SWP 35/91

MANUFACTURING - LED COMPETITIVENESS : USE MATHS NOT MYTHS

MICHAEL T SWEENEY
Cranfield School of Management
Cranfield Institute of Technology
Cranfield
Bedford MK43 OAL

(Tel: 0234 751122)

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MICHAEL T. SWEENEY
CRANFIELD SCHOOL OF MANAGEMENT
ENGLAND

ABSTRACT

Many batch manufacturing businesses stagger from one period-end despatch crisis to another. Such organizational behaviour is a consequence of too great an emphasis on financial measures of performance and poor production throughput management.

There is very little published research that provides a plan for an escape from this unfortunate cycle of events. This paper is based upon research designed to provide such a strategy. A model is presented to aid the process of manufacturing strategy planning with descriptions of the generic manufacturing strategies identified by the research.

To achieve manufacturing-led competitive advantage will require many businesses to restructure their operations. The type of audit required to prepare for the needed transformation to their methods of production is detailed in the paper. Significant as these changes are, they are perhaps not as difficult to implement as the acceptance of the radically different performance measurements used to manage manufacturing operations in the 1990s. The measures to use to achieve manufacturing-led competitiveness is the principal subject of this paper.

INTRODUCTION

The prospect of the creation of the single European market and an anticipated increase in the intensity of competition clearly should have inspired all manufacturing companies to determine a strategy to improve manufacturing performance and to maintain a competitive edge. However, it would appear that the urgency of such action is not appreciated by the management of all UK manufacturing companies. The reasons for such myopic strategic manufacturing management are well understood. These include some or all of the following:

1. Many UK manufacturing companies are managed without a coherent strategic plan for their production operations. A large number of the so-called market-led manufacturing businesses do not adequately define how the requirements of the firm's competitive strategy are to be accomplished by the strategic management of their manufacturing operations [1]. This is a widespread problem but its cause is still uncertain. The findings of this research have shown that, in some of the firms studied, the senior management is still preoccupied with resolving operational problems and therefore they have insufficient time to prepare a strategic plan for the manufacturing operations of the business. The consequence of this style of production management is a maintenance of the status quo, i.e. no explicit statement is made to define the firm's manufacturing strategy and therefore, the strategy is assumed. This is to continue as before. In a constantly changing environment, managing manufacturing in this way will only produce a result that was predicated by King Solomon [2] many years ago i.e. "Where no wise guidance is, the people falleth". The emphasis here is on "wise guidance", i.e. changes in direction in the way a business is to compete may necessitate changes to the established practices used for the management of the manufacturing resources.

2. The continued use of established measures of production performance legitimizes the use of historical and proven manufacturing management practices which are now inconsistent with the changed needs of the firm's current customers [3]. In many cases the established measures of production performance are founded upon outdated and now irrelevant operations management precepts and these management "rules of thumb" constitute the major barriers to change. Consequently, the performance measures used now only reflect traditional thinking about what the market wants or how manufacturing should be managed.

3. A lack of knowledge or understanding of the substitute or supplementary manufacturing performance measures that are required to improve the competitiveness of the company's customer service. Radical changes to the quality of customer service offered may also require similar changes to the product delivery system. Uncertainties about implementing radical changes to the methods of production throughput management may be increased by a lack of knowledge about the most appropriate performance measures to use with a redesigned manufacturing system.

Evidence to date [4] has shown that these performance measures are different in kind to the traditional financial measures used. This does not mean that financial management reporting is no longer useful or used but that these data are often provided too late to be effective and are usually not directly related to the company's strategy. Toshiro Hiromoto has summarised the Japanese approach to performance measurement for competitive manufacturing operations, i.e. "Japanese don't let these accounting procedures determine how they measure and control organizational activities" [5]. The accounting procedures that Hiromoto referred to are cost and management accounting.

THE PURPOSE OF THE PAPER

The purpose of the paper is to present the findings of a study of manufacturing strategy implementation in twelve UK batch manufacturing companies. Included in the paper is an explanation of a conceptual framework which has been developed to facilitate the matching of generic competitive strategies with the appropriate generic manufacturing strategies.

The principal purpose of the paper is to recommend performance measurements that are congruent with the strategic objective of establishing a manufacturing-led competitive advantage. These performance measurements are proposed as a challenge to the stereotypical view of what constitutes manufacturing efficiency and the unquestioned reliance upon cost accounting measures of performance.

