CHAPTER 12

Employees and the Development and Use of New Technology

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CHAPTER 12

Employees and the Development and Use of New Technology

Summary

An industry's human resources are a vital factor in its ability to develop and adopt more competitive process technologies or to produce improved products. Steel industry personnel may be differentiated on the basis of education and compensation method. For the purposes of this study, technically trained personnel are employees with academic degrees in physical or computer sciences or engineering disciplines. Also included in this category are nondegree salaried employees, such as "melters," who have a high degree of technical expertise, training, and responsibility. Employees in the labor category generally have lower levels of education than technical personnel and are paid on an hourly basis.

The steel industry uses smaller numbers of technically trained personnel, and those personnel have lower levels of education, than is typical of most other industries. Slightly more than half of all technical personnel are employed in production and quality control, followed by somewhat less than one-fifth in engineering and R&D. Integrated firms employ large numbers of technical personnel in production, while alloy/specialty firms have a high proportion in quality control and marketing. These differences in the use of technical personnel are, to some extent, a reflection of the relative importance of these areas to the two industry segments. The nonintegrated segment employs the fewest technical personnel, consistent with the greater simplicity of both its processes and its products.

Research personnel are mainly responsible for market-oriented research that will lead to evolutionary changes in process and product. Their number declined during the early 1970's and has since slowly climbed back to 1970 levels.[1] Steel-related research in foreign nations provides more long-term intellectual and professional opportunities for technically trained personnel than in the United States. This may be attributed to greater government support for research abroad and also to the greater involvement of foreign steel companies in the sale of machinery and technology.

Opportunities for personnel-based technology transfer in the United States are limited, partly because movement by technical personnel into steel from nonsteel high-technology industries is negligible, and partly because the support given to continuing education by the steel industry is generally limited. A technical manpower shortage, now developing in a few selected areas, could become serious if the industry were to embark on vigorous modernization, R&D, and innovation programs.

The adoption of new steelmaking equipment or technology affects steelworkers in the labor category in several ways. Retraining programs may be needed and job classifications may need to be changed to accommodate skill changes. Plant labor practices need to allow for greater flexibility in work assignments.

There is some concern, particularly among those in the academic community familiar with the steel industry, that apprenticeship and retraining programs do not adequately train people for changing job requirements associated with the adoption of new technologies. On the whole, however, it appears that labor conditions have not been a constraint

[1] Bureau of the Census, "The Number of Scientists and Engineers in the Basic Steel Industry, 1970-1977," 1978.

on the adoption of new or more modern steelmaking equipment. Job classification schedules are periodically updated to accommodate gradual shifts in skill requirements resulting from technological change; and local practices do change, at least among those immediately affected, to allow for the efficient introduction of new technologies.

Technically Trained Personnel

OTA's information on technical personnel is largely based on a representative sample of companies responding to a written survey conducted by an OTA contractor. The companies covered in the survey represent close to 60 percent of the integrated producers, almost one-fourth of the nonintegrated firms, and more than one-third of the alloy/specialty companies. The information gathered was used to examine the adequacy of prevailing levels of education and training, technical manpower use patterns, and present and future technical personnel needs.

About 10 percent, or 16,000 employees, of the integrated companies are technical personnel. The greatest use of technical personnel by integrated steel companies is made by large plants with advanced technological bases. For the other two industry segments, the percentage of technical personnel ranges between 3 and 4 percent (table 148).

These figures are consistent with data on the profitability y of the three segments (see ch. 4): the low employment costs of nonintegrated producers contribute to their greater profitability, and the same appears true for the alloy/specialty producers. The most likely explanation for this pattern is that these two segments are largely free of the need for technical personnel in the primary, ironmaking stages of the industry; moreover, there is evidence that these two segments have made greater use of equipment suppliers for much of their technical support, particularly in the development of steelmaking furnaces.

The employment figures are also consistent with the lower capital costs for modernization and expansion in nonintegrated versus integrated plants (see ch. 10). As a result, OTA's Renewal scenario, with its emphasis on the nonintegrated segment, would have lower technical personnel requirements than the High Investment scenario, and its lower capital costs would be paralleled by lower employment costs.

