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# Japanese manufacturing strategy and the role of total productive maintenance

Japanese  
manufacturing  
strategy

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## Introduction

It is Japanese policy to create prosperity through industrialization and there is little doubt that the development of the Japanese economy has been well supported by the growth of manufacturing industry. In Japan it is firmly believed that the prosperity of a nation depends on the excellence of its production capability and that those who conquer manufacturing will eventually conquer technical innovation. It has been the Japanese commitment to continuous technical innovation in manufacturing industry that has allowed it to become a leading economic power. Currently, however, Japanese manufacturing companies are facing very tough competition primarily owing to the appreciation of the Yen and the dramatic improvements in competitiveness from both advanced countries and the rapidly growing Asian Tigers. The objective of this article is to provide an insight into the strategies currently being adopted by Japanese manufacturers in an effort to address these very serious issues.

## Japanese manufacturing strategy prior to the appreciation of the Yen

Many Japanese manufacturing companies believe that there are two key factors needed to establish a competitive advantage: one is attractive products and the other is strong manufacturing capability. To have attractive products one must ensure originality and creativity. The Japanese have long argued that there are two kinds of originality: originality to discover and originality to develop, and Japan's strengths lie in the latter. For example, the transistor radio, VCR, TV, and compact disc all originated in the West, but were developed into commercial products by the Japanese (see Table I). Creative development goes together with, and is as important as, creativity in invention.

Japan has made a concerted effort to strengthen its manufacturing capability over the last three decades and this is shown in the general trend of organizational structure (see Figure 1). Over the last 30 years production techniques departments, sections, centres, headquarters and R&D have been added to organizational structures to support production capability through improvements in production technique. At Toshiba or Matsushita there are a substantial number of people involved in such activities and there will continue to be so, as long as they maintain their focus on manufacturing capability.

From 1945 to 1994, four periods of Japanese manufacturing strategy emerged (see Figure 2). The first period from 1945 to 1974 was the "product-out" phase,

when demand exceeded supply and Japan focused on increased production volume. The measurement of various factors such as output per hour, lost time due to machine breakdowns and defect rates, was undertaken to ensure competitiveness in manufacturing. In 1973/74 the first crisis struck: markets for consumer goods such as washing machines, refrigerators and vacuum cleaners started to show saturation. The second period began and was known as the “market-in” phase. Japanese manufacturing companies needed new strategies to cope with the fall in demand and diversification theory emerged.