THE DEFAULT MANUFACTURING STRATEGY

The extensive and almost exclusive use of cost-related measures of manufacturing performance has encouraged many manufacturing decision-makers to adopt policies designed to minimize the unit cost of value adding activities performed in individual manufacturing sub-systems. Such an approach in a discrete manufacturing environment is dysfunctional to efficient throughput management and belies any claim that the company is managing its production operations strategically.

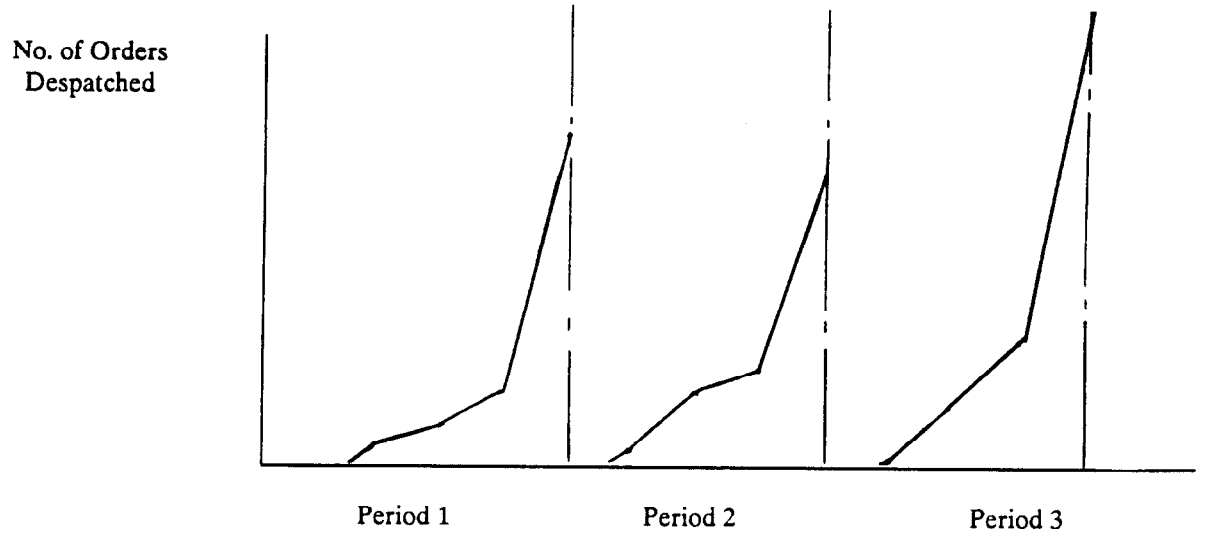
If total unit cost minimization is the goal and its realization is essential to the achievement of the firm's competitive strategy then strategic manufacturing management is evident. The firm has determined that the strategic role for manufacturing is similar to that defined by Hayes and Wheelwright as one of seeking internal neutrality [6].

However, this study provided substantial evidence of the existence of a strategic role for manufacturing which the author has termed as the "default caretaker" strategy. The manufacturing management of five of the twelve collaborating firms were employing policies and using performance measurements that focused only on cost efficiencies and quality but their competitive strategy was stated to be more than just one of least cost. An examination of the reasons for the use of these performance measures found the rationale to be that they were inherited from their predecessors. Although attention to minimising unit cost and striving for quality consistency may have been the most appropriate strategy to implement in the past, the competitive strategy of these firms had subsequently changed. Unfortunately, neither the manufacturing throughput methods used nor the performance measures applied had been altered to remain consistent with the revised competitive strategy. In effect, reliance upon the use of these measures concealed the need for senior manufacturing management to direct its attention to other or more important customer service criteria that may increase their firm's competitiveness. The results are as King Soloman forecast, the market share "falleth" and cost increases are avoided by reducing manufacturing capacity. A "default caretaker" strategic role for manufacturing is a recipe for disaster. It's failure is inevitable because of the inconsistency between the methods used to implement the firm's manufacturing strategy and those essential to its competitive strategy. In firms that strategically manage in this way, the financial performance objectives are perceived by all to supersede all others because they are the only tangible representations of what senior management consider to be of greatest significance to them. If this were not the case, why do they ensure that such measurements

of performance are reported? Similarly, if these measures are the ones used to evaluate the performance of the firm, its management and work force, then these are the criteria which will be optimised when trade-off decisions are required.

