Foreign Labor Developments

The impact of microelectronics on employment: Japan's experience

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Spurred by both political and economic factors, Japan has achieved a position of clear preeminence in the production and consumption of robotic technology, including a comprehensive industrial program aimed at microelectronic development.[1] The fact that output and consumption are 3 to 4 times the U.S. levels, a ratio that is expected to persist well into the 1980's, has led to the conclusion that the Japanese are roughly 5 years ahead of the United States in applying various kinds of microelectronic equipment.

In response to rapid innovations in the workplace, the Japanese Ministry of Labor surveyed several manufacturing firms to determine the impact of technology on workers.[2] The study, entitled "The Relationship Between Technical Innovation and Labor," was made available to the U.S. Department of Labor through a cooperative program with the Japanese Ministry of Labor. This program and those with other countries encourages the sharing of information on labor-related issues that may be of mutual interest.

This report presents significant results of the survey which was designed to ascertain the impact of the changes brought about by the application and production of integrated circuitry (or microelectronics) referred to as IC equipment. Approximately 10,000 private manufacturing enterprises employing 100 or more workers were surveyed in November 1982. Actually, the sample inculdes nearly all Japanese manufacturing firms with 100 employees or more.

Of course, given social and cultural differences, each country may differ in adjusting to technological change, but the *initial* impact of the introduction may be very similar.[3]

The increased use of computer-controlled machines and robots in U.S. factories has resulted in a rising concern of the impact that these new technologies will have on employment. Many believe that factory automation is necessary to help troubled U.S. manufacturers become more productive and competitive. However, there are adjustment costs associated with moving from the old to the new way of doing things. The extent of these costs is embodied in three issues put forth by a congressional examination of the spread of programmable automation in manufacturing. Will the new technologies put a significant number of people out of work? Will their introduction 'dehumanize' the work environment of those who remain? And how can the United States best prepare its education and training system to respond to the growing use of computerized manufacturing automation? [4]

Until recently, there was relatively little concern in Japan about the impact of technological innovation on jobs and working conditions.[5] Now, however, attitudes have shifted toward concern. The overall economic situation has deteriorated somewhat and technology is spreading from big to small businesses and from manufacturing to service industries.

Applications of microelectronics

The proportion of Japanese enterprises using IC equipment was 59.4 percent. Almost all large firms with 1,000 or more workers used such equipment, as did three-fourths of the medium-sized firms with 200–999 employees, and about half of the small firms with 100–199 workers. The vast majority of these firms (47.9 percent) were only users—not users as well as producers—of IC equipment.

The application of IC equipment in Japan is widespread among manufacturing industries. The proportion of usage is highest in the four machinery-related industries—general machinery, precision machinery, electric equipment, and transport equipment. Even in the textile, clothing, foodstuffs, and tobacco industries, IC equipment is used in around 40 percent of the firms.

The extent of usage also varied by manufacturing processes: Processing (changing raw materials) was nearly 90 percent automated, assembly and inspection each about 50 percent, and shipping around 30 percent. Application of IC equipment progressed from processing and inspection processes—many of which were implemented by 1974—to assembly, shipping, and other processes. The primary reasons for implementing the new technology were related to improving the firm's competitive position in the market place. Two-thirds of the firms employing IC equipment cited "to improve product quality and precision" and "a labor-

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saving measure'' as their reasons for doing so. These reasons did not vary much by firm size.

Impact on employment

The introduction of IC equipment changed, in a number of cases, both the method of production and the contents of production steps. In manufacturing, great progress was made in processing and assembly by automating several individual steps. Moreover, in inspection and shipping, the conventional flow of work changed completely. Job tasks were added as well as eliminated in the processes employing IC equipment. Such changes also extended to other processes elsewhere in the plant. These changes affected employment levels, training needs, skill requirement, working hours, and working conditions.

Employment levels. A comparison was made of the number of employees in the entire firm (excluding office employees) between the date the IC equipment was introduced and the previous year. Although factors other than the introduction of IC equipment were involved, employment increased in 5 percent of the firms employing such equipment and decreased in 30 percent. However, in two-thirds of the firms that reported a decline in employment, the decrease was less than 20 percent. (See table 1.) Small firms reported larger employment increases and smaller decreases than large firms. Not surprisingly, most of the employment changes occurred in the manufacturing processes where IC equipment was introduced. There were no employment level changes in about two-thirds of the firms using IC equipment. Among firms that were only *producers* (not users) of IC equipment, twice as many reported increases than decreases in employment.

The employment cutbacks were absorbed with very minimal dismissals by internal reassignments and transfers to associated facilities. Almost all of the workers who were reassigned or transferred remained at the same business site; most were usually transferred to other production processes within the same plant, only about 10 percent were transferred into office or sales sections. Dismissals or recruitment of voluntary retirees occurred in only 0.4 percent of the firms using IC equipment. Provisions for changes in working conditions, including transfers and required training, were generally discussed with trade union representatives in advance of the introduction of the new equipment.