Education

Compared to other manufacturing industries, the steel industry employs small numbers of technically trained personnel. Based on its total work force, the industry employs only about 60 percent as many scientists and engineers as the average manufacturing industry. This compares to 220 percent for petroleum refining, zoo percent for chemical and allied products, and 130 percent for electrical equipment.

The steel industry also relies more heavily on scientists and engineers with 1 to 3 years of college than is typical of manufacturing in-

Table 148.—Steel Industry Technical Personnel: Proportion in Total Work Force; Tonnes per Technical Personnel, 1979

	Integrated carbon steel	Non integrated carbon steel	Alloy/specialty	Total
Percent of technical personnel in total work force.........	**9.60/.**	**3.3%**	**3.60/.**	**8.71%**
Tonnes per technical employee	*2,256.3*	11,947.2	*2,131.8*	*2,352.3*

SOURCE: OTA contractor report by F A Cassell, et al, dustries in general.[2] For example, about 5.4 percent of the aluminum industry's work force has completed a 4-year college education in science or engineering, but this is the case with only 3.9 percent of all steel industry employees. Technical personnel with undergraduate degrees make up three-fourths of the steel industry's technical staff. They are well represented in production, but less so in engineering, R&D, and administration. Only 12 percent of all technical employees have graduate degrees— mostly at the Master's level. Larger companies tend to have more personnel with graduate degrees (table 149). Significantly, slightly more than 4 percent of technical employees have nondegree technical training.

The largest numbers of technical employees in the steel industry are mechanical and electrical engineers and material scientists (including metallurgists). A much smaller number are chemists and chemical engineers, and even fewer mining engineers and physicists work for the steel industry. In recent years, steel companies have brought in computer specialists, electronic engineers, and pollution engineers (table 150). With the exception of researchers, nearly all technical personnel are recruited upon graduation from college.

For steel-related technical input, the steel industry also relies heavily on domestic equipment manufacturers and engineering-construction firms, many of which are associated with foreign engineering firms and increasingly with foreign steel companies and equipment manufacturers. Domestic equipment companies have rather limited R&D programs. They tend to promote from within and maintain stable engineering groups, although their blue-collar work force may fluctuate

[2] Bureau of the Census, 1970 Census of the Population: Industrial Characteristics.

Table 149.—Technical Personnel; Degree and Work Assignment

	Engineering R&D	Administration	Sales/marketing	Production	Quality control	Other	Total Number	Total Percent	Employees in top management Number	Employees in top management Percent
Integrated										
Ph. D	222	12	3	15	8	5	277	3.1	26	9.4
M.S./M.A. .	382	104	43	199	53	64	845	9.5	71	8.4
B.S./B.A.	1,041	807	377	4,480	502	347	7,564	85.0	321	4.2
Associate ...	11	10	1	65	3	—	90	1.0	—	—
Nondegree	11	8	–	99	3	3	124	1.4	3	2.4
Total. . .	1,667	'94 1	424	4,858	569	419	8,900		421	
Percent of total	(18.70/~)	(10,6°/0)	(4.80/~)	(54.60/')	(6.5°/0)	(4.7°/0)			(4.7°/0)	
Nonintegrated										
Ph.D.	—	—	—	l	—	—	1	0.5	1	100.0
M.S./M.A, ...	4	2	–	3	3	4	**16**	7.8	**8**	50,0
B.S./B.A. .	21	25	9	23	12	31	**121**	58.7	20	16.5
Associate	3	—	3	4	—	10	20	9.7	—	—
Nondegree . . .	5	1	—	20	3	18	48	23.3	1	2.1
Total.	33	28	12	50	18	81	206			
Percent of total	(16.0°/0)	(13,6°/0)	(5.8°/0)	(24.3°/0)	(8.7°/0)	(39.3°/0)			(1 4.%0)	
Alloy/specialt y										
Ph.D.	**23**	1	**2**	1	1	1	29	2.6	6	10,7
M . S . / M . A .	**24**	**5**	**5**	10	5	5	54	4.8	2	3.7
B.S./B.A.	**137**	**123**	101	190	122	19	692	61.8	51	7.4
Associate	**20**	9	9	25	5	3			—	—
Nondegree . . .	**18**	62	69	69	45	11	274	24.5	1	0.4
Total.	**222**	200	186	295	178		1,120			
Percent of total	**(19.8%)**	(17.9%)	(16.6°/0)	(26.3%)	(15.9°/0)	(3.5%)			(5.4%)	

