Indexes of output per employee hour measure changes in the relation between the output of an industry and employee hours expended on that output. An index of output per employee hour is derived by dividing an index of output by an index of industry employee hours.

The preferred output index for manufacturing industries would be obtained from data on quantities of the various goods produced by the industry, each weighted (multiplied) by the employee hours required to produce one unit of each good in some specified base period. Thus, those goods which require more labor time to produce are given more importance in the index.

In the absence of physical quantity data, the output index for the industry which produces switchgear was constructed using a deflated value technique. The value of shipments of the various product classes were adjusted for price changes by appropriate Producer Price Indexes to derive real output measures. These, in turn, were combined with employee hour weights to derive the overall output measure. These procedures result in a final output index that is conceptually close to the preferred output measure.

Employment and employee hour indexes were derived from data from the Bureau of the Census. Employees and employee hours are each considered homogeneous and additive, and thus do not reflect changes in the qualitative aspects of labor such as skill and experience.

The indexes of output per employee hour relate total output to one input—labor time. The indexes do not measure the specific contribution of labor, capital, or any other single factor. Rather, they reflect the joint effect of factors such as changes in technology, capital investment, capacity utilization, plant design and layout, skill and effort of the work force, managerial ability, and labor-management relations.