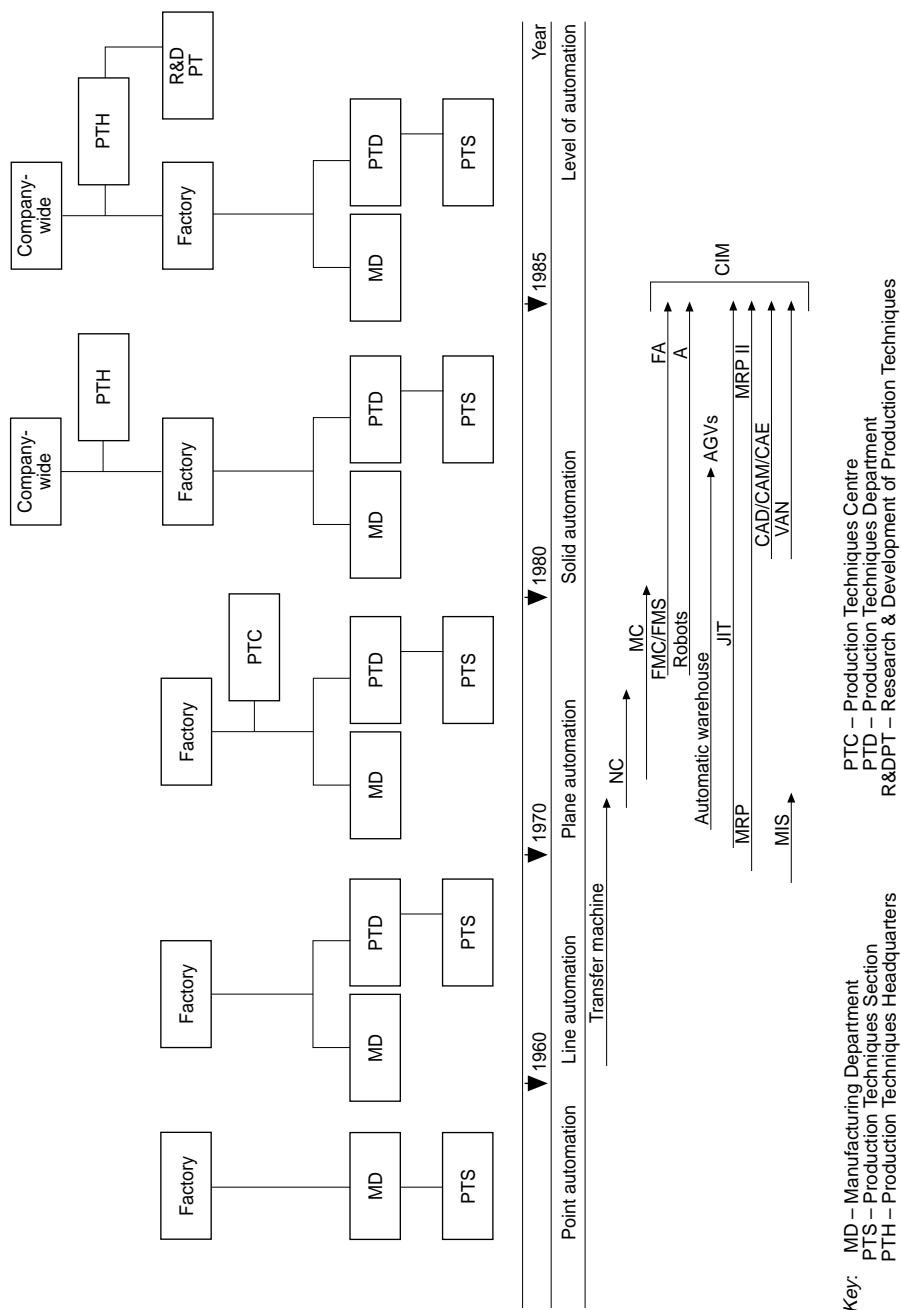
Diversification theory encompassed the idea that if a certain product can sell a given volume, then if the good is differentiated – produced with many variations to fit every different kind of market need – then there is an opportunity of an increase in demand. If people were all the same we would not need to make so many kinds of printers, but people are different. Based on this principle, many companies started to produce goods with many variations, and firms began to develop an appreciation of customer needs and satisfaction levels. As a result, additional performance measurement techniques were introduced, such as the number of claims from the customers – the thinking was that if the customer was not happy with what he bought then he would not buy it again. Other measures included the straight going rate, manufacturing lead times, delivery lead times, set-up times and stock turns.

While diversification undeniably increases sales, it also carries costs. It requires more work in design. In addition, if production cannot cope with changing market requirements quickly enough, it can lead to waste as a result of mismatches between production and sales – overproduction and inventory pile-ups of products in low demand, together with inability to supply products in high demand. In short, it is vital for the manufacturing company to provide customers with the right products at the right time at the right price – in other words, to implement just-in-time manufacturing, which incidentally needs essential support of good maintenance practices.

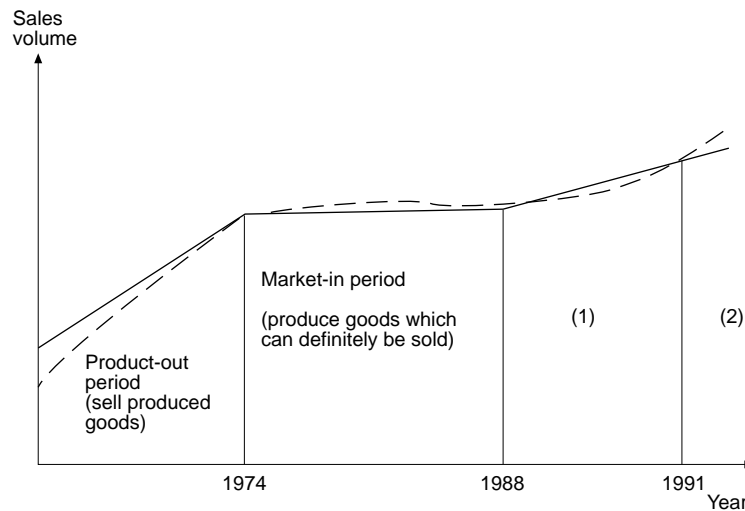
Japan had been quite successful in supplying and creating market needs up to 1988 with strategies based on the theory of diversification. But there was a limit to this idea and in 1988 a new period emerged known as the “constantly launching new products” period. High level industrialization, strong competition and the maturity of particular markets resulted in a “squeezing” of the product life cycle. A variety of manufacturers responded to growing competition by launching a