SOURCE. OTA survey, 1979 The sample represents close to 60 percent of the Integrated producers, almost one. fourth of the non!ntegrated producers, and more than one.third of the alloy/specialty producers

Table 150.—Technical Personnel by Degree and Field

	Mat. sci.	Chem.	Comp. sci.	Physics	Chem. eng.	Elect. eng.	Mech. eng.	Ind. eng.	Mining eng.	Other	Total
Integrated											
Ph. D.	85	64	–	14	19	6	17	4	6	**60**	277
M.S./M.A.	99	80	15	18	81	70	93	79	34	**276**	845
B.S./B.A. .	704	514	57	106	523	1,065	1,271	597	158	**2,569**	7,564
Associate .	2	6	9	–	1	16	7	—		**49**	90
Nondegree	6	12	11	2	4	16	12	**6**		**55**	124
Total. .	896	676	92	140	628	1,173	1,400	686	198	3.009	8,900
Nonintegrated											
Ph. D.	1	—	—	—	–	—	—	—	—	—	1
M. S./M.A. . . .	2	2	—	—	—	1	4	2	—	**5**	16
B.S./B.A.	18	7	9	–	–	13	20	17	1	**36**	121
Associate . .	—	—	8	–	–	6	1	1	—	**4**	20
Nondegree .	—	—	14	–	—	—	5	3	—	**26**	48
Total. . .	21	9	31	“ –	–	20	30	**23**	1	**71**	**206**
Alloy/specialt y											
Ph. D.	19	3	–	1	—	—	1	—	—	**5**	**29**
M.S./M.A.	19	4	—	1	—	2	7	**2**	—	19	54
B.S./B.A. . . .	139	34	9	11	22	64	108	**65**	16	223	692
Associate .	3	1	3	1	—	20	8	**5**	—	30	71
Nondegree .	22	6	17	—	—	6	6	**2**	—	215	274
Total. .	202	48	29	14	22	**92**	130	74	16	492	1,120

SOURCE OTA survey, 1979 The sample represents close to 60 percent of the integrated producers; almost one-fourth of the nonlntegraled producers, and more than one-third of the alloy/specialty producers

with changing business conditions. Many engineering-construction firms have broadly trained staffs, skilled in developing, organizing, and executing major projects from planning to startup. These staffs are well informed about new technological developments in steel and they know how such developments can best be incorporated into existing or new plants.

Technical Manpower Use

Production and Quality Control.—The steel industry employs slightly more than half of all its technical personnel in production and quality control (table 149). The industry's orientation toward engineering and product improvement as important means of responding to market needs gives these two functional areas great importance. Employees with responsibilities for technological problems tend to spend most of their time in the role of "firemen, " responding to particular problems at particular shops or plants that are beyond the capability of local operating and engineering managers to solve. Steel industry technical personnel are generally well trained to perform in the existing environment, which emphasizes incremental engineering and product improvements rather than major innovations based on new scientific or engineering knowledge.

Research and Development.—About 18 percent of all technical personnel in the steel industry is employed in engineering and R&D (table 149). There has been no growth in the number of research personnel during recent years. This may be attributed to a real dollar decline in steel R&D expenditures and to the virtual standstill in new plant construction. Not all steel companies even have R&D departments; in some cases, consulting firms are used instead of in-house technical R&D staff.

Steel industry research has been focused for the most part on cost improvement and on new products and alloys, and the development of new processes has been undertaken mostly to achieve these ends. A considerable amount of process research is carried out jointly by several steel companies, the entire industry, or by equipment manufacturers.

Sometimes research personnel undertake specific studies for the purpose of designing new equipment, but more often they function as troubleshooters in defining and solving problems that occur in the course of production with existing equipment. According to industry sources, approximately 20 percent of R&D staff works on meeting environmental requirements. For instance, U.S. Steel estimates that 12 percent of its scientists and 25 percent of its engineers are currently engaged in environmental control activities. The proportion of R&D personnel working on energy-related technologies is unknown.

