ADAPTABLE PRODUCTION AND ITS REALISATION: SOME CASES OF JAPANESE MANUFACTURERS

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ABSTRACT

In this paper the concept of "Adaptable Production" is discussed and some pilot trials are described in factories which need to cope with an uncertain market environment. The typical cases described for understanding the concept include a semiconductor manufacturer, a photocopying machine manufacturer and a personal handyphone system manufacturer. Using these investigations, the advantageous features of the adaptable production concept are emphasised, in particular its robustness in an era of globalised and uncertain markets together with the application of KAIZEN which still retains its effectiveness as the traditional tool for giving Japanese manufacturers their competitive advantage

INTRODUCTION

Most manufacturing enterprises in the world today are experiencing dramatic changes to their competitive environment as a result of greater globalisation, market instability, information intensive technological development etc. One of the most relevant of these issues, globalisation, has caused a distortion of the competitive situation and manufacturers are increasingly required to address problems of different cultures and underdeveloped support environments. Market instability, which is caused by greater domination of the customer, was first an emerging issue in mature economies but is now a phenomenon that is being more widely experienced elsewhere as a result of the globalisation issue. As these two factors have placed greater demands on companies, information technology has increasingly provided the means of adjusting to and managing their new environment. In the USA for example "agile manufacturing" (Kidd, 1994) and "re- engineering" (Daniel, 1993) have emerged as relevant measures. However, in Japan manufacturers appear to face more difficult problems than elsewhere as a result of the country experiencing an unprecedented period of relative recession (Nishimura and Chiba, 1995).

Japanese production management techniques and technologies have been a driving force throughout the world of manufacturing for the last two decades, being embodied in KAIZEN activities, lean production methods etc. However, the ability to sustain their superiority has been thrown into question as a result of the difficult economic situation as well as the saturation of performance improvements (Miyai, 1995). In particular, as the nature of Japan's

markets move away from being characterised by mass demand towards a situation where requirements are for wider variety and smaller scale, so the emphasis on cost reduction, higher shop floor performance and increasing market share has become outdated.
Within the context of the situation described the main consideration for many manufacturers is how to realise the adaptability of the manufacturing process so it can meet the requirements of an uncertain market without the need for a large fixed investment (Katayama and Bennett, 1996). This necessitates focusing on the cost structure of the manufacturing system and abandoning the emphasis given to facility investment as a means of increasing the efficiency of operation. Instead there needs to be a cost structure which supports adaptability through reduced fixed costs even though this means sacrificing some of the benefits of lower variable costs. Over investment results in a burden of high fixed cost as a mechanism for substantially reducing variable costs but this exposes manufacturing enterprises to considerable risk when they are in an uncertain or shrinking market situation. For this reason many Japanese factories have started to modify their cost structure by reconstructing their manufacturing systems as well as their support functions.
Based on this understanding, the concept of "Adaptable Production" is discussed and some pilot trials in factories which are needing to cope with an uncertain market environment are described in this paper.

LEAN PRODUCTION: A SUCCESS STORY IN THE PAST

It is said that the lean production system is the superior way of producing manufactured goods (Womack et al, 1990). A key feature of lean production is that fewer resource inputs are required by the manufacturing system (less material, fewer parts, shorter production operations, less unproductive time needed for set-ups, etc.). At the same time there is pressure for higher output performance to be achieved (better quality, higher technical specifications, greater product variety, etc.).

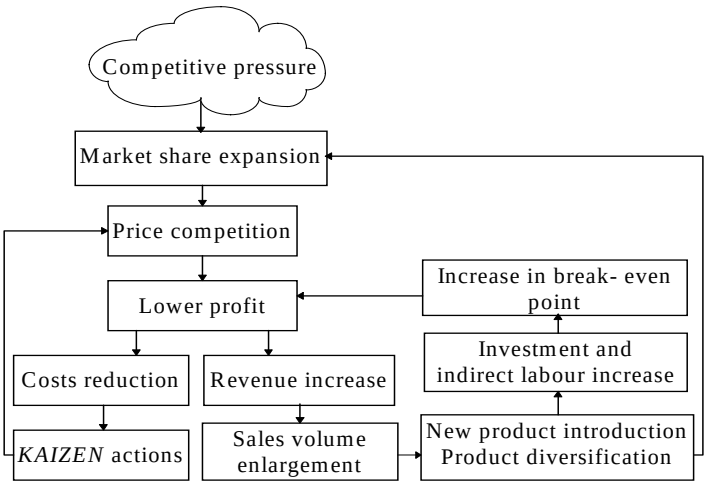


Figure 1. The past behavioural pattern of Japanese manufacturers (Katayama and Bennett, 1996)

