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The social impact of micro-electronics in Japan

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In spite of the speed and extent of micro-electronic technology growth in Japan, concern about its possible social consequences has developed later than in most Western societies. Since 1980, however, a number of research findings on the subject – though often inconclusive and at times even contradictory – have begun to influence the thinking and policies of the Government and of the industrial relations partners. This article reviews some of these findings and attempts to place them in perspective.

The economic context

Diffusion of micro-electronic technology

So far the most reliable statistics on how widely micro-electronic equipment is used are those that were compiled by the Ministry of Labour in a 1982 survey of 10,000 factories with 100 workers or more. About 60 per cent of all the factories surveyed, and 96 per cent of those with more than 1,000 workers, had introduced one or more machines incorporating microprocessors. Diffusion rates were particularly high in machinery industries, printing and publishing, and some processing industries. In factories, manufacturing processes involving machining and painting had the highest diffusion rates (89 per cent), followed by inspection and assembly (52 and 48 per cent respectively), with internal factory transport coming last (27 per cent).

A survey carried out by the Japanese Federation of Electrical Machine Workers' Unions in 1982 showed that 255 establishments producing electrical and electronic goods (92 per cent of the total surveyed) had an average of 67 micro-electronic machines each, or one machine for every 20 workers (see table 1).

There are various reasons for the rapid spread of micro-electronics in factories. The Ministry of Labour's survey found that the principal motives for introducing this technology were to save labour input, i.e. to increase labour productivity, and to improve product quality or precision standards. Over 60 per cent of factory managers answering the questionnaire mentioned

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Table 1. Diffusion of micro-electronic (ME) machines in establishments (N=277) producing electrical and electronic goods

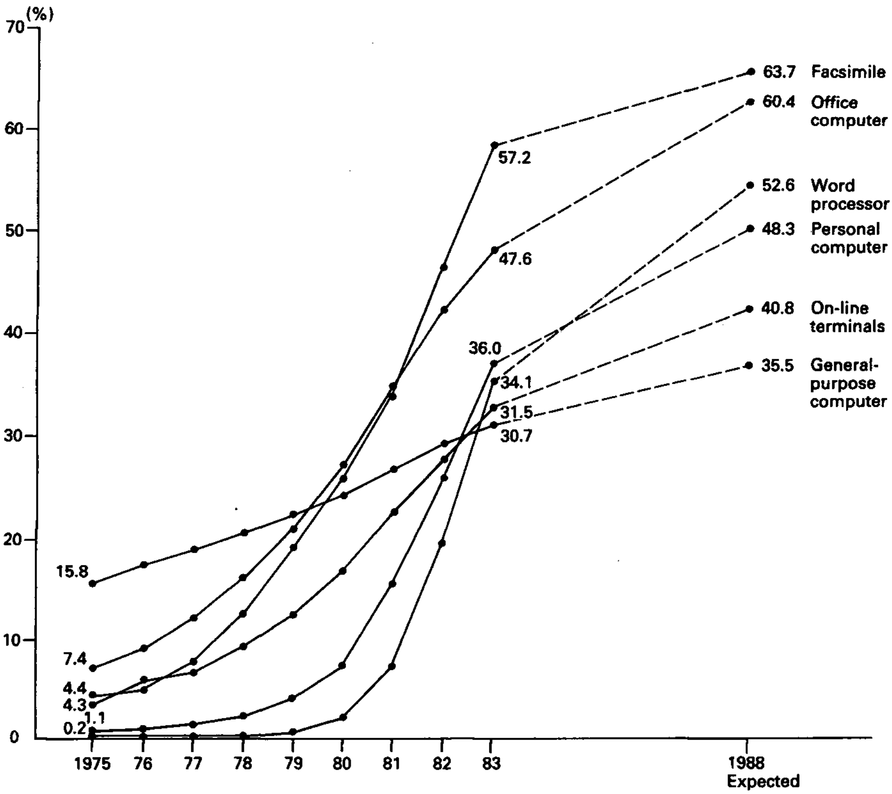
Type of equipment	% of establishments with ME equipment	Total no. of ME machines	No. of ME machines per establishment
Numerically controlled machine tools	63.5	1 995	11.6
Machining centres	35.7	485	4.6
Industrial robots			
Manual manipulators	17.0	556	11.9
Fixed sequence	42.2	3 451	29.5
Variable sequence	34.7	832	8.7
Playback	29.2	401	5.0
Numerically controlled	25.3	667	9.5
Intelligent	5.8	135	8.4
Insert machines	47.3	1 281	9.9
Automatic wire-bending	16.6	899	19.5
Automatic testing and measuring	69.3	4 217	22.0
Automatic carriers	42.6	1 086	9.2
Computer-aided design	47.3	406	3.1
Others	12.3	720	22.0
Not specified	7.6	...	...

Source: Japanese Federation of Electrical Machine Workers' Unions, 1983.

these two reasons, 33 per cent mentioned cutting production costs and only 4 per cent mentioned improving the working environment. The last reason was mentioned particularly by managers in vehicle manufacturing industries, including automobile manufacturers. Some small factories have welcomed micro-electronics as a way of coping with labour shortages. But this, too, makes only a minor contribution to the diffusion of micro-electronics. Other surveys on factory automation have similarly shown that it is favoured by management mostly for reasons of efficiency in the broad sense – to improve productivity, to cut production costs or to strengthen the company's competitive position.

Automation in office and other commercial activities in Japan began in the 1960s with the introduction of large general-purpose computers in big companies. The use of such equipment continues to spread gradually; it serves mainly for the processing of routine paper work and as a central "brain" to which a whole network of terminals may be connected. The medium-sized office computer and the personal computer have been spreading very rapidly since the late 1970s. The Japanese language word processor made its appearance around 1980. The facsimile is another piece of automation equipment which is increasingly seen in ordinary offices. Many firms are now building networks of this stand-alone item (see figure 1).

Figure 1. Diffusion rates of office automation equipment, 1975-88



Note: Cumulative figures for 1983 are for the month of October. The survey, which was conducted in 1983, covered 6,000 enterprises. Firms for which the date of introduction is unknown are not included.
Source: Ministry of Labour, 1984.

So far the point-of-sale system has been introduced in supermarkets only by a few large companies, though many others are planning to follow suit in 1986. Probably the best-known example of automation in the services sector to date is the installation of automatic cash dispensers in banks.

The reasons for automating offices are much the same as those for automating factories. A survey carried out by the Ministry of Labour in 1983, covering enterprises in all non-agricultural sectors, found that the commonest reason for introducing office automation equipment is to rationalise office work or make it more efficient (87.5 per cent of all respondents), often with a view to cutting administrative costs and keeping staff levels to a minimum. The need for rapid processing of information is the second most important reason (36 per cent), followed by the provision of improved services to customers (11 per cent) and the need to facilitate planning (6 per cent). The purpose is rarely to improve working conditions (1 per cent).