Table 1. Percent of increases or decreases in employment and percent of firms providing training to production workers in integrated circuitry-equipped firms, by provider of training and firm size, November 1982

Item	Total	Large firms (1,000 workers or more)	Medium firms (300–999 workers)	Small firms (100–299 workers)
Percent of firms with integrated-circuitry-related employment changes				
Increases:				
Total	4.6	3.5	4.1	5.1
9 percent or less	22.2	9.5	27.4	21.6
10–19 percent	31.2	33.3	23.5	33.9
20–29 percent	13.8	19.0	15.3	12.8
30–49 percent	12.9	4.8	17.6	11.9
50–99 percent	6.3	14.3	3.5	6.6
100 percent	14.7	14.3	12.9	14.0
Decreases:				
Total	30.6	40.3	34.3	26.8
9 percent or less	37.2	40.2	39.6	35.1
10–19 percent	27.7	30.3	29.2	26.3
20–29 percent	16.5	12.7	15.0	18.1
30–49 percent	14.3	11.5	9.6	12.3
50 or greater	6.2	2.0	5.4	7.6
Percent of IC-equipped firms providing training to workers				
Total	60.0	65.3	63.8	57.5
Provider of training:[1]				
Company	53.5	85.3	61.4	44.6
Vendor	76.7	72.7	75.5	77.9
Parent company	7.3	1.8	6.6	8.4
Other	3.0	2.3	3.0	3.1

[1]Percentages do not add to 100 because some firms used more than one method to provide training.

Training needs. An education and training program allowing for time away from the job, was available to most workers (60 percent) who remained a part of the production process.

Of the firms where workers were transferred to another unit, a higher proportion carried out ''off-the-job'' education and training programs when transferring workers to office or sales sections (51 percent), than when transferring them to another manufacturing process (38 percent). These trends were the same in all enterprise sizes.

Vendors and manufacturers of IC equipment were the main providers of education and training to workers who remained in the process where the IC equipment was used. A large percentage of IC equipment users provided the training themselves or supplemented their training with that provided by the vendors, or both. (See table 1.) Large firms, for example, were more apt than other firms to provide the training themselves. Although large firms were more likely than small firms to make training available in general, the difference—65 percent versus 58 percent—was not very great. Small firms relied on the parent company much more than large firms for their training needs.

Skill requirements. The need for an education and training program is related to the large number of changes in the skills required for the manufacturing processes subsequent to the introduction of IC equipment. Nearly 70 percent of the firms using IC equipment experienced a change in the types or levels of skills required in the production process. In nearly two-thirds of these firms, new skills in addition to the conventional ones were required. (See table 2.) Nearly the same percentages of firms (15 percent) required workers with ''new skills in lieu of conventional skills'' as workers where ''lower level of skills was sufficient.''

The requirement for new skills and higher levels of skills

Table 2. Percent distribution of changes in skills required by manufacturing processes in integrated circuitry-equipped firms, by type of process, November 1982
[In percent]

Process	Percent requiring IC-related skill changes	New skills required	New skills and conventional skills required	Higher level of conventional skills required	Lower level of skills sufficient
All manufacturing processes	67.5	15.1	63.1	24.2	14.2
Processing	74.8	16.6	67.5	21.3	12.5
Assembly	68.7	15.0	60.4	25.0	15.6
Inspection	63.9	11.9	57.6	28.6	17.2
Shipping	52.6	17.3	58.4	21.0	18.3
Other processes	61.0	13.7	62.8	28.1	11.5

was slightly more prominent for processes directly involving production, such as processing and assembly, than for auxiliary processes such as inspection and shipping.

The reason behind the change in skill requirements was the change in job tasks that followed the introduction of new equipment. Nearly two thirds of the firms employing IC equipment reported major changes in job tasks. Generally, heavy, dangerous, and repetitive work decreased while supervision and maintenance of equipment tasks increased:

		Percent
Reporting decreases in:	Heavy labor	36.8
	Simple, repetitive tasks	35.5
	Dangerous and harmful work	30.5
Reporting increases in:	Equipment surveillance or supervision	51.9
	Equipment maintenance	43.0
	Simple, repetitive tasks	18.2

Reactions to microelectronics

Recruitment. The changes in job tasks and skill requirements that accompanied the introduction of IC equipment in the production process also lead to changes in recruitment. Slightly more than 10 percent of such firms experienced large changes in the types of workers they recruited. For example, nearly seven times as many firms reported increases than decreases in recruiting college graduates with science and engineering majors. (See table 3.) Decreases were more prevalent in recruiting college graduates in other fields. Recruitment of male high school graduates increased, while female recruitment decreased slightly overall. The recruitment of part-time workers increased a little, especially in smaller firms. The ratio of increases to decreases in the total number recruited was highest in small, rather than large firms among the worker groups studied.

Work force composition. Changes in the composition of the firms' work forces resulted from the internal transfers and changes in recruitment that accompanied the introduction of IC equipment. Twelve percent of the firms with IC equipment reported large compositional work force changes and a greater percentage of large (rather than small) firms reported such changes. (See table 3.)