The industry's orientation towards incremental, market-oriented R&D is generally reinforced by a reward structure that does not encourage independent and creative research. Although R&D and engineering personnel of steel companies may reach management positions by promotion in those units, a more typical route to higher levels of management is for a scientist or engineer starting in an R&D or engineering department to move first into other areas, such as marketing and production, where there are greater opportunities. Thus, competent researchers may not stay in R&D because they are more likely to reach higher salaries and more prestigious positions through other departments. The main disadvantage of drawing directly from R&D staff for management is that technical personnel may not have appropriate expertise for business and policy work. An advantage, however, is that such promotions will lead to greater awareness at the management level of the technological base of the company and a more effective use of technical feedback for process improvement and market development.

Of the steel industry's major international competitors, only the Japanese steel industry has an R&D program that is as strongly market-oriented as that of the United States. France, England, and West Germany have more diversified steel R&D activities, ranging from basic to applied research, than is the case in either the United States or Japan. Foreign steel producers are often the beneficiaries of publicly supported steel-related R&D, and they are also involved to a much greater extent in the sale of steelmaking equipment. All of these conditions combine to make R&D less subject to short-term fluctuations in the business cycle and to create more numerous long-term intellectual opportunities for R&D personnel than is the case in the United States.

Top Management.— Only 5 percent of all technical personnel in the entire industry have top management positions (table 149). Some steel industry analysts and customers argue that the overall influence of accounting and financial executives in the steel industry is far stronger than in the past; others disagree. If this is indeed the case, it is likely a reflection of declining profit margins in the industry and a resulting interest in tighter, more formal budgeting and proposal evaluation. Nevertheless, top executives of many of the most profitable and technologically competitive firms do have technical backgrounds. Although not heavily represented in top management, research department personnel regularly participate in the planning, conceptualization, and specification stages of capital proposals, Their primary functions in this role are to help anticipate technological changes and to evaluate the technological feasibility of various equipment features.

Technological change per se is generally not a primary concern of steel executives. Managers usually make an investment decision on the basis of the general necessity or wisdom of making such an investment, calculated or at least justified in terms of the profits and rate of return to be realized. Financial considerations are given priority, operating considerations are secondary, and technology is at best ranked third. *

*Important factors encouraging new investment are growth in markets, followed by considerations about the price level of steel. Still another factor affecting the decision to invest in new facilities is the rate of payoff from alternative investment opportunities outside steel. Tax factors also affect the extent and timing of investment in new facilities. The degree of technological change as it affects expected rates of return and risk also has considerable impact on the kind of equipment being acquired, but less so on the extent of investments being made. (D. L. Hiestand, High Level Manpower and Technological *Change in the* Steel *Industry, New* York, Praeger, 1974, pp. 29-30.)

Research personnel are sensitive to the reluctance of steel company executives to adopt new technologies. The receptivity of particular steel companies towards new technology largely depends on the top executives themselves. If top management creates an environment that is receptive to ideas and risk taking, those below them will be innovative; if adventurous planning, operating, and engineering managers are penalized or their suggestions discouraged, they will hold back.[3]

Differences Between Industry Segments

The major industry segments—integrated, nonintegrated, and alloy/specialty companies—show some interesting variations in their use of technical personnel (see table 149). On the whole, these differences are related to the greater complexity of integrated steelmaking and the greater emphasis on quality control and marketing in the alloy/specialty segment of the industry. The most significant differences are in the educational level of the technical staffs and in the way technical personnel are used.

Differences in Educational Level.—In general, lower level technicians are more prevalent in the nonintegrated and alloy/specialty segments of the steel industry, while integrated companies tend to require technicians with undergraduate and graduate degrees. Only about 2.5 percent of all technical employees in integrated companies have limited technical training rather than full degrees. By comparison, almost 35 percent of the technical staffs of nonintegrated companies and about 30 percent of those in alloy/specialty companies do not have baccalaureate degrees. Of those who do have degrees, about 3 percent of those in integrated companies, 8 percent in nonintegrated companies, and 7 percent in the alloy/specialty companies have advanced graduate degrees. One-third of all R&D technical employees in integrated companies have graduate degrees, compared with one-fifth for alloy/specialty companies and only one-tenth for nonintegrated companies.