The level of employment

The main reason, then, for both factory and office automation has been the search for increased efficiency. This might suggest a strong tendency to eliminate jobs. The reality, however, is more complex. For one thing, indirect employment, such as maintenance work related to newly automated processes, may increase; for another, in many instances micro-electronic machines are introduced to meet the increasing demand for products, while retaining current employment levels. In 1982 the Osaka Prefectural Office, in a survey of establishments with 30 workers or more, even reported that employment increases were more frequent in establishments using micro-electronic equipment than in traditional factories. This is explained of course by the fact that the higher profitability of companies using labour-saving technology allows them to expand and take on more employees. To try to isolate the effects of micro-electronics on employment would therefore be not only difficult but unrealistic since they are likely to vary with the prosperity of the company concerned.

Optimistic employment projections tend to stress the expansion of consumer demand. Certainly the demand for domestic goods and services incorporating micro-electronic technology is growing, boosted by the lower prices and improved quality the technology makes possible. Moreover, unlike innovations in the past, micro-electronic equipment cannot work without software, which requires an intensive input of new types of labour.

Not all employment prospects are bright, however, since the introduction of micro-electronics nearly always has labour-saving effects within the enterprise. Furthermore, the competitive position of Japanese industries producing micro-electronic appliances is deteriorating as comparable industries emerge in the newly industrialised countries, while to secure an improvement in its trade relations with the Western countries Japan may also have to slow down the expansion of its exports.

All in all, it is difficult to say at present exactly what effects the micro-electronics revolution will have on employment in future, though there is general agreement that so far it has not produced any visible technological unemployment in Japan.

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While research on the overall effects of micro-electronic technology on employment in Japan is made difficult by the importance of the exogenous variables and dynamic interactions that dominate an export-oriented economy, a considerable amount of reliable and concrete information is available about its effects on the content and organisation of work at the enterprise level. In the long run, these effects are likely to have great social significance even if economic growth is maintained and unemployment kept under control. Moreoever, it is increasingly understood that day-to-day human inputs are critical to the effectiveness of advanced technological applications. Future efficiency depends on understanding the constraints and opportunities that are being created by current innovations.

It is obvious that micro-electronic technology alters what workers actually do while on the job. The nature of these changes, the adjustments required of workers and the policies emerging at various levels are discussed below.

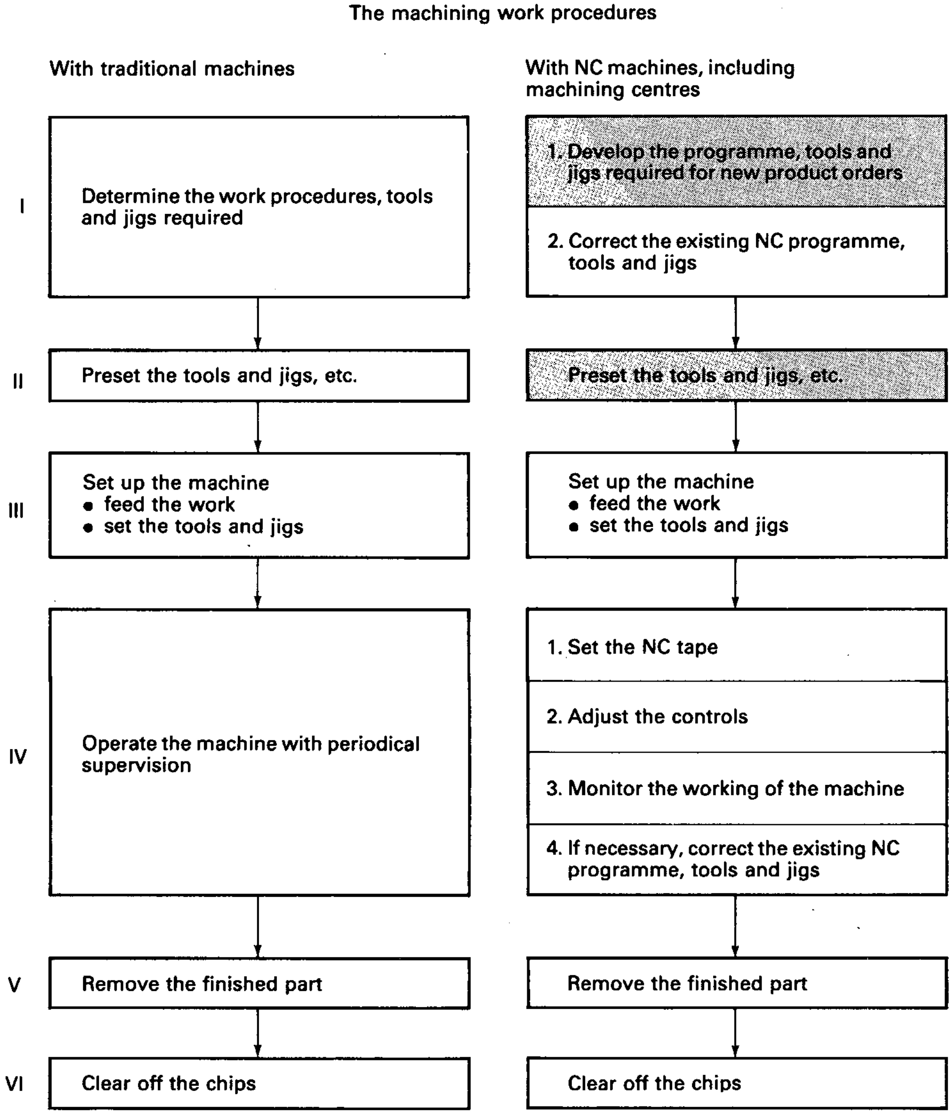
Implications for job content and task allocation