Item	Originator	Developer
Transistor radio	Regency	Sony
VTR	Ampex	Sony, Victor
TV	RCA	Matsushita
Rotary engine	Vanchel	Mazda
CD	Philips	Sony

**Table I.**  
Invention and  
development



**Figure 1.**  
Increasingly sophisticated organization of production techniques



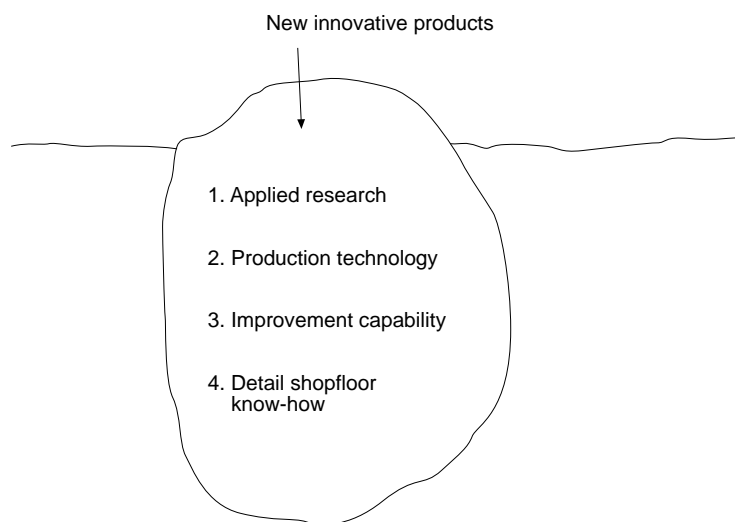
**Figure 2.**  
Four periods of  
Japanese manufacturing  
strategy

- Key:
- (1) Constantly launching new product period (develop, produce and sell new products faster than competitors)
  - (2) The period of launching prospective profit-making products and manufacturing profit-making products

barrage of new products with ever shorter life cycles. It became an imperative for Japanese firms to secure profits earlier than their competitors. In other words, increasing emphasis was placed on shortening the time between product development, manufacture and distribution in order to create productivity improvements. This whole process was exacerbated by the improvements in information technology – companies could launch new products using the media as a tool for the rapid and comprehensive transmission of their product information to the customer base, significantly assisting in the maintenance of old and the creation of new markets.

Think of production as an iceberg. The innovative, diversified products that consumers see in the stores are the visible tip, as shown in Figure 3. Below the waterline is the necessary infrastructure of, in descending order, applied research, production technology, and, right at the bottom, the base on which everything else floats, detailed shopfloor production know-how, which inevitably involves good maintenance practices.

To improve the process of launching and designing new products, the measurement of product development lead times including research, development, design, production preparation and manufacture, man-hours of product development, design quality, the number of design changes, etc., was introduced. For example, data taken from 1 April 1991 up to 31 March 1992 show that 89 out of 211 television models available during the year underwent model changes – this translates into a life cycle shorter than one year. The lifetime of the products became shorter and shorter. At an organization like Toshiba, the number of employees has remained fairly static since the 1970s, but engineers involved in the



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**Figure 3.**  
Importance of 1, 2, 3  
and 4 to support new  
innovative product  
development

indirect division have risen from 39 per cent to 69 per cent. This means that the company structure has changed from a business where technology is quite stable to one where the speed of technical innovation is fast – that is from a labour-intensive industry of assembly to a technology-intensive industry of development and application of electronic engineering. This shift is in line with the changing pattern of consumer goods: the first generation was mass production; the second generation was the production of many variations to meet diversified needs, with higher quality than is possible through mass production; and the third generation is a separate model for every customer, in other words, mass customization. Industry needs to be ready to meet these market changes with competitive manufacturing capability.

After 1991, the fourth period emerged and was entitled the “period of launching prospective profit-making products and manufacturing profit-making products”. This phase developed in response to various new market trends that emerged during the 1990s. One such change was the need for Japanese manufacturers to face the increasing problems related to the protection of the ecological environment and the disposal of industrial waste, by developing resource-saving factories producing less waste and little or no pollutants. Moreover, Japanese firms recognized the need to match market demand by manufacturing products which were energy-saving, produced no pollutants and were recyclable at the time of disposal.