THE PROOF OF INTERNAL CONFLICT

The most common manifestation of a batch manufacturing business being torn apart by applying ill-considered cost accounting measures of performance is the end of month despatch syndrome. This occurs when the number of orders despatched during the first part of a reporting period (typically one month) is relatively few and the rate of despatch only increases gradually. However, towards the end of the reporting period, the despatch rate increases rapidly. This pattern for the timing of orders despatched repeats itself period after period and has been termed the "hockey stick" [7] delivery cycle. This is illustrated in Figure 1.



"Hockey Sticks" Despatch Patterns

Figure 1

The most interesting feature of the hockey stick despatch pattern is that it is evident in all types and sizes of batch manufacturing plants. It is also observed in facilities that differ in the extent of the use of manufacturing technology. In addition, although there is diversity in the scale of the differences between the firms' peak and early period despatch rates, the basic pattern remains. The only parameter that affects the despatch rate phenomenon is the length of the reporting period, i.e. if the reporting period is four weeks then the peak despatch rate occurs in the fourth week rather than at the end of the month. It is therefore evident that the manner in which performance data are reported significantly effects the actions taken within the company.

The cause of this pattern of corporate behaviour is claimed [7] to be directly related to the performance evaluation system. Umble states that "In the first part of the month, the actions of the workforce are primarily influenced by standard cost performance measures. These measures have a very localized focus. They typically emphasize the efficiency and utilization of specific machines, workers, work centres and departments. The measures stress the standard time to run a part and the cost to process that part at each operation" [7]. In this type of manufacturing system, the manufacturing management philosophy is the economic batch quantity and the scheduling of large batches, irrespective of the down stream consequences to throughput management.

This emphasis upon minimising unit cost continues until there is a danger of failure to meet the despatch target for the period. At this point, the plant manager intervenes and the emphasis shifts to customer service, or to the achievement of objectives that are external to the organization and may be in conflict with the strategy followed up to that point. All energies are now focused on expediting those partially completed orders which are required to meet the despatch target for the period. Production efficiencies are sacrificed

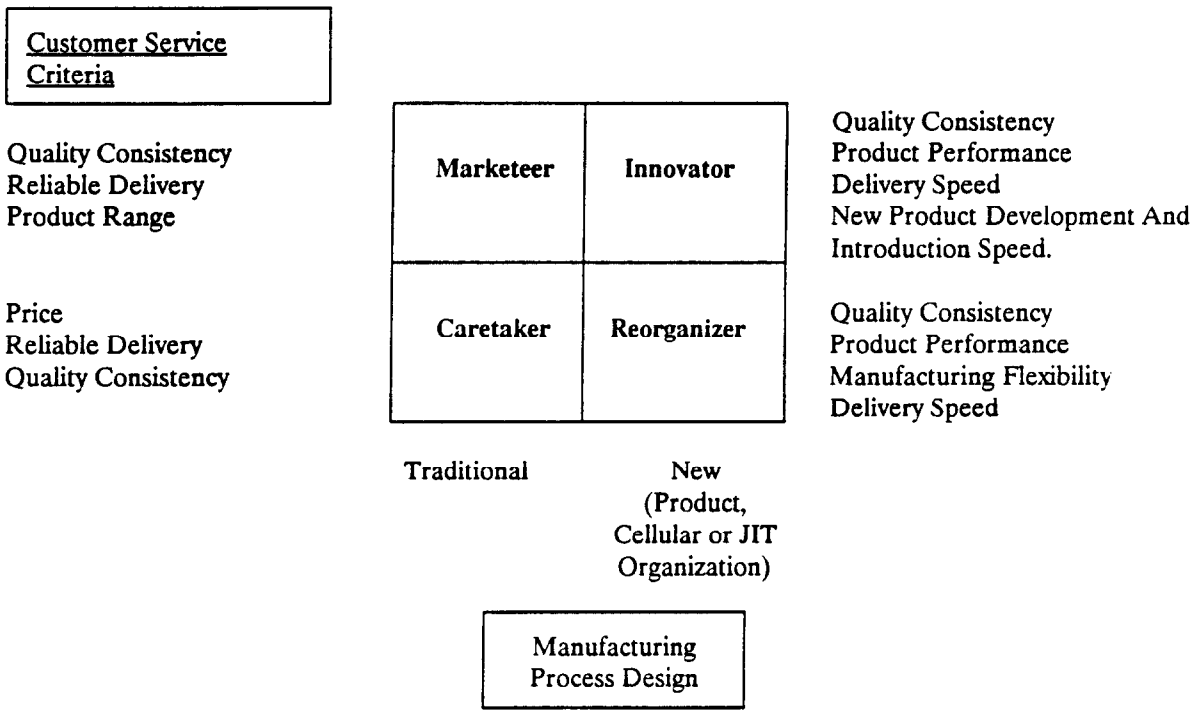
and actions are taken based upon a rationale which is in total contrast to that used for decisions made during the early part of the reporting period. Once the crisis is over, the plant reverts to attention to local cost measures. Therefore, without changes to the performance evaluation criteria and methods of production throughput management the cycle will inevitably and consistently be repeated.