This should result in greater customer satisfaction which in turn provides the opportunity for the lean company to gain a larger market share than that of its competitors. Therefore, it could be argued that lean production is a relevant organisational component of a competitive environment.
The essential cause-and-effect relationship of company behaviour in the past, i.e. higher economic growth environment, is illustrated in Figure 1, where strong competitive pressure is the major driving force of companies' behaviour. The main competitive pressure on companies has been to expand market share, the principal means of achieving which has been through price competition.
This in turn has reduced profits, thereby necessitating cost reductions and increased revenues.

Cost reductions have been achieved through KAIZEN (continuous improvement) activities, which have further stimulated price competition, while increased revenues have necessitated larger sales volumes and required new products to be introduced and products to be diversified. This has required increased investment and more indirect labour, so increasing the break-even Point and reducing profit.
Japanese industry was able to maintain this continuous cycle during high economic growth era as well as the "bubble" economy but more recently the chain of events in Figure 1 has been broken. In particular the increase in revenues through larger sales volumes can no longer be a presumed step in the cycle with the increase in interest rates and levelling of disposable incomes. Moreover, the increasing value of the yen, brought about by the strength of the industrial economy, has reduced the opportunity for Japanese companies to rely on exports as a means of compensating for lower domestic sales.
As well as these economic factors which have broken the manufacturing cycle there are, in addition, a number of influences which have called into question the viability of lean production principles within the context of Japan's current situation.

ADAPTABLE PRODUCTION: A POSSIBLE NEW SCHEME

A possible new behavioural scheme of manufacturing companies in the current recession and long term future is illustrated in Figure 2, where the fundamental driver of their behaviour is defensive pressure, i.e. pressure of survival because of so many occurrences of bankruptcy.
The objective of management is no longer market share expansion, but profit making. This target will be achieved by a customer oriented approach as well as through cost/performance considerations. As markets tend to be volatile the necessary means to cope with this is by realising adaptability in manufacturing organisation.
On the other hand, manufacturing power should be refined in terms of higher cost/performance and strong adaptability. Particularly, it is important that, in volatile markets, manufacturing cost should be reflected to the grade of product specification, i.e. rate of value addition, properly according to the demand fluctuation. Therefore, efforts towards adaptable production are made by many factories as a means of survival.

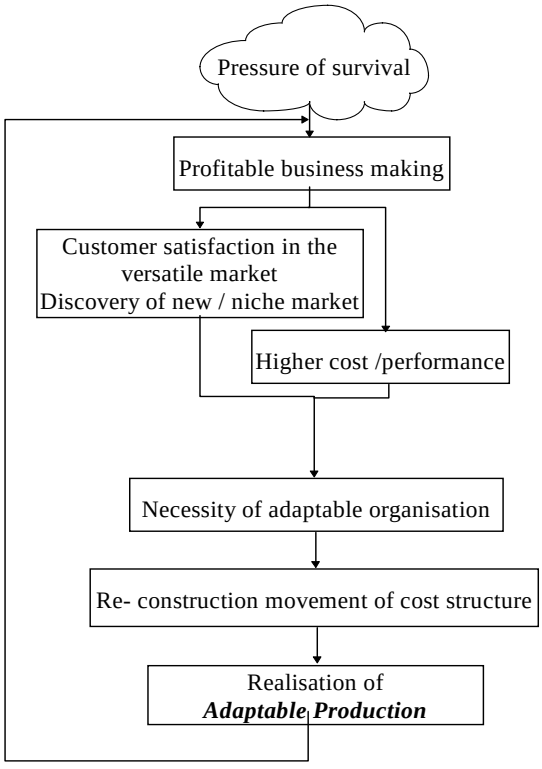
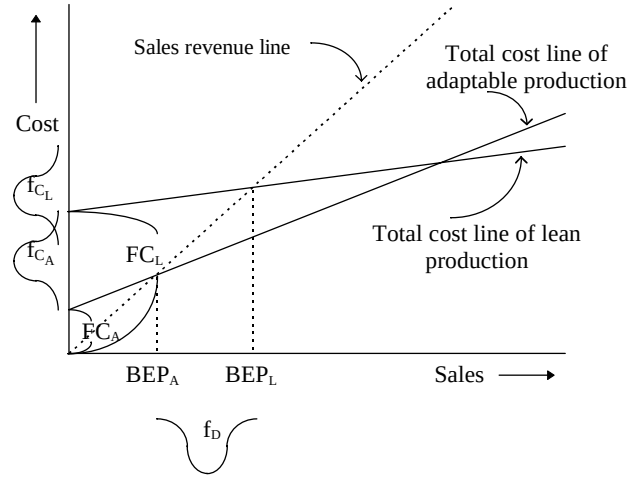