During this period, manufacturing companies also faced major fluctuations in demand, both in content and quantity, and the market no longer had enough capacity to absorb all the new incoming products. The Japanese manufacturing philosophy, based on the concept of mass production of better products at lower prices in large volume, had come to saturation and it was time to reassess the manufacturing philosophy.

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By 1988 intense competition from both advanced countries and the newly industrialized economies seriously started to challenge Japanese manufacturing. This was compounded by intensified economic friction with America, Europe and Asia and required an increased focus on international co-operation. To make matters worse, Japan was also beginning to be caught in the grips of a very serious recession.

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### **The problems of the 1990s: the appreciation of the Yen, cost structures and offshore production**

Japanese manufacturing is currently undergoing a period of severe economic change, exacerbated by the recession and uncertainty surrounding the Yen. Serious problems have been encountered by the strength of the Yen, especially when it rose to higher than US\$1 = ¥100. These problems are different from the ones raised in the Plaza Accord of US\$1 = ¥120 in the latter half of 1980.

The step-by-step increase in exports has been overtaken by the increase in imports, and the appreciation of the Yen has done little to help other areas of the economy, especially as Japan wishes to become a high social welfare country, which costs money. It is easy to identify the problems of a strong Yen: with ¥10,000 one can buy 25.5 Big Mac hamburgers in Tokyo compared with 32 in New York; 14 kilos of rice in Tokyo compared with 83 kilos in America; in New York you can buy 90 litres of milk, whereas in Tokyo it is only 49 litres – prices are almost double. Petrol, taxis, TVs, whatever: Japanese prices are almost double. So the stronger Yen translates into higher costs. In 1982 a Japanese manufacturer could make a small car for \$4,211 but today, owing to the rise of the Yen, it costs \$7,313.

The USA and Asia have caught up with Japan in the areas where she had a competitive advantage – Japanese manufacturing's competitive edge has been fading away in the 1990s. Japan has been unable to overcome problems in areas where she has always been weak, and is therefore struggling to draw a clear vision of the way ahead in the future. During the years 1980 to 1992, for example, US car makers like GM, Ford and Chrysler made significant efficiency improvements, especially in the area of labour productivity, while Toyota, Nissan and Honda actually reduced labour productivity, because of the introduction of various car models.

Many companies believe that, although Japan provides a big consumer market, it is no longer a suitable base for production because of the high level of land prices, taxes and prices of consumer goods. The overall cost structures in Japan may well inhibit efficient production. For example, it costs Canon in Japan 100 Yen to produce a given item, compared with 120 Yen in Europe for the same item, versus 70 Yen in the USA, and less than 70 Yen in Asia. How can Canon USA produce with such a low cost? The reasons include the appreciation of the Yen coupled with the depreciation of the dollar; high energy and raw material costs (US manufacturers can obtain steel at half the cost compared with Japanese manufacturers); and an inflexible labour market – in the USA re-structuring a business is far easier than it is in Japan, because of their flexible labour market. So if the production bases are moved offshore as much as possible, the present crisis caused by the stronger Yen and given costs structures can be overcome.

What then are the demerits of moving production offshore? One major difficulty arises from the ability to obtain good engineers abroad. This is a key point for those of us familiar with manufacturing line techniques – a lack of technical accumulation will lead to the decrease of product development capability. In other words, if Japan relied on producing goods which rely on cheap labour costs by offshore production, she will eventually lose competitive power. For example, US industries have not been able to be competitive in high-tech product fields such as VTRs or compact discs because they have shifted their production overseas and have not been able to maintain their engineering capability. The second problem with moving production bases abroad is that, without exception, companies which rely on the sales of OEM products are unstable and dependent on their suppliers. Even if they can obtain a stable product supply they are constrained by the fact that they must produce their stable main products and if they are unable to because of problems derived from offshore production then their economic structure is significantly weakened. The third factor is that manufacturing industries can only maintain international competitiveness by continuous improvements of technical innovation, and technical innovation is closely connected to production shop-floor activities. For the Japanese, the aim is to develop new innovative products primarily through applied research, but the support services are just as important – Japan needs to have excellent production technology. Unless excellent production technology and continuous improvement capability exist, then new and attractive products that are produced quickly and efficiently will not result as previously shown in Figure 3. The shopfloor people are integral to this process. This is a main reason why many Japanese factories implement TPM. The essence of production know-how can only be accumulated through actual production experience and product development will not really be cultivated unless production is done in-house.