Explanatory examples

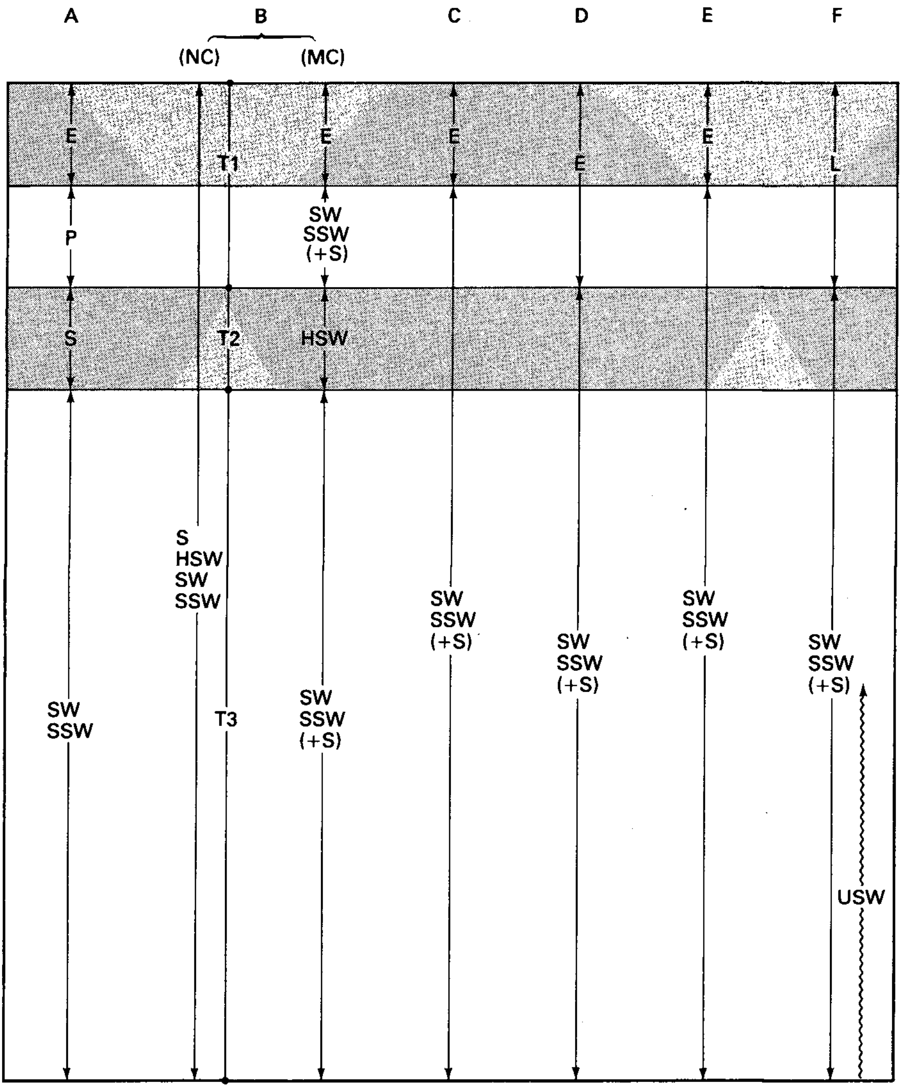
The introduction of new technology does not take place in a deterministic way with one dominant configuration of machines and jobs. The reality is more complex and can perhaps best be illustrated by an example. Figure 2 is based on detailed case studies carried out by the National Institute of Employment and Vocational Research in 1982 and shows how the tasks involved in performing machining jobs are altered by the introduction of numerically controlled (NC) machines, including machining centres. In the first column we see the six basic tasks that have to be performed when machining work is done in a traditional shop without NC machines. In the second we see the tasks when NC machines are introduced. New tasks have been introduced in step I, which is divided into two parts, and in step IV, which is divided into four tasks (one of which is the same as the second task in step I). These new tasks, which are all related to the operation of microcomputers incorporated in the machines, to developing, adjusting and setting the programmes and monitoring machines operated by the programmes, lead to new work structures and changes in the allocation of tasks to particular workers. However, the structure is not always the same. The right-hand part of figure 2 shows how these tasks were allocated in different enterprises. The first procedure (developing new programmes, jigs and tools) is generally the responsibility of production engineers, while alterations and adjustments to the established programmes, jigs and tools are often made by production workers. The programmers in the first case (Company A) have job experience similar to that of other production workers, so that this case departs the least from a traditional shop.

Production workers, i.e. skilled and semi-skilled workers, often including supervisors, are responsible for procedures III to VI (setting up machines, feeding the work and removing the finished part, operating machines and clearing chips). The second procedure (preparing and presetting jigs and tools) is assigned to the general production workers responsible for procedures III to VI, to highly skilled workers or to supervisors. In the NC machine shop of Company B general production workers, highly skilled workers and a supervisor are grouped into three teams, which take three-month turns performing each set of tasks, as shown in the figure. The flexible practice of team rotation is confined to this case. Even in the case of the

Figure 2. Changes in tasks as a result of installing NC machines in machining workshops



Allocation of tasks in companies A to F



E = Engineers. L = Leaders. P = Programmers. S = Supervisors. HSW = Highly skilled workers. SW = Skilled workers. SSW = Semi-skilled workers. USW = Unskilled workers. T1, T2 and T3 = Rotating teams composed of SSW, SW, HSW and S.

Source: National Institute of Employment and Vocational Research, 1983.

machining centre (MC) machine shop of Company B engineers are permanently in charge of programme development, and highly skilled workers are always responsible for preparing and presetting jigs and tools, as these are time-consuming or difficult tasks.

Company F is smaller and its production less diversified than that of the others. Two leaders are specialised in programming, some workers can prepare and preset jigs and tools, but the others are confined to the operation of machines. Hence there is a clear division of tasks according to skill level.

Trends in task allocation: Factories

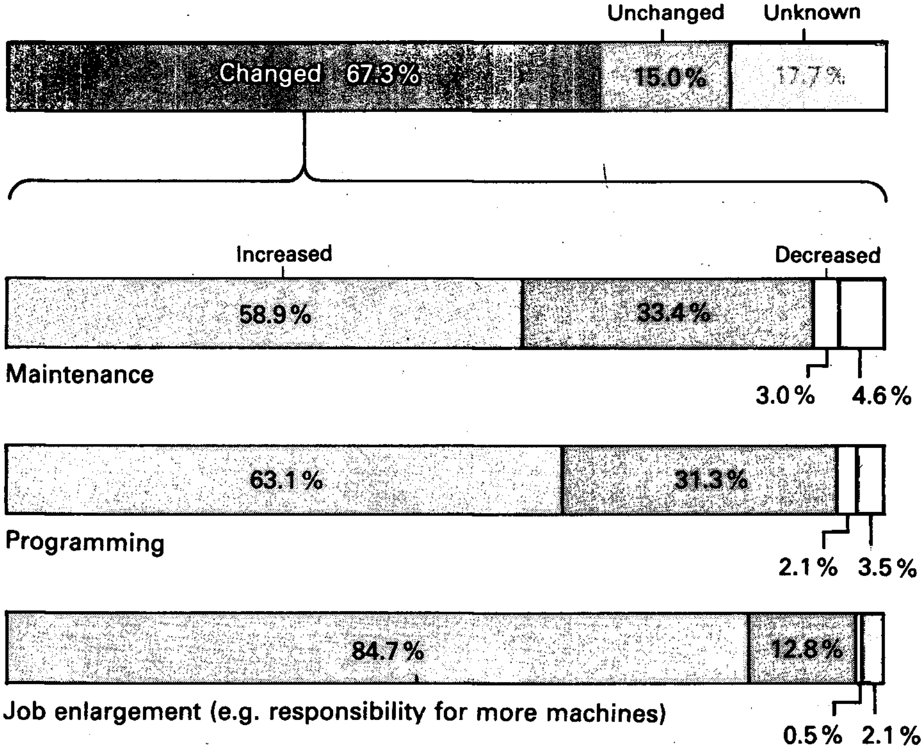
Data from various sources indicate that the introduction of microelectronic machines and equipment usually results in the job content of production workers being upgraded (see figure 3). But there are also cases where the opposite occurs and the division of tasks brings with it a marked stratification by level of skill and knowledge. For instance, where there is a high degree of automation, programming tends to be separated from production tasks, which in turn are combined with maintenance work. The 1982 survey by the Japanese Federation of Electrical Machine Workers' Unions found that maintenance and repair tasks were separated from production tasks in only 40 per cent of the plants covered.