Differences in Use of Technical Personnel.—Nonintegrated and particularly alloy/specialty companies employ a somewhat larger percentage of technical personnel in administration (14 and 18 percent, respectively) than do integrated producers (11 percent). Of greater interest, alloy/specialty companies use proportionately more technical employees in marketing and quality control than do the other segments (30 percent as opposed to 10 and 15 percent for integrated and nonintegrated firms). Alloy/specialty firms use about three times more of their technical personnel in marketing than do the nonintegrated producers. This is a reflection of the relative importance of product quality and marketing to alloy/specialty producers.

Integrated producers use more than half (about 54 percent) of their technical employees in production, twice the level for the other two segments (about 25 percent). To some degree this difference occurs because integrated companies use more processes than the others, so the technical side of production plays a more important role in their operations.

Although the nonintegrated companies have the smallest number of technical employees in relation to total production, they use a greater fraction of them in top management than do companies in the other steel industry segments. Fifteen percent of all technical personnel in nonintegrated companies are in top management, compared to about five percent for the other segments. Nonintegrated companies thus appear to encourage greater coordination between the economic and technological dimensions of management. One result of this may be the apparent rapid adoption of new technology made available by equipment manufacturers (foreign and domestic) and the constant attempt to reduce costs through technological change.

[3] D. L. Hiestand, High Level Manpower *and Technological Change* in the Steel Industry, New York, Praeger, 1974, pp. 29-30.

Employment and Continuing Education

Most steel companies have tuition support programs for undergraduate and graduate education. There is generally much less support for publishing in professional journals and for sabbaticals at domestic and foreign universities. Technical personnel in R&D are given some opportunity to attend meetings and conferences, but technical people in other departments tend to have few such opportunities, There is some criticism of the industry because the training and development of technical staff are geared to managerial and executive development rather than to ongoing education in technical specialties. These are the areas viewed by management as the industry's backbone, an orientation reflected in mobility patterns that generally reemphasize R&D.

The steel industry draws only small numbers of technical personnel from high-technology industries, such as aerospace, computers, and electronics, or from similar types of process industries such as chemical, glass, and aluminum. There appears to be a trend among steel technicians toward retiring to Government and university jobs; there is little flow of personnel in the opposite direction. The U.S. steel industry also lacks strong links with other industries, universities, or the Government with respect to midcareer employment or training, This limits the industry's ability to draw on technological ideas originating in other areas or to otherwise strengthen the professional background of its technical personnel. In Europe and Japan, on the other hand, there are opportunities for intersectoral training and mobility of technical manpower; in West Germany, there is much greater opportunity than in the United States for technical talent to move back and forth between Government and industry and between basic and applied research. The underlying goal is to provide industrial activities oriented towards the international market with a strong science and engineering basis. Clearly, this approach allows and even encourages considerable training and technology transfer between different sectors of the economy.

Present and Future Manpower Needs

The steel industry claims that it does not have problems in meeting its current technical personnel requirements. The industry's ability to attract technical personnel in sufficient numbers is in part related to improvements in steel industry pay scales during the 1970's. Starting salaries have become more competitive with those of other industries. Many steel executives make the following manpower assumptions:

- Most or all of the necessary manpower, with the required skills, is already present in the organization.
- If not already available, the necessary skills can be acquired by present employees through training, experience, or other means quickly enough to avoid hindering a project.
- If there are no present employees who can acquire the needed skills quickly and easily enough, trained personnel can be attracted from elsewhere either to meet fully the company's needs or to help develop existing employees.
- If all of the above are inadequate, some other organization can be engaged on contract to meet all of the company's needs or to develop the manpower required.[1]

Other industry representatives, particularly college recruiters, are concerned that more growth-oriented industries may be attracting the best technical talent. Clearly, the ability to meet personnel requirements does not fully lay to rest the question concerning the performance of the industry's technical personnel—particularly when more sophisticated equipment or processes are involved.

Occupational projections by the Department of Labor show that demand for steel industry professional technical personnel will

[1]Ibid., p. 38

increase by 5.6 percent between 1976 and 1985.[5] The use of lower level technicians in control and monitoring of production promises to enlarge. However, most growth and replacement demand is expected to be for chemical, civil, electrical, and sales engineers. This is the result of an ongoing emphasis on the development and application of existing steelmaking technologies.