ESCAPING FROM CRISIS MANAGEMENT

An explanation for the inconsistent behaviour that produces the hockey stick phenomenon is a lack of adherence to an agreed manufacturing strategy. The stimulus for this behaviour is the choice of criteria used to evaluate manufacturing performance. Therefore, the prerequisites to break out from this cyclical pattern of organizational behaviour must be an agreed strategic role for manufacturing and the use of appropriate manufacturing performance measures. The fundamental task for management is to ensure the consistency between the firm's competitive strategy and the agreed strategic role for manufacturing.

The subject of this paper is a strategy which will establish a competitive edge through manufacturing performance, i.e. it is what Hayes and Wheelwright classify as externally supportive [8].

How can this role be better defined? Considerable research effort has been expended on the search for a taxonomy of generic manufacturing strategies. [9-13] The findings of these studies have been used to develop a conceptual framework to facilitate the strategic planning of manufacturing operations [14]. This is shown in figure 3



The Match between Competitive and Manufacturing Strategies
Figure 3

The four generic manufacturing strategies shown in figure 3 fulfil roles which are designed to satisfy different combinations of customer service criteria. The caretaker strategy is the manufacturing strategy employed when senior management consider that little competitive advantage can be gained through differentiation. Senior management's expectations about the performance of the manufacturing task are that the plant must produce efficiently and the firm must provide a reliable delivery service to the customers. It is therefore the manufacturing strategy applied by businesses adopting the least cost producer competitive strategy. Many organizations apply this strategy by design and some by default. The main drivers for the implementation of this strategy are the traditional cost and management accounting measures of output, unit cost variance, machine utilisation, labour utilisation, material cost variances etc.

The marketeer strategy is frequently used by organizations that are experiencing increased competition and they need to enhance and extend the standards of customer service they offer. Their responses include a broadening of their product lines or the instigation of plans to improve the quality and specification of their products. The catalyst for a change to this type of manufacturing strategy is usually the company's marketing function. Market-led organizations seek new opportunities to differentiate and sell their products.

The marketeer strategy is therefore often implemented in response to competitor actions or it may be adopted in an attempt to establish a strategy of differentiation through an improved customer service. The emphasis of the marketeer strategy is to strengthen the manufacturing function usually through infrastructural changes such as total quality management and delivery performance reporting. Broadening the portfolio of products and the methods of distribution increases the complexity of the operations management task. Management usually responds to this consequence of change by altering the organization structure and enhancing the management information systems. Such actions constitute the implementation of a marketeer strategy. Additions to the range of products offered do not usually initiate an examination of the need to restructure the manufacturing process. An increased manufacturing capability is often expected by stretching the capability of the existing production process and methods.

The drivers for the management of the marketeer strategy differ little from those used for implementing a caretaker strategy, i.e. the cost and management accounting measures of performance. This is because very little change is made to the way that products are produced and so there would appear to be very little need to change the types of performance measures used. However, some organisations have improved their delivery performance with the assistance of a despatch date monitoring system, which has proved to be a valued addition to the performance measures that they use.

The reorganizer strategy is adopted by manufacturing businesses to enhance the quality and the performance of their products and to reduce customer delivery lead times. The motivation to implement such a manufacturing strategy is often an inability to satisfy the order winning criteria of customers to a better standard than that provided by competitors.

Firms that elect to implement this strategy recognize the need for better management of the tangible elements of manufacturing strategy, i.e. capacity, facilities and technology. Such organizations therefore make investments in computer aided design and manufacture, dedicated and/or flexible manufacturing equipment and in the installation of plant configurations that simplify managing the production throughput efficiency.