The ways in which and the extent to which the tasks assigned to workers are combined in order to upgrade skills have not yet been fully analysed, though several important observations by researchers can be noted. First, a study carried out by Mr. M. Ito of the National Institute of Employment and Vocational Research found that programme correction is a task that is often gradually transferred to general production workers, skilled workers or supervisors. One of the reasons for the transfer is that engineers are expected to concentrate on developmental work. Another is the need to keep up the morale of production workers, whose skills are partly transferred to the machines, by recognising the contribution that their work experience enables them to make to improving the programmes.

Second, as was found in the survey conducted by the Ministry of International Trade and Industry (MITI) in 1982, on which figures 3 and 4 are based, the tasks involved in programming may in some cases be too complicated or voluminous to be assigned to skilled production workers. This is true of the MC shop in Company B and of most of the other companies in figure 2 where the task of developing programmes is reserved for engineers.

Third, a survey carried out in 1982 by the Vocational Training Research and Development Institute of the Promotion Projects Corporation found that the proportion of general production workers engaged in programming tended to increase slightly with the size of the firm. The survey report ascribed this to the fact that smaller firms could not afford to train most workers for new skills. It also noted that smaller firms tended to assign

Figure 3. Changes in production workers' tasks following the introduction of ME machines



Note: Information provided by management.
Source: Ministry of International Trade and Industry, 1984.

routine tasks to unskilled workers, as did Company F in figure 2, while large firms endeavoured to provide permanent workers with opportunities for developing their skills. However, the survey of the Osaka Prefectural Office found, on the contrary, that in smaller firms more production workers were engaged in programming than in larger firms, though the differences again seem to be slight. It can therefore be said that room exists for different approaches to job structuring regardless of the size of the firm.

The production workers who spend some of their time on maintenance and repair are necessarily multi-skilled. A few surveys found that maintenance workers were also sometimes engaged in programming. The development of multi-skills means the workers are given responsibility for a wider range of production jobs. Micro-electronic innovations have often led to a plant switching over from a system of functional organisation, where machines of the same kind are installed in each workshop, to a productoriented system in which the workshop houses several different kinds of machines. This system is also called group technology, being designed for semi-autonomous work groups in which workers tend a number of different machines regardless of the nature of the technology.

Since workers need less time to operate micro-electronic machines than traditional equipment, the same worker can monitor several machines (figure 3). Some researchers claim that, since machine operation is simplified, the broadening of skills resulting from the handling of multiple machines does not necessarily mean that they are upgraded. This is true where programming, maintenance and other tasks are assigned to different workers but, as we have seen, this is not always the case.

Factory automation is based on a combination of machines, electronics and other technologies and accordingly necessitates new knowledge and skills on the part of production workers. But the main burden falls on the engineers, who already have a heavy workload because of the constantly increasing need to develop new products and production systems. Having undergone a lengthy training to become qualified in a particular technology, the engineer today is expected to be an expert in several disciplines that were hitherto unrelated. This means that engineers have to adjust to the new needs through self-instruction, continuous training and so on.

Trends in task allocation: Offices

The impact of office automation on job content has not yet been investigated in detail, though the conflicting tendencies found in factories are also observed in office and service activities. First of all, routine office work, such as the processing of current business transactions, payroll computing, etc., are suitable jobs for computers. If the work volume is large enough, the data will be processed by a general-purpose computer, with visual display terminals (VDTs) in various offices. If the offices have a considerable volume of data to be processed, the terminals can be operated by specialised "keypunchers", who feed information into the system by means of the VDT keyboards. Otherwise the data will be processed by general office workers operating automatic machines as they do traditional office equipment. The working hours saved by the use of office automation equipment can be applied to activities that machines are unable to perform. The job content of office workers in such cases is likely to be enlarged.

Second, specialised knowledge is needed for the development and operation of a large or medium-sized computer and a computer-connected network. The first in line for these jobs are system engineers and programmers with their software know-how. There does not seem to be any strict dividing line between the two occupations; programmers may have a rigid or loose job description according to the practice of the individual firm. Some managements rotate employees between the data-processing department and other departments, and the programmes are drawn up by the experts of individual departments rather than by specialised computer staff. Such a policy may permit office employees to broaden and upgrade their knowledge and skills.

Work organisation and the managerial hierarchy

The unit to which workers belong administratively is the one on which the managerial hierarchy is built. The introduction of micro-electronics is bound to affect the system of work organisation and especially the relations between the basic units and management.

Though few studies have been made on this subject, some observations in research reports point to possible major changes in future.

First, the new machines and equipment are generally labour-saving, so that the size of work units will become smaller. This simple development may have important effects. Intermediate managerial levels are being done away with in some companies. One report said that small teams were easier for supervisors to manage, but another noted that the looser personal contacts between supervisors and ordinary workers made it difficult for supervisors to do their job.

Second, as figure 4 shows, the tasks of supervisors are tending to expand. They have to ensure the smooth operation of a set of machines, so that training of workers and maintenance become more important duties for them. Besides, their roles now resemble those of middle management in respect of production and quality control. A report of the Japanese Federation of Electrical Machine Workers' Unions found that responsibility for meeting quality standards and production schedules was increasingly entrusted to work teams and that workers tended to help each other more than before, which showed that work organisation was becoming more decentralised.