Therefore, for those manufacturing industries which retain production plants in Japan, there will be a concentration on improving productivity and developing new products. Within Japan priority will increasingly be given in the fields of marketing, R&D, product engineering, production engineering and continuous improvement in production plants.

### **Japanese strategies for manufacturing in the 1990s and beyond**

Even though the recession has been severe, there are still companies which have been experiencing growth and prosperity. These companies were studied and common features identified: they had lofty, but understandable policy; good products with good profit margins (high value-added products); effective education of employees from the top management to the shopfloor workers, and made extensive use of cost management.

The Japanese, because of their language, cannot be leaders in the service sector; their challenge for economic survival is in manufacturing and the keys to success in this area are high level technology and continuous technical innovation. It is firmly believed that revitalizing the power of industrial competitiveness lies in the engineering and manufacturing capability within each firm in each industry – labour-intensive industry will not survive in Japan, only the technology-intensive.

In the scientific fields of quality buildings and market research, Japanese manufacturing industries are still leading. Products with static demand must be made abroad from a cost reduction perspective, but those that require technological innovation need to be made in Japan. For example, exports of Japanese TV sets have outperformed imports for the last 20 years, although this gap has shrunk substantially over the past decade. This has occurred even though the average price of export TVs is higher than the import price, and is primarily due to product differentiation – the Japanese export sets are big, widescreen models, whereas imports tend to be small. Interestingly, most of the imports (88 per cent) come from newly developing or ASEAN countries, reflecting the significant transition in trade structure with Asian nations.

What then are the causes and effects of de-industrialization and is this really Japanese strategy? Three factors were significant in the USA's move to de-industrialization:

- (1) Low savings and profit rates have resulted in stagnant plant investment.
- (2) Investment has been relatively ineffective because it has not been targeted to export or technology-intensive industries owing to restricted employment rules and unsteady labour relations.
- (3) There has been an increasing intensity of international competition in low value-added industrial products resulting from the rapid industrialization of the developing countries.

However, the real reason for de-industrialization stems from the fact that there was a shortage of investment and that product and labour markets lacked flexibility. This produced idle resources which are not always channelled into the high value-added product-making industries.

If the ratio of plant investment to GDP in manufacturing industries in the USA is examined, in 1985 the ratio was 2.4 per cent and in 1990 rose only to 2.5 per cent. If this is compared with Japan, in 1985 the ratio was 6.0 per cent rising to 7.7 per cent in 1990. Even more interesting are the figures for Korea; in 1985 the ratio was 8.2 per cent and in 1990 10.4 per cent. Japanese strategy is to improve competitiveness and maintain the edge by shifting people out of low value-added areas to high value-added areas. The principle of growth will be through repeating the cycle of developing new technology and creating new markets.

There is little doubt that over time there will be an increasing move in Japan to transfer production offshore, but this does not mean that the Japanese will have to worry about de-industrialization for some time. The ratio of overseas production remains at 7 per cent and is considered to be low, especially compared with that of USA being at its highest, 26 to 27 per cent. It is still vitally important that, to reinforce a position of economic power, Japan must maintain its large manufacturing presence *within* Japan. Even if overseas expansion takes place, more than 50 per cent of a company's functions *must* remain within Japan, otherwise the innovation and development of business can no longer exist.

Research by MITI on the domestic production programmes needed to cope with increased overseas production shows that 62 per cent of respondents feel that shifting domestic production to high value-added products is the correct route to

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take; another 56 per cent feel that maintaining the production levels by further cultivation of the domestic market is needed; while 24 per cent cite the creation of new domestic business areas. (The research undertaken was multiple response, hence the percentages do not add up to 100.)

Another feature of the Japanese manufacturing sector is that they import the necessary raw materials and then produce the end product: this is known as “full set” policy. In recent years, however, there has been a shift from full set policy to the “international division of work” policy in order to overcome the problems exacerbated by the appreciation of the Yen. An example of this shift is a silverware producer in Tsubame who, in the face of very high labour costs and increasingly tough international competition, has changed its policy. They now import steel material from Korea rather than from domestic sources and are making thorough rationalizations – centralizing and saving in manpower – to compete with other Asian countries. In addition they have moved those processes in which they must compete on a cost-alone basis, offshore to China. In return they try to expand their markets into the whole of Asia. Therefore, although a part of the production process has been de-industrialized, the company has compensated for it by expanding the market for their products within the rapidly developing Asian countries.