Some of the changes at first glance may appear to be contradictory to the findings reported earlier in this summary. For example, although increases in the number of technicians outnumbered decreases 5 to 1, the percentage of firms reporting an increase in the number of skilled workers was only slightly higher than the percentage reporting a decrease. Moreover, the percentage of firms that reported an increase in the number of unskilled workers was larger than those that reported a decrease. The large increase in the number of technicians is, however, consistent with the increased recruitment of science and engineering graduates. The expected losses in the number of skilled precision production occupations and machine operators, assemblers and inspectors, all of which can be handled to some extent by IC equipment, would somewhat offset gains in other jobs requiring new or higher skills, or both. The fact that there was an increase in the number of unskilled workers in firms reporting large compositional changes is consistent with the finding that conventional skills were still needed in conjunction with new skills or were sufficient in some cases.

Subsequent to installing IC equipment, the work force of small firms reflected a higher proportion of young workers and male workers than previously. By contrast, the composition of the work force in large firms shifted towards

Table 3. Ratio of increases to decreases, by firm size, in the number of recruits, by education and in the number of workers, by selected groups in integrated–circuitry firms, November 1982

Characteristic	Total	Large firms (1,000 workers or more)	Medium firms (300–999 workers)	Small firms (100–299 workers)
Education of worker				
Percent of IC-equipped firms with large changes in recruitment	11.2	15.9	11.4	10.5
Ratio of increases to decreases:				
Total	0.9	0.5	0.7	1.2
College graduates:				
Science and engineering	6.9	4.8	4.6	11.6
Other	0.9	0.4	0.4	0.9
High School graduates:				
Men	1.3	0.4	1.0	2.1
Women	0.9	1.0	0.8	1.3
Selected group				
Percent of IC-equipped firms with large changes in work force composition	12.2	15.9	12.7	11.5
Ratio of increases to decreases:				
Skilled workers	0.3	0.3	0.2	0.3
Unskilled workers	1.9	1.0	2.4	2.0
Technicians	5.4	12.2	4.7	5.1
Men[1]	1.8	2.8	1.9	1.7
Average age of work force[2]	0.5	1.3	0.8	0.3

[1]Ratio of the percentage of firms reporting an increase in the population of male laborers to the percentage reporting a decrease.

[2]Ratio of the percentage of firms reporting that the age composition of their work force became older to the percentage reporting it became younger.

NOTE: A ratio of 1.0 means that increases equalled decreases; less than 1.0 means decreases exceeded increases; and greater than 1.0 means increases exceeded decreases.

older workers and male workers, perhaps because younger workers, especially women, were the first to be transferred. (See table 3.)

Working conditions, hours, and concerns. The impact of the introduction of IC equipment on working conditions and work organizations was also examined. A large majority of the firms guaranteed to maintain conventional wages. In terms of working hours, 80 percent of the firms using IC equipment reported no change, and among firms where it did change, working hours became shorter. A number of firms employing IC equipment introduced shiftwork, perhaps as a way to avoid dismissals.

In matters of major interest to workers whose jobs were affected, the proportion reporting "wage concerns" was the lowest at 7.5 percent (partly because of the wage guarantee). (See table 4.) Not far behind that proportion was job security at 13 percent. Education and training (64 percent), safety and health (41 percent), and working hours (31 percent) were the areas of most concern. These high-to-low percentages of concerns did not vary much by firm size. However, workers in small firms were not as likely as those in large to report training and safety and health matters as major area of interest.

Although employers were also concerned with how to best retrain their workforces, they were more concerned with how they would obtain technically oriented workers and how they would utilize older workers. □

Table 4. Matters of major interest to workers in integrated circuitry-equipped firms by size of firm, November 1982
[In percent]

Item	Total	Large firms (1,000 workers or more)	Medium firms (300–999 workers)	Small firms (100–299 workers)
Job security	13.1	16.8	14.3	11.5
Education and training	63.8	74.3	67.2	59.2
Wages	7.5	3.7	6.3	9.2
Working hours	30.7	27.2	28.8	32.7
Safety and health	40.9	50.0	44.9	36.3
Other	10.3	3.4	8.8	12.9

——*FOOTNOTES*——

[1] The 150 page, 40 table report that presents the survey results is an outline of a study on the *Relationship Between Technical Innovation and Labor* (Tokyo, Japan, Ministry of Labor, Department of Statistics and Information, August 1983). The complete study is available from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA, report number PB84–174937 ($21.50).

[2] *U.S.–Japan Comparative Study of Employment Adjustment* (Washington, DC, U.S. Department of Labor, Bureau of International Labor Affairs, Division of Foreign Economic Research and Japan Ministry of Labor, March 1985).

[3] *The Robotics Industry* (Washington, DC, U.S. Department of Commerce, International Trade Administration, April 1983).

[4] *Computerized Manufacturing Automation: Employment, Education, and the Workplace* (Washington, DC, U.S. Congress, Office of Technology Assessment, OTA–CIT–235, April 1, 1984).

[5] Kimihiro Masamura, "Minimizing High Tech's Adverse Effects," *Economic Eye*, June 1984, pp. 27–29.