Research activity in mining and metallurgical engineering is virtually nonexistent; this represents a national weakness in the preparation of sufficient numbers of such personnel. In addition to the lack of manpower, funding is a problem. Given the growing demand for high-performance steels and the growing use of computers in steelmaking, additional shortage areas are likely to include material scientists and electrical engineers familiar with both the industry and process control technology. Anticipated shortages of mining and metallurgical engineers and of process control experts will make it difficult for the steel industry to meet its needs for cost reduction, energy economies, and environmental compliance.

The future availability of technical personnel must also be viewed in terms of alternatives to present industry strategies. Current investment strategies entail leadtimes from concept to installation of new capacity that provide technical personnel with sufficient opportunity to learn what needs to be known about the improved technology. Should the industry decide to shift to a more extensive research program involving a greater emphasis on basic research and accompanied by a vigorous investment program in new steelmaking technology, it is uncertain that present staff would be fully capable of making the transition. Familiarity with fundamentally new technological concepts and completely new skills could be required, and most steel technicians are not now equipped to deal with such new skill requirements. Furthermore, the steel industry could face difficulty in recruiting some types of personnel. Unlike the highly regarded government-supported steel industries in other countries, the U.S. steel industry could have problems in attracting capable domestic technical personnel who now are inclined to work in higher technology, more R&D-intensive, and higher growth industries than steel.

[5] F. A. Cassell, The Use *of* Technical Personnel in the *Steel Industry* Including Comparison With *Japanese and* German *Industries*, contractor report for OTA, 1979.

Labor

Generally, steel industry employees in the labor category have not impeded technological change. However, the job classification system and local union work practices, as well as limited familiarity with new technologies, are potential constraints on the flexibility needed to introduce new steelmaking equipment and processes.

Apprenticeships and Retraining

The median age of steel industry employees is higher than the all-manufacturing average. * Nevertheless, a number of companies provide programs for the training or retraining of workers for jobs made more complicated by new technologies.** At one company, a program has been in effect since 1962 to retrain electrical workers for efficient main-

*In 1970, the median age for steel industry employees was 43.9 years, compared to the all-manufacturing average of 39,9 years. (Department of Commerce, Bureau of the Census, 1970 Census of Population: Industrial Characteristics, table 32.) Because of declining steel industry employment, it is likely that the industry's median age has increased at a faster rate during the past decade than the all-manufacturing average.

**Entry into apprenticeship training does not guarantee subsequent employment in a craft. Training may be terminated upon a substantial reduction in the number of required craftspeople within specific crafts as a result of technological changes in steelmaking process, practices, or equipment, (Agreement Between U.S. Steel and the USWA, 1977, p. 205.)

tenance of modern electrical equipment and controls. These updating and upgrading programs consist of classroom and laboratory training of up to 5 years. Most companies conduct some form of apprenticeship program to meet their maintenance requirements. There are such programs for about 20 different crafts in the steel industry, usually of 3 to 4 years duration, consisting mainly of shop training and classes.' Apprenticeship training provides companies with the growing number of craft workers that are needed in today's plants. An industry-labor committee develops educational attainment and work achievement standards for the various types of apprenticeships.

There is some concern, however, particularly among members of the academic community familiar with the steel industry, that these apprenticeships and retraining programs are inadequate because the instructors themselves may lack sufficient familiarity with new steelmaking technologies.

Job Classification

Generally, production processes and operating procedures in the steel industry have changed slowly over the years. Nevertheless, gradual technological and operational changes in steelmaking have created shifts in job content and occupational requirements for employees in the industry. During the 1950's and 1960's, the industry made major investments in blast furnaces, basic oxygen furnaces, and computer-controlled processes. A number of open hearths were gradually phased out. These technological changes reduced the need for unskilled workers and increased the need for craft workers and process-control specialists. Fewer workers are now directly engaged in production processes, and more nonproduction workers are needed. *

When such shifts in occupational requirements occur, job classifications may change too. The job classification system used in the steel industry describes skill requirements for 12 major job categories. These descriptions are developed and agreed upon by separate industry and union committees. A major overhaul of the job classification system took place in 1971 to bring job categories in line with gradually changing skill requirements.