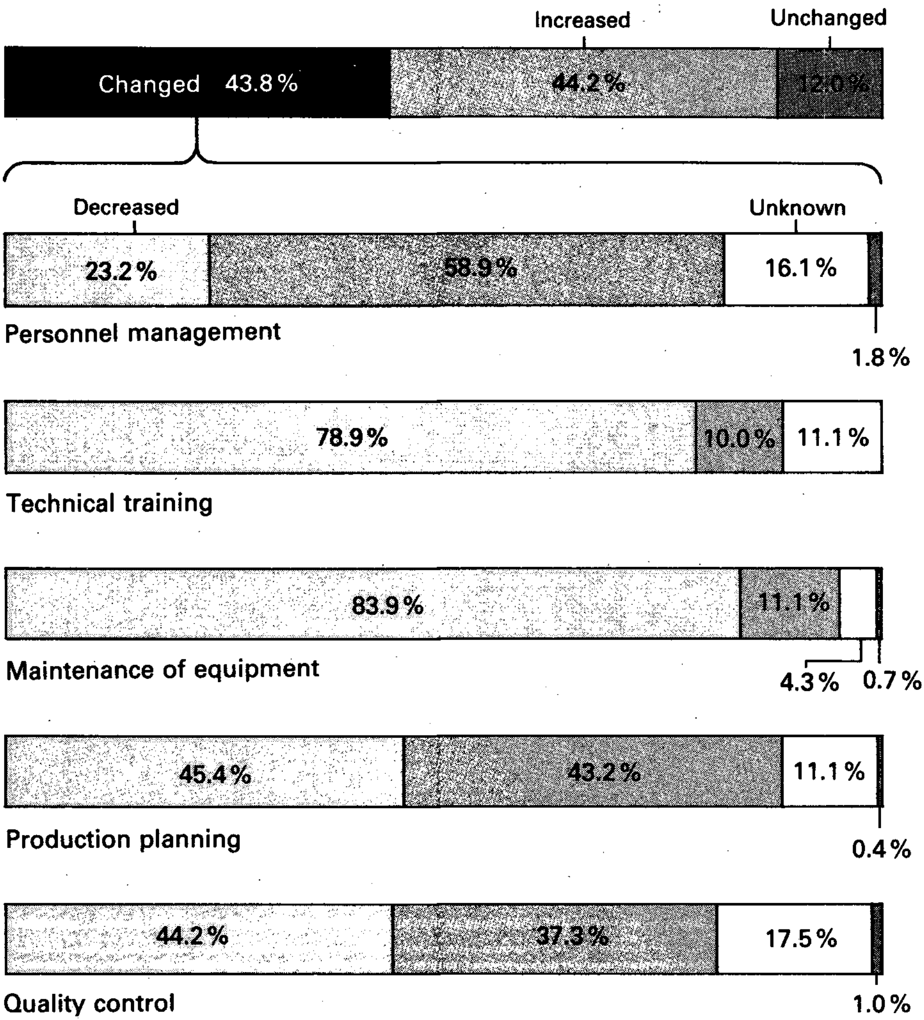
Third, not all managerial functions are being decentralised by the new technology, which can also be used for centralising decision-making. High-level managers are able to obtain the information they need for making decisions at any time from the common "data base" through computer networks. However, just how far decision-making power is being centralised, which would run counter to the Japanese practice of "group" decision-making, is not yet clear.

Other effects on workers

Displacement

When micro-electronic technology is introduced, some workers become redundant from a quantitative point of view, unless the plant's output increases beyond a certain level. Even where it does, some traditional skills may become redundant from a qualitative point of view since certain

Figure 4. Changes in tasks of first-line supervisors following the introduction of ME machines



Note: Information provided by management.
Source: Ministry of International Trade and Industry, 1984.

activities previously performed by workers are transferred to the new machines. For example, NC machine tools and robots take over important functions for which the workers' experience and knowledge were essential before. These workers must learn how to operate the new machines to which their former skills have been transferred if they are not to be downgraded. Workers affected by the introduction of micro-electronic equipment thus have the choice of learning new skills, remaining in the same workplace but doing less skilled jobs, being transferred to other workplaces, or resigning. Statistics show that few workers have been laid off so far as a result of the introduction of new machines.

Displacement is a frequent occurrence, however. The 1982 Ministry of Labour survey reported that 30 per cent of the establishments which had introduced micro-electronic machines had transferred workers from their former workplaces, mostly to others within the same plant (98 per cent of these – see table 2). The proportion of large establishments making such transfers is higher than that of smaller ones. The social costs to the workers and employers depend on the type of transfer made. Transfer within an establishment and without a change of jobs, which is very frequent, entails the lowest costs. Transfer within an establishment but with a change of job and transfer to another establishment without a change of job may prove more costly. The highest costs occur when the workers change jobs and locations at the same time. Large companies may also send their employees to subsidiary companies, which is another type of transfer.

Downgrading and adjustment difficulties

In most cases transfers prevent the lay-off of workers displaced by the introduction of micro-electronic technology. But transfers also involve some problems. A major one is the kind of jobs to which the displaced workers are assigned. In the best of cases a skilled worker who has been transferred will be engaged in a job similar to his previous one without being downgraded. The MITI recently carried out a survey of over 3,000 workers displaced by the introduction of industrial robots; the findings are summarised in table 3.

While the MITI research group interpreted the results as positive on the whole, a less optimistic observer might well draw different conclusions. Probably 20 per cent of the workers are assigned to lower-grade jobs. If several innovations are introduced one after the other, the negative effects will be cumulative. Some worker opinion polls on the subject of micro-electronics have revealed a sense of uneasiness among many respondents about transfers. This feeling may be ascribed in part to difficulties confronting their colleagues. In a survey of employees of six manufacturing firms carried out by the Kansai Productivity Centre in 1982, the workers expressed their anxiety about the impact of micro-electronic innovations on older workers (table 4), considering that those who remain in the same workplace are likely to be adversely affected. The survey carried out in the same year by the Vocational Training Research and Development Institute also pointed up the difficulties of older workers who are forced to change jobs as a result of transfer or reassignment. Of the 10,000 workers surveyed, 56 per cent said that their jobs had changed to a slight or large degree and, of these, over half said that they had to make an effort to adjust to the new work. Adjustment seems particularly difficult for middle-aged and older workers. Indeed some

Table 2. Displacement of workers following the introduction of ME machines

Type of displacement	% of establishments
Total establishments surveyed	**100.0**
Establishments not applying transfers or lay-offs	70.4
Establishments applying transfers or lay-offs	29.6
Transfers within the same establishment	28.0 (100.0)
Workers moved to production departments	(97.7)
Workers moved to office or sales departments	(10.6)
Transfers to other establishments within the same enterprise	3.3 (100.0)
Workers moved to production departments	(92.0)
Workers moved to office or sales departments	(43.3)
Establishments transferring workers to subsidiary firms or subcontractors	1.2
Establishments applying voluntary or compulsory lay-offs	0.4

Note: Percentages do not total 100 owing to multiple answers to the questionnaire.
Source: Ministry of Labour, 1984.

Table 3. Changes in the status of workers displaced by robots

Change of status	No.	%
Total workers surveyed	**3 193**	**100.0**
Assigned to robot-related work	184	5.8
Transferred without change in job	1 818	56.9
Transferred:		
to higher-skilled job	365	11.4
to simpler job	123	3.9
to sales or office job	15	0.5
to technical job	16	0.5
Transferred to subsidiary firms or subcontractors	18	0.6
Employment terminated:		
by compulsory retirement	49	1.5
by lay-off	7	0.2
Other[1]	598	18.7

[1] Includes workers assigned to new lines intended to increase production.
Source: Ministry of International Trade and Industry, 1984.

Table 4. Workers' opinions about the probable impact of ME machines on older workers

Respondents' replies	%
Total respondents (N = 1,158)	**100.0**
Older workers will generally be forced out	9.2
Older workers who cannot adjust will be forced out	19.4
Older workers will be transferred to light jobs	38.2
Workplaces will be created where they can use their former skills	18.7
Older workers will generally be able to acquire new skills	14.4

Source: Kansai Productivity Centre, 1983.

employers are quite sceptical about the ability of middle-aged and older workers to adjust to the new technology. In the 1982 MITI survey 55 per cent of the managers interviewed considered that the least adaptable age group was that aged 40 years or over, though 36 per cent did not single out any specific age group as having difficulties in adjusting. With the ageing of Japan's population, the workforce in many companies is also ageing, and some employers accordingly have adopted a deliberate policy of training older workers to cope with innovations.