When Japan went into this recession, two things began to be focused on: the development of new attractive products which were durable; and cost reduction. This strategy is the current consensus of Japanese management and it is an integral policy to combat the appreciation of the Yen. Current national thinking comprises eight objectives:

- (1) the development of original technology;
- (2) production of originality not only in technology but also in new product development;
- (3) further improvement of manufacturing techniques;
- (4) the independence of part industries;
- (5) the creation of a strong domestic market for advanced technology;
- (6) attraction of engineering and science graduates into manufacturing by remunerating and treating them well;
- (7) establishing a reputation that shows concern for the environment/safety;
- (8) expansion of export and overseas production without trade disputes.

There are some good examples of companies which can still make profits in the middle of a very deep recession and a high Yen. These companies were studied and it was found that the necessary conditions for prosperity are: the need to have growing products in line with market needs and in accordance with megatrends; very active R&D; needs-oriented product development; very active organizations; progressive development of new businesses; utilization of ideas and knowledge from outside sources; extensive utilization of information technology; and clear and easy management policy able to be implemented from the shopfloor to the senior management. These are lessons Japan has learned after the “continuous launching new product period” post-1988.

### **The role of TPM today**

In Japan it is said that in order to be strong enough in manufacturing one has to have good brains, which requires total quality management (TQM), but one also needs to have strong muscles or, in other words, strong manufacturing capability. Therefore one has total productive maintenance (TPM). The brains need to be connected with the muscles by a good nervous system with just-in-time principles. So in manufacturing, one needs to have TQM, just-in-time and especially today TPM – because it really gives tangible results and cuts costs.

Looking at the history of Japanese maintenance activities, the time prior to 1950 can be referred to as the “breakdown maintenance” period. Preventive maintenance was introduced in the 1950s from the USA and productive maintenance became well established during the 1960s. The development of total productive maintenance (TPM) began in the 1970s with the recognition of a single and true fact by management: it is the operators of machines and processes who know the status quo of a machine or process and prevent it from breaking down. Also, without getting operators’ interest and co-operation, no proper maintenance can be established. No matter how well plants are equipped with advanced manufacturing techniques, it is operators, not managers or systems, who affect the plant’s performance. In this highly competitive market, the poor performance of operators is no longer affordable. Operators with little responsibility for their equipment are likely to look at it as a mere machine with which they have no connection. In many cases they are not aware of abnormalities. Maintenance personnel, who are responsible for checking deterioration, are kept busy remedying sporadic large breakdowns.

Ideally, whoever operates equipment should maintain it, and originally, those two functions were carried out by the same people. Gradually, however, the maintenance and production functions were separated as equipment became more sophisticated and as businesses grew larger. During Japan’s post-war period of rapid industrial growth, most equipment was replaced by newer, unfamiliar equipment. Responding to demands for increased production, production departments mainly concentrated on output, while maintenance departments gradually assumed responsibility for almost all maintenance functions according to the concept of the division of labour. Under these circumstances, operators and maintenance staff considered a machine to be in adequate condition if it was simply up and running. The resulting bipolar specialization continued until TPM was developed.

Efficient production depends on both production and maintenance activities, but the relationship between operators and maintenance personnel is often somewhat adversarial. No matter how hard maintenance personnel work, they can make little progress in maintenance and equipment improvement as long as the operator’s attitude towards maintenance is “I operate – you fix.”

If, on the other hand, operators can participate in the maintenance function by becoming responsible for the prevention of deterioration, competitive manufacturing is more likely to be achieved. To pursue competitiveness in

manufacturing, the central role of operators in equipment operation, condition, and maintenance must be acknowledged. The co-operative effort allows maintenance personnel to focus their energies on tasks requiring their technical expertise and to learn about and use more sophisticated techniques for advanced manufacturing; it represents the first step towards more efficient maintenance. The two departments must do more than share the responsibility for equipment – they must work together in the spirit of co-operation. There is no way competitive manufacturing will be achieved, if the two groups fail to understand each other's situation or, in an extreme case, if they are at odds with each other.