Local Work Practices

Changes in skill requirements and declining steel industry employment levels** may require modifications of established work practices. These practices evolve from management policy, supplementary agreements with local unions, arbitrary decisions, and verbal understandings. Specific local practices cover such issues as job content, workload, crew size, seniority practices, and coffeebreaks. By their very nature, local practices may vary from plant to plant across the country.

A number of work practices go back many years in origin and during World War II a considerable number of local practices were added, either unilaterally by management or by agreement with local unions. At the height of the postwar economic boom, plants were operating at maximum rates and domestic market conditions were such that potential labor instability could be more counterproductive to the industry than limited protection for existing work rules. Local practices were given formal recognition by the well-known "local practices" (z-B) clause in labor's agreements with the major steel companies. Most, but not all, companies now have this provision in their contracts; a few

'Bureau of Labor Statistics, "Labor Productivity of the Steel Industry in the United States, " BLS report No. 310, 1966, p. 23.

*A 1969 Bureau of Labor Statistics study of the manpower implications of computer process control in blast furnaces, steel works, and rolling mills found that the major impact was a change in job duties rather than a change in the number employed. Job changes among operators generally consisted of a shift from manual to automatic control of dials, levers, and other control devices, Nevertheless, unskilled jobs are being eliminated wherever possible as labor-saving devices are adopted. For example, more efficient blast furnaces using processed ores eliminate many unskilled jobs. (Bureau of Labor Statistics, "Technological Change and Manpower Trends in Five Industries," Bulletin 1856, 1975,)

**Steel industry employment levels have decreased by 21.4 percent since 1960 as a result of limited growth and improved productivity. (See ch. 4.)

companies are bound by a weaker version of 2-B. The 2-B clause regulates unilateral management changes in local work practices. It requires management to maintain local practices unless change is required by contractually defined "changed conditions, " such as technological innovations, or by union agreement with proposed changes. *

As time passes, the gap between current conditions and those for which the local practices rule was originally established may grow wider. With the introduction of new steelmaking technologies, there has been a sudden surge in the number and gravity of labor issues. During the late 1950's, for instance, the various effects of automation on employment, job content, and organization of work dominated collective bargaining.

Work rules may become dysfunctional from a productivity point of view, although they may continue to serve the best interests of individual workers. Herein lies the potential for disagreement about the value of specific rules. It is often difficult to determine which local rules are inefficient, make-work rules. The U.S. Supreme Court has generally taken the position that because make-work practices sanctioned by union-management agreements are intended to protect labor, they are allowable. Most disagreements on local work rules are settled by arbitrators, and over the years a sizable body of formal understanding has developed from arbitration alone.

Regulations concerning the size of whole crews are the local practice usually held responsible for inefficiency. Management made unsuccessful efforts during the 1959 steel strike to have the 2-B clause removed from contracts in order to increase flexibility when using new technology such as fully automated equipment. Instead, the 1960 settlement of the steel strike provided for establishing a joint committee to study local working conditions.[7] This committee never became effective because the parties were unable to agree on a neutral chairman. Nevertheless, labor-management discussions continued on the subject, During the 1965 contract negotiations, the union made an unsuccessful demand for stronger union control over eliminating or changing job duties because of technological change. Finally, the 1974 Experimental Negotiating Agreement, the "no strike agreement, " retained the union's right to strike and management's right to lock workers out at a particular operation over local issues unique to that operation. *

Contractual changes relating specifically to 2-B continue to be made at the plant level during formal bargaining on local issues. These talks coincide with industrywide contract negotiations held every few years. Arbitrators have in general interpreted the local practices section in such a way as to give management a free hand in introducing technological changes and new equipment. Substantial changes in production methods have also been held to justify eliminating local practices. An accumulation of small changes over a reasonable length of time has been held to have the same effect as a single substantial change. When such changes occur, arbitrators have upheld management's unlimited right to make a fresh start in crew assignments rather than to be held to assignments in proportion to former workloads. Clause 2-B has been held to apply in many contract areas, but it has been narrowly applied in most cases. Most 2-B cases have been decided in management's favor. In part, this is because unions have failed to screen arbitration cases, and in part because charges of violation of 2-B have tended to be thrown into cases in which local working conditions are at best a peripheral issue. These arbitration

*"The Company shall have the right to change or eliminate any local working condition if, as the result of action taken by Management under Section 3, the basis for the existence of the local working condition is changed or eliminated, thereby making it unnecessary to continue such local working condition. Management's action is subject to the grievance procedure. " (Section 2-B, paragraph 4, of the basic steel industry agree-merit.)