The situation in relation to middle-aged and older workers can be summed up as follows. First, some skilled workers in these age groups, including supervisory staff, are being trained to operate micro-electronic machines or are learning to do so on their own initiative. In such cases most of their former skills continue to be used and new knowledge and skills are acquired. Second, some continue to perform the same job in the same workplace (where the job is retained) or in other workplaces in the same establishment or company. Third, some are assigned to lower-skilled jobs in the same workplace or are transferred to other workplaces. Lastly, jobs may be redesigned for older workers remaining at the same workplace through the use of micro-electronic devices; for instance, robots can relieve them of heavy work.

Working conditions

Japanese workers, convinced of the irresistible advance of technology and aware of the competitive needs of their firms, tend to take a more favourable view of micro-electronics than workers in the West. In a survey carried out in 1981 by the Institute for Social Problems in Asia 79.2 per cent of the Japanese workers interviewed were in favour of the introduction of micro-electronic machines as compared with only 34.2 per cent of their counterparts in the Federal Republic of Germany. Many Japanese workers consider that the use of the new technology is likely to make their work easier.

At the same time opinion polls, especially those made by trade unions, often reflect widespread apprehensions about working conditions, and particularly **safety and health**, following the introduction of the new technology. Two union surveys found that some 80 per cent of the metalworkers and electrical and electronic workers interviewed were anxious about possible new health hazards.

Major health problems that are attracting attention are the possibly harmful effects of the use of visual display terminals or units and mental disorders associated with occupational stress, although the relation of cause and effect in these cases has yet to be determined. The question of standards for the operation of VDTs is discussed below.

Generally speaking, the use of micro-electronics has helped to make workplaces safer. An example is the robot which takes over dangerous jobs from the human being. While ridding the workplace of old dangers, however, the new technology has also created new ones. The hazards involved in the use of industrial robots suddenly became a matter of public concern when two workers were killed by robots: after this, safety standards for their operation were established. The hazards are due to their technical characteristics. Robots are highly powerful metal tools that can easily crush a human body. They are directed by programmes and, if there are programming mistakes, their behaviour will be unpredictable. Electrical interference can also cause irregular behaviour. It is often difficult for workers to know whether a robot at a standstill will move the next instant. In the case of playback robots, workers have to approach them to teach them the gestures to be performed.

Accidents in plants using micro-electronic machines are rare, though the survey by the Kansai Productivity Centre showed that most workers operating such machines had experienced dangerous incidents that could have resulted in injuries. Some hazards related to micro-electronic equipment can be and have been removed by technical measures. Others can be prevented if safety committees and other organisational arrangements are made to work more effectively.

It has often been said that micro-electronic equipment is cheap compared with other innovations in the past. But technology is developing so swiftly that enterprises are obliged to recover their investments as quickly as possible, and this need often prompts them to resort to **shift work**. Nor is there any labour legislation that effectively restricts shift work. The General Council of Trade Unions (Sôhyô) sharply attacked night shift work in its interim policy report in 1981, citing an opinion poll in which workers complained of the serious health risks involved. In reality, shift work has expanded slightly. Some computerised systems, especially flexible manufacturing systems, seem to be operating around the clock. But these systems are said to be run with virtually no staff on night duty. Large computers in offices, too, are often operated at night by only a few specialised workers.

Micro-electronic innovations have also affected the practice of **overtime** in several ways. In a few cases the amount of overtime being worked is longer than before, but in most cases it tends to be shorter. Specialised computer staff and workers engaged in programming often work longer hours than other workers, partly because they are in short supply. An opinion poll by the Federation of Electrical Machine Workers' Unions found that many workers have the impression that, in spite of the innovations, they have to work at the same pace as before. Strict manning standards no doubt account for this. The conditions governing working hours are not determined by technology alone.

Monotonous jobs are not a thing of the past, although labour market conditions have completely changed since the early 1970s. This can be illustrated by two cases of factories manufacturing integrated circuits (ICs). In a survey of five plants carried out by the electrical machine workers' federation it was found that complaints about physical health conditions were most frequent and mental stress was most marked among the workers of a highly automated plant located in beautiful surroundings and equipped with a modern air conditioning system. The plant was staffed by young male employees engaged mostly in monitoring duties and working a two-shift schedule. Dissatisfaction with other working conditions, such as the manning level and annual leave, was also more marked than in the other plants. This case is something of an exception, however, since most researchers have found greater job satisfaction among workers operating advanced equipment.

A journalist on the staff of the *Asahi Shimbun* recently reported that IC plants set up in backward areas with an abundant supply of labour were having difficulty in recruiting female high-school leavers, partly because of the monotonous monitoring jobs the plants were offering and partly because of the unpopular two-shift system on which they were run.

New qualifications

As new technology is introduced, the qualifications required of industrial and office workers are bound to change. Three aspects can be singled out: scientific and technical knowledge, manual or mental skills acquired through experience, and particular psychological traits. The precise level of qualifications required will naturally depend on the tasks which the new worker-machine systems assign to the workers. If the volume or frequency of a specific task is such that it can be assigned to an individual worker for a certain period of time, the worker may specialise in the task and be given the corresponding job title. Hence if a new technology is widely introduced in a society, new job titles are likely to appear while old ones disappear.

A research report on the long-term policy for reorganising training facilities drawn up by the Kanagawa Prefectural Office in 1981 showed that in 40 per cent of the establishments surveyed new job titles had appeared within four or five years of the introduction of new technology and in a slightly lower proportion the job content of workers had changed significantly. Most of the new titles were for the occupations of engineers and workers concerned with "mechatronics", i.e. the combination of mechanics and electronics, occupations related to computerised production control and those of computer engineers and operators.

According to that report, the qualifications most frequently required at present are specialised technical knowledge and traditional manual skills acquired through experience. Qualities such as initiative and attentiveness are often required in enterprises using new technology, whereas physical strength and tolerance of arduous conditions are not. These findings were corroborated, by and large, by other reports. The 1982 survey of the Vocational Training Research and Development Institute noted that knowledge of quality control was widely required and production workers in large firms were expected to integrate into a self-contained production system. In other words, rank-and-file workers are required to have the knowledge and ability to solve problems encountered in the production process, to understand what is happening in the preceding and following phases and to repair the machines used in their own phase – in short, they need what are often called system-oriented knowledge and skills. The survey also noted that the abilities required of workers in smaller firms are traditional manual skills supplemented by a knowledge of quality control, rather than system-oriented knowledge and skills.

The reasons for these changes in skill profiles will be clear if we look at a machine shop where NC machine tools have been introduced. Traditional manual skills continue to be indispensable since machine operation is directed by programmes that are objective copies of manual skills, but manual workers also require some knowledge of programming. Production workers have to tend a set of machines rather than perform individual tasks. Supervisory workers have to oversee a self-contained production process. The technical staff require additional knowledge of engineering in order to work out a new system. All this is reflected in the changes shown in table 5. It will be noted that the skills of most of the workers tend to be upgraded, though a small but significant proportion experience downgrading.