No matter how well equipment was designed, it is liable to have design weaknesses and will deteriorate as time passes. To make matters worse, it needs alteration and adjustment to cope with increasing change of market demand. Moreover, the equipment must be modified by introducing newly developed production techniques in order to maintain competitiveness in existing equipment. To counter such problems it is vital to develop capable and competent maintenance personnel and operators as shown in Table II.

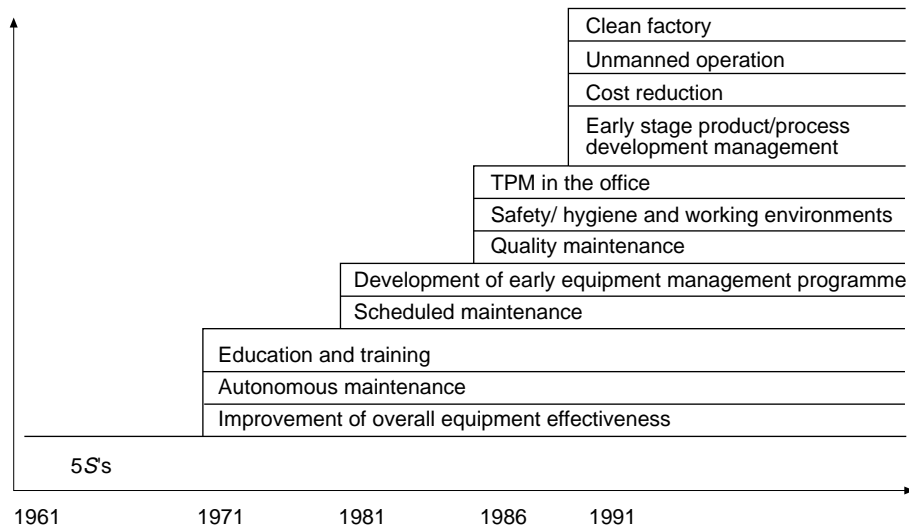
Total productive maintenance is a comprehensive maintenance system starting from the designing of new equipment to the daily autonomous maintenance by operators – TPM development is based on human factors. Thus, TPM will suit perfectly well the need for developing capable and competent human resources.

The ultimate goal of education and training for maintenance personnel and operators should be the development of capable human resources that can maintain equipment and control it with strict attention to detail, and can cope with changing work conditions with new products and/or new machines. Top management must bear in mind that developing such capable and competent human resources is a multi-year continuous improvement process and must thus give 100 per cent commitment.

Figure 4 shows how TPM has been developing step by step. As shown, TPM has extended the areas to handle because maintenance carried out only at the shopfloor level obviously has limitations; actually the best time to take maintenance into consideration is at an early design stage of developing a new product and equipment. Today TPM covers all the measurements introduced in those four periods mentioned before and is eventually aiming to deal with all the lessons Japan has learned after the “continuous launching new product period”, post-1988. Because of this, TPM is often referred to as total productive manufacturing or sometimes total productive management.

Problems	Countermeasure
Bad design	Development of capable maintenance personnel and operators who can cope with the problems
Maintenance	
Market change	
New technology	

**Table II.**  
The need for  
continuous  
improvement on the  
production floor



**Figure 4.**  
How TPM has been developed

As mentioned before, Japan is in the middle of a very deep recession and a high Yen. Today many Japanese manufacturing companies are focusing their strategy on cost reduction and/or launching more attractive new products which are able to stay in the market longer, and trying to have the structure by TPM to reduce costs effectively to cope with the recession and to cover exchange rate losses owing to the high Yen. Thus, TPM today is focusing especially on cost reduction and further improvement of the capability of human resources by effective education in order to make the organization very active.

### Conclusion

The way the Japanese have managed in the past and the way they want to continue to manage in the future is to match manufacturing capability with market changes – the effects of the disparity in the human resources of an organization have become more, not less, significant as the demand on manufacturing increases to match changes in the market. The general trend of organizational change has been very simple since the Second World War – Japan has always sought to incorporate flexibility into its systems so that change can take place to match market needs. Today the most important thing continues to be the ability to change and to do it quickly enough. There is a very serious need for Japan to cope with increasing change and very intense competition from both the advanced countries and the rapidly growing Asian Tigers. Many Japanese manufacturing companies are seeking to do this through just-in-time product developments and cost reduction with the help of TPM. These are the two subjects they are addressing at the moment to help them to maintain their strength in manufacturing.