"'Featherbedding and Union Work Rules, " in Editorial Research Reports, vol. H, R. M. Boeckel (cd.), 1959, pp. 815, 824-828.

*The agreement aims to stabilize steel production and employment in a cyclical economic environment faced with growing import penetration by labor agreeing not to strike during industrywide bargaining in return for cooperative contract negotiations.

decisions have encouraged most companies to consider local working conditions no longer a major barrier to eliminating inefficient work practices and certainly no barrier to introducing new technology.'

Companies differ in their ability to eliminate work rules that are inappropriate for new, modern equipment. * Only in a few companies or plants do employee pressures prevent the effective and efficient adoption of new equipment.[9] Successful companies wisely attempt to make new equipment more attractive to their employees: they develop wages and other incentives that reward highly productive operation and that cover a large proportion of their work forces. Established local practices do not prevent management from making unilateral changes in local practices such as reducing crew sizes if "conditions change" as specified in 2-B. The installation of new equipment, for instance, makes it possible to change local practices and improve productivity, although the 2-B clause makes it difficult to extend such changes to adjacent production areas that are not directly involved with the new equipment. *

"G. L. Magnum, "Interaction of Contract Administration and Contract Negotiation in the Basic Steel Industry," Labor Law Journal, September 1961, p. 856.

*Nonunionized companies, such as smaller nonintegrated steelmaker ("minimills"), are not bound by the 2-B contract provisions. They have much greater latitude in changing local work rules, regardless of whether such changes result from the use of new technology or new operating procedures. However. such companies might also be fared with informal resistance on the part of individual employees.

[9]In conversation with Milton Deaner, vice president, National Steel Corp.

*The following arbitration issue illustrates justifiable and unjustifiable management actions under 2-B:

While introducing a new incentive plan in a butt mill, management installed cooling table synchronization and reduced the crew size in the process. At the same time, for purposes of the incentive program, management reduced the spell time and crew size at a welder station on the same production line not affected by the changed mechanical condition.

The arbitrator upheld the first action but reversed the second, [J. Stieber, "Workrules Issue in the Basic Steel Industry, " Monthly Labor Review, March 1962, pp. 267-268.)

Conclusions

The training and skills of steel industry employees and their execution of responsibilities on the whole have not impeded the development and use of new technologies. The industry has successfully developed and marketed new products, although its record of process development is less strong. Nevertheless, there is room for improvement with respect to technical education and training, the use of R&D personnel, and local staffing practices,

The proportion of technical employees in the steel industry's work force is lower than the all-manufacturing average, and their educational attainment is somewhat lower than for other basic industries, Continuing education is generally adequate, although extensive career changes by means of sabbaticals or exchanges with universities and Government are not very common. Insufficient instructor familiarity with new steelmaking technologies appears to be a constraint in apprenticeship and retraining programs. Assuming that steelmaking technologies continue to grow in complexity and that product quality requirements continue to increase, then it appears that a future manpower shortage in mining engineers, metallurgists, electrical engineers, and computer scientists is likely.

Prevailing manpower use patterns are functional in that they reflect the industry's concern about production capability. The great majority of technical personnel employed by integrated producers work in this area. The technical staffing patterns of alloy/specialty companies place a greater emphasis on quality control and marketing. Only about 18 percent of all steel industry technical personnel are engaged in engineering R&D; an even smaller proportion is in steelmaking R&D because of considerable engineering work and environmental R&D being conducted by R&D staff.

Job classification schedules appear to have incorporated most changing skill requirements associated with technological change. Staffing flexibility at the plant level appears to be constrained, however, by the fact that local unions must approve changes in past staffing practices in production areas adjacent to those where new equipment has been installed.

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