Adjusting to the new technology

Training

The new knowledge and skills that workers require to operate microelectronic machines can only be acquired through appropriate training, which is therefore a major concern of labour and management alike. In the case of factory automation it is a fairly common practice to send potential "core" workers and supervisory staff to the company manufacturing the equipment for a short period of initial training. If the machines were produced by the

Table 5. Percentage of employees experiencing and not experiencing changes in skills following the introduction of machines incorporating microprocessors

Effect on skills	All industries	Processes using NC machine tools	Processes using robots
Total	**100.0**	**100.0**	**100.0**
No substantial changes in skills	32.5	12.8	9.1
Skills changed	67.5 (100.0)	87.2 (100.0)	91.0 (100.0)
Previous skills unnecessary but new skills required	(15.1)	(16.3)	(16.9)
New skills required in addition to previous skills	(63.1)	(73.4)	(77.3)
Higher skills required	(24.2)	(20.2)	(22.5)
Lower skills required	(14.2)	(10.2)	(11.5)

Note: Percentages for skill changes do not total 100 owing to multiple answers to the questionnaire.
Source: Ministry of Labour, 1984.

development department of their own company, the workers can be trained by the responsible engineers. On completing off-the-job training, the workers practise operating the machines and impart the knowledge they have acquired to their fellow workers. This process tends to last for several months. During this period the core and supervisory workers have to acquire the know-how needed to apply the principles they have learned to their own workplace, possibly with the assistance of the plant's technical staff. Although micro-electronic machines can be run with a minimum of control, that know-how is nevertheless essential. And manual workers have very important roles to play in this respect.

The core and supervisory workers already have the skills needed to operate traditional machines, and these skills are normally indispensable for operating the new machines. In the case of NC machine tools, the experience which skilled workers have acquired in the past is transferred to the operating programmes: the higher the traditional skills, the better the programme. In the case of playback robots, skilled workers teach them the appropriate movements and manipulations. Interestingly enough, in some plants inexperienced workers are positioned near the robots, which act as skilled workers, in order to learn from them. But robots cannot act better than highly skilled workers, who continue to perform the most highly skilled manual work. For this reason, it is only natural that management should be concerned to preserve traditional advanced manual skills. If such skills are taken over by the machines, workers may be deprived of the opportunity to learn them. In machine shops rotation of workers between traditional and NC machines is used as the basis for training in the higher manual skills.

As regards training in micro-electronics, the Japanese Federation of Electrical Machine Workers' Unions has reported some advanced practices. One company has initiated various levels of training in electronics for all its employees. In some companies technical staff provide on-the-job training that was formerly given by supervisory staff. To encourage positive attitudes towards innovations, others require workers to undergo training in the new technology in order to qualify for promotion. On-the-job training has always been a common practice in Japanese industries, so that off-the-job training in new technology is something of a novelty; and, as the above examples suggest, other new practices may well emerge in future.

Not much research has been carried out so far on training in office automation, though an overview is provided by the Ministry of Labour's survey carried out in 1983 (table 6). Off-the-job training in the operation of individual equipment is fairly common. Short training courses are often organised by the user company, the manufacturer or the dealer. Special knowledge of software is needed to operate computers, especially large general-purpose and medium-sized ones. Personnel policies concerning staff employed on computer or computer-related systems vary according to the case. Some companies operating large systems that require specialised workers, such as system engineers and programmers, rely on recruiting new staff who already possess the necessary qualifications, whereas others send existing staff to outside institutes for specialised training. The programmes for business use can be developed by the user's staff, by outside specialists, by a combination of the two or, in the case of routine data processing, can simply be purchased ready-made. The method of programming will depend on the office employees' degree of specialisation and on the firm's training practices. Self-instruction is also an important aspect of training for office automation.

Wage practices

Where wage differentials are based on skills and working conditions, changes in these brought about by the current innovations are bound to lead to a review of wage practices, as happened in the past when innovations were introduced in several industries, including iron and steel, and wage practices were partially modified as a result.

So far there do not appear to have been any major changes in wage practices, although the granting of special allowances for qualified computer staff is fairly common. However, as the opinion poll of electrical machine workers showed, workers are not satisfied with the status quo. Dissatisfaction with the current wage practices will necessarily produce growing pressure for change.

The so-called seniority-based wages, which are found in most large firms, have helped to ease the introduction of new technology since displaced or downgraded workers suffer no loss of earnings. Since seniority-based

Table 6. Methods of training workers to operate office automation equipment, by sex

Training method	Total %	Male %	Female %
Total workers operating office automation equipment	**100.0**	**100.0**	**100.0**
Company's training course	59.3	50.2	72.4
Outside facilities at company's expense	20.2	24.1	14.6
Outside facilities at worker's expense	2.5	3.5	1.1
Self-instruction through reading manuals and books	37.6	47.4	23.5
Not specified	5.9	5.7	6.3

Note: Columns do not total 100 owing to multiple answers to the questionnaire.
Source: Ministry of Labour, 1984.

wages are not strictly related to skills, the changes in skills entailed by innovations do not necessarily mean a change in wages. Both sides of industry recognise that the seniority-based wage system has proved its worth, so it is unlikely that either will call for a complete revision of current wage practices.

Worker information and consultation

It is difficult to generalise about the procedures applied concerning worker information and consultation when micro-electronic machines are introduced. Table 7, which is based on the 1982 survey of the Ministry of Labour, shows that management communicated with the workers or their unions prior to or after introducing new machines in only half of the establishments surveyed. Joint consultations between management and union representatives were held in more than half of these cases. Collective bargaining took place in only a few instances. Direct contacts between management and employees are common in unorganised plants, and apparently occur in some unionised plants as well. In some cases joint consultations based on a collective agreement may be held at the enterprise level regarding the general implications of the proposed changes and be followed up by direct contacts between lower-grade managers and the workers regarding specific machines. Table 7 also shows that over 90 per cent of the contacts were initiated by the management and that workers were able to influence management plans in only a limited number of cases. The main concerns expressed by the workers during these talks had to do with transfers and training, safety and health, and working hours. While job security is of course a major preoccupation of workers when new technology is being introduced, managements seldom try to lay off workers at such times.

The Ministry of Labour's 1983 survey on office automation found that joint consultations were held in fewer cases in this sector and that workers exercised even less influence over management plans.

Table 7. Worker information and consultation procedures in establishments introducing ME machines

Type of procedure	%
Total establishments surveyed	**100.0**
No worker information or consultation	50.7
Some worker information or consultation	49.3
	(100.0)
Shop-floor communications at shop meetings were organised by management	(44.0)
Joint consultation	(52.9)
Collective bargaining	(3.0)
Contact initiated by management	(93.4)
Contact initiated by unions	(6.0)
Management provided explanations only	(42.2)
Management listened to workers	(17.2)
Management consulted unions	(20.5)
Management agreed to union recommendations	(19.5)

Note: The last two groups had a 0.6 per cent non-response rate.
Source: Ministry of Labour, 1984.