Figure 2. A current / future direction of survivable manufacturing

Figure 3 explains the superiority of the adaptable production concept against lean production, and shows the relative costs of both production concepts. The variable costs of lean production are low as a consequence of the reduction in resource inputs and the drive for higher process performance from the manufacturing system. However, set against this low

level of variable costs must be the high cost of fixed assets, indirect labour and indirect overheads (FC_L). This is caused, among other things, by the need to develop new products constantly and to acquire the facilities to produce them in the most resource- efficient manner. By contrast the variable costs of adaptable production are higher since it may involve more manual work, greater inventories and use of less efficient (although more flexible) equipment. Set against this, however, is the lower level of fixed investment (FC_A) since equipment will not need to be replaced as frequently and its acquisition cost is likely to be lower since it would be more general purpose in nature. Looking at the sales revenue line in Figure 3, it can be seen that lean production potentially generates the greater profit at higher levels of demand. However, from the intersection point of the sales revenue line and the total cost lines of the two production system types it can be seen that the break- even point for adaptable production is at a lower level of demand than for lean production. This means that when demand is lower adaptable production becomes the more profitable of the two systems. This point is further emphasised by the figure, which shows the cost sensitivity of the two system types. Here a possible distribution pattern of demand is shown (f_D), together with the associated cost distributions for lean production (f_{C_L}) and adaptable production (f_{C_A}).



BEP_A :Break even point (BEP) of adaptable production (AP)
BEP_L :BEP of lean production (LP)
f_D :Demand distribution
f_{C_A} :Cost distribution of AP
f_{C_L} :Cost distribution of LP
FC_A :Fixed cost of AP
FC_L :Fixed cost of LP

Figure 3. Cost structures of manufactures

SOME EFFORTS TOWARDS ADAPTABLE PRODUCTION

Our investigations were carried out during December 1995 and March 1996 and several factories/plants were studied through a visit comprising a plant tour together with a separate question-and-answer session. Prior to the Qs & As, the adaptable production concept was explained and discussed for understanding its importance. The cases described in this paper are three of the successful efforts for adaptable production including a semiconductor manufacturer, a photocopying machine manufacturer and a personal handyphone system manufacturer (PHS). The plants have been given fictitious names.

Case 1: Semiconductor manufacturing plant A

In this plant, an adaptable planning system for high variety chip production is being developed which monitors each item's yield rate and work-in-progress inventories for adaptability enhancement. The system is called "new clean room CIM system". Figure 4

illustrates actual behaviour of yield rate and the need for improvement.

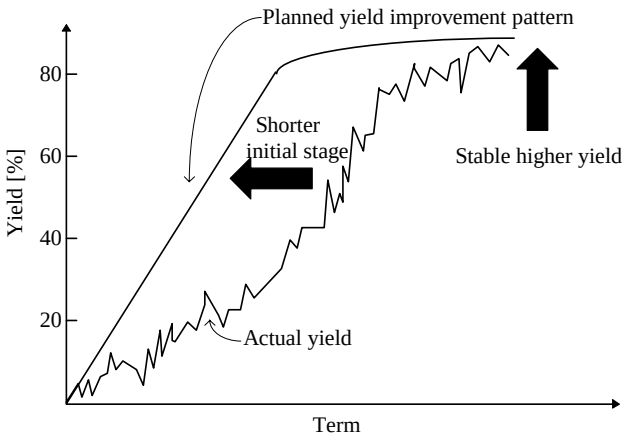


Figure 4. Time series of yield improvement

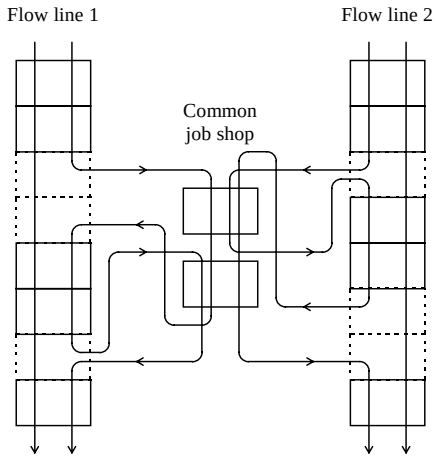


Figure 5. Mixture of flow lines and common job shop

Figure 5 shows the new layout of production facilities, which consist of mixture of conventional flow type lines and common job shops to reduce redundant investment of expensive facilities. Figure 6 demonstrates the significant improvement of work man- hours for chip defect cause analysis. Substantial fixed cost reduction of super precision micro facilities was realised through common job shop introduction and quick response for yield management is enabled by the new system.