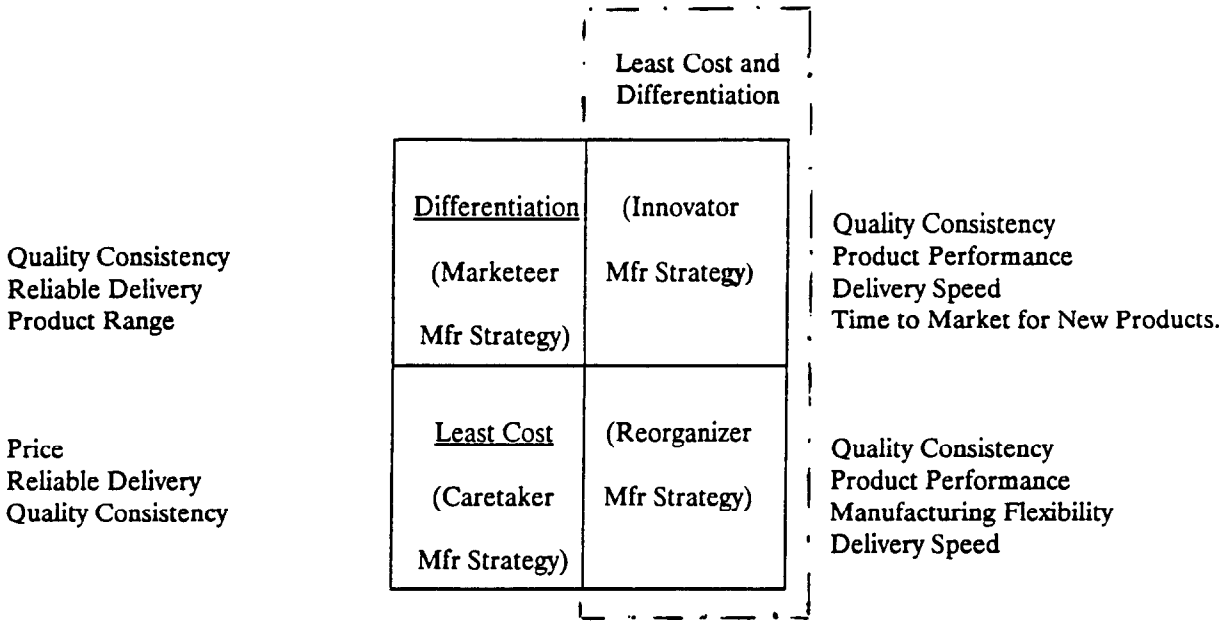
The performance measures used to steer the application of this type of manufacturing strategy are significantly less financial in emphasis. Greater attention is paid to customer service, i.e. delivery performance, delivery quality (zero defects) and customer lead time. Financial measurements are still required but are more related to the efficiency of production flow, e.g. work in process stock turns, than those used for standard costing purposes. The ultimate goal of firms that adopt this strategy is to establish a capability to exploit a manufacturing-led competitive advantage.

The innovator strategy is the synthesis of the marketeer and reorganizer strategies. The objective of implementing this strategy is to outperform the competition in terms of both product performance and the quality of service to the customer. It is to achieve engineering-led competitive advantage, ie. both product and process engineering.

To achieve this goal requires the highest standards of design and manufacturing performance. Consequently, to succeed at implementing the innovator strategy will require simultaneous engineering expertise since this is the means for creating a time-based competitive advantage.

The measures of performance recommended for use with the implementation of this type of strategy are predominantly time-based, i.e. time for new products to reach the market from the time that the design process begins, life cycle time and the life cycle costs to the company, delivery lead time and manufacturing cycle time. The others are the same as those used for the marketeer and reorganizer strategies.

The relationships between the customer service criteria detailed in figure 3 and Porter's [15] generic competitive strategies are shown in figure 4.



Matching the Taxonomies of Generic Competitive and Manufacturing Strategies
Figure 4

It is clear from figure 4 that the goal of all batch manufacturing businesses is to achieve a competitive strategy of least cost and differentiation and to achieve world class status. However there are two forms of world class status for such organizations, i.e. those that achieve a manufacturing-led competitive advantage by the successful implementation of the reorganizer manufacturing strategy and those that fully develop the innovator manufacturing strategy to achieve engineering-led competitive advantage. This paper examines the changes required to escape from a corporate culture of crisis manufacturing management to the adoption of the reorganizer manufacturing strategy in a firm.

MANAGEMENT BY MATHS INSTEAD OF MYTHS

The "hockey sticks" pattern of despatches provide irrefutable evidence of the influence that performance measures have upon organizational behaviour