A survey of individual trade unions carried out by the Japan Institute of Labour in 1983 gave a similar picture of labour-management procedures regarding innovations. But a few specific findings of this survey are worth noting. First, the basic attitudes of trade unions towards the introduction of micro-electronic machines differ according to their national affiliation. Unions affiliated to the Japanese Confederation of Labour (Dômei), which has Social Democratic sympathies, tend to support innovations, while those affiliated to the left-wing Sôhyô tend to oppose them. These attitudes reflect the ideological differences of the two federations. However, the actual behaviour of individual trade unions may at times differ from the official stance taken by the federations.

Second, the issues dealt with by managements and unions cover the same worker concerns as those mentioned above, but they are likely to be discussed in particular detail wherever there are aspects that touch on the workers' status as union members: for instance, how many workers will be transferred, and to what locations, how are they to be selected, what arrangements will be made for their training, what safeguards will be adopted regarding their working conditions, and so on. The survey found that consultations were more frequent than in the case of innovations in the past. It is becoming a common practice for management to provide information in advance. A consultative relationship is thus developing in private industry.

Third, trade union leaders think that new issues related to innovations should be taken up in the near future, such as the training of older workers, improved means of joint consultation, measures to enhance job content, job security, training of union members (especially in financial matters), manning standards and so on.

Joint consultation is an accepted procedure in most circumstances, but the real question is whether workers are able to influence management plans. In its 1981 interim report Sôhyô warned that, in the absence of industry-wide union regulations on joint consultation, the procedure was likely to result in excessively cosy co-operation with management. The extent and nature of the procedure vary greatly from one industry or firm to another. In a few cases joint consultation takes the form of insistent worker demands for a say in matters that have traditionally been considered management prerogatives. In others it amounts to little more than an informal meeting for planning or problem-solving purposes. Traditional collective bargaining regarding innovations is the exception, though some trade union leaders, encouraged by a few instances of successful negotiation, adhere to this procedure.

How to develop suitable procedural practices is a fundamental question for the trade union movement. The development of joint consultation so far has depended on the co-operative attitude of trade unions, and managements will continue to be reluctant to disclose essential information to unions taking a hard line or looking out only for their own interests.

Model agreements on micro-electronics

A few industry-level trade union federations have drawn up model agreements to govern the introduction and application of micro-electronic equipment, based to some extent on the so-called new technology agreements in the West. There is nothing new about the contents of these model agreements in the Japanese context of labour-management practices. Their originality lies in spelling out in writing practices that already exist but in an ill-defined form. A written agreement is a step forward for the unions, and the Japan Federation of Employers' Associations (Nikkeiren) naturally views the conclusion of any such agreements with circumspection.

The company-level model agreement drawn up by the Japanese Federation of Electrical Machine Workers' Unions contains the following provisions.

(1) Prior to introducing any micro-electronic system the company will consult the union and explain the proposed changes and their possible effects on the workforce.
(2) The company will not lay off any employees or announce its readiness to accept voluntary resignations.
(3) The company will consult the union before introducing or extending shift work.

(4) The company will consult the union before proceeding to any transfers; transfers shall be subject to the consent of the workers concerned and shall entail no disadvantages with respect to working conditions or job content; and a procedure will be established for hearing grievances on the matter of transfers.
(5) The company will organise any necessary training and will consult the union beforehand about the training programme.
(6) The company will take every possible measure to ensure the workers' safety and health.
(7) Adequate training facilities and opportunities will be provided to middle-aged and older workers for acquiring new skills.
(8) Job opportunities for women workers will be expanded and women will be afforded the same training facilities as men.
(9) The company will consult the union about possible repercussions on subsidiary firms and subcontractors and will take the necessary measures to protect their workforce.
(10) The company will consult the union about the allocation of benefits due to productivity increases.

A few other model or actual agreements have been published containing similar provisions. For example, the agreement between Nissan and the Dômei union concerned contains clauses comparable with provisions (1), (2), (4), (5) and (6) above. This agreement, however, differs from the others in that the union undertakes to promote the new technology.

Safety standards for the use of visual display terminals

Although concern over the possible health risks facing operators of visual display terminals (VDTs) appeared later in Japan than in Europe, the past two years have seen a flurry of activity in this field. A MITI report laid down desirable equipment specifications, the Ministry of Labour published two sets of guide-lines, the Japan Industrial Health Association issued recommendations, trade union federations provided guidance for union negotiators, and company managements drew up work rules on the subject.

The provisional guide-lines issued by the Ministry of Labour in February 1984 cover (i) ergonomic standards of equipment and working conditions, (ii) the management of VDT work, including the recommendation that workers operating a VDT continuously should be required to take a 10-15 minute break every hour, (iii) measures to protect workers' health (such as medical examinations), (iv) education in the operation of VDTs and occupational safety, and (v) the organisation of health and safety activities within firms. Most of the other guide-lines and recommendations cover the same five fields.

In December 1985 the Ministry issued revised and updated guide-lines governing, inter alia, the nature of prescribed medical examinations and of the education to be provided to VDT operators and their supervisors, and the classification of VDT work (by its duration, type, intensity and so on) for the differentiated application of health and safety measures. The new guide-lines recommend making working hours as short as possible and – for workers operating a terminal continuously – combining or rotating VDT work with other jobs.

The recommendations drawn up by the Japan Industrial Health Association and the trade union federations echo these provisions and insist, in addition, on allowing VDT operators to schedule and control their own work. More emphasis is placed, especially by the unions, on joint consultation arrangements and the non-assignment of VDT work to workers with health problems. Occasionally, as in the case of the All-Japan Prefectural and Municipal Workers' Union (Jichiro), the guide-lines are fairly detailed, but the provisions on VDT use in labour-management agreements actually concluded – in local government, broadcasting companies and so on – are far less so. It is possible, of course, that measures such as those discussed above have been introduced after joint consultation or by management initiative after informal talks with the workers concerned.

Concluding remarks

We have tried here to give an overview of developments in the field of micro-electronics and their impact on work organisation and job content and to interpret a number of contradictory phenomena in the light of recently published research. Future developments are difficult to predict. Although there are some signs of a slow-down in the diffusion of new machines, flexible manufacturing systems requiring few workers are likely to be adopted for a growing number of production activities. The point-of-sale system in the distributive trades is not highly developed in Japan, but it may soon gain ground. The effects of fully systematised office automation are still unknown.

As we have seen, some of the contradictory phenomena are due to different approaches by management, possibly influenced by trade unions. The new technology is not the sole factor determining employment levels, skill profiles, working conditions and so on. At the stage of designing new equipment human factors have to be considered, as in the case of VDTs. Ways and means of preventing the harmful effects of micro-electronic innovations and of ensuring the greatest possible benefits, along with the appropriate pace of introduction, will continue to be the subject of trade union, management and public policies.

The philosophy underlying the efforts to make work more human and to improve the quality of working life that first got under way some ten years ago has left its imprint on current policy moves. This is all to the good, of course, and it should help to dispel the vague apprehension felt by many people that highly developed micro-electronic systems, instead of bringing unprecedented benefits, will soon make slaves of us all.