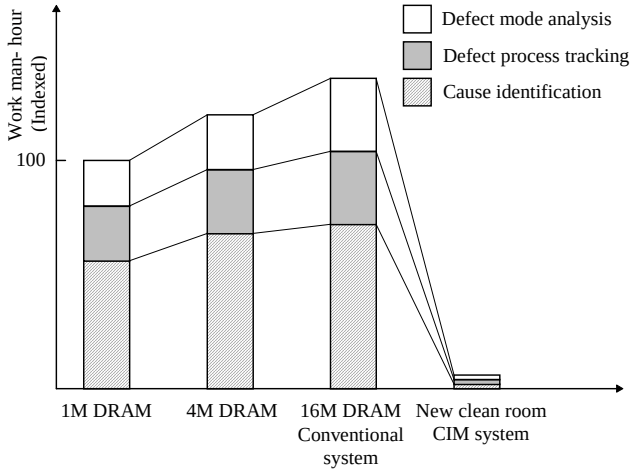


Figure 6. Scale of work man- hours for defect analysis

Case 2: A photocopying machine manufacturing factory B

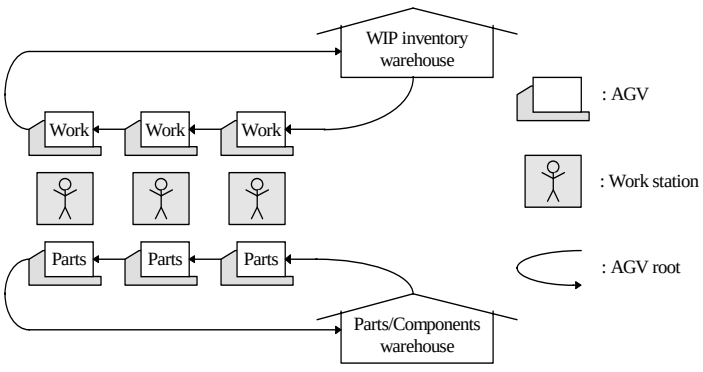


Figure 7. AGV oriented assembly system

This factory introduced a number of in-house made automated guided vehicles to realise the adaptability of the final assembly line, Figure 7. The fixed cost for new product introduction to the conventional assembly line was significantly saved even though manufacturing cost of an AGV was about 10,000. In addition, capability of product mix was improved significantly.

Case 3: A personal handyphone system (PHS) manufacturing factory C

In this factory, a reliable small PCB assembly operation has been developed to allow free modification of the outer shell design. Table 1 compares the old and new PHS product models. Attention has mainly been paid to reducing the number of parts, especially for final assembly, which was realised by consideration of parts commonality. Remarkable result was attained such as significant improvement on number of parts, mass and weight of new product without sacrificing functional variety. Therefore the assembly system was simplified and this resulted in a fixed cost reduction of the production system. Finally, this success was reflected in the product price.

Table 1. Comparison of PHS Models

Model name	PHS Model D1	PHS Model D2
Price [1)]	100	45
Mass	150 cc	100 cc
Weight	250 g	150 g
Number of parts [2)]	13 / 435	2 / 394

1) Normalised price(Model D1=100)
2) a / b
a: Number of parts assembled in the final assembly line
b: Total number of parts

CONCLUSIONS

The concept of adaptable production has been proposed, which is an effective direction in volatile markets and low growth economic environments. One of its relevant features is enabling factories to operate with lower fixed costs, thereby benefiting from a higher variable cost element. Another feature is to improve its ability to produce a mix of products and number of varieties while still remaining competitive as well as strategically viable. It is also seen from the cases that efforts to realise adaptability are made in the factories in terms of new production management technologies. As the final remark, it should be emphasised that adaptable production will sustain its robustness in an era of globalised and uncertain markets by being applied together with the KAIZEN which still retains its effectiveness as the traditional tool for giving Japanese manufacturers their competitive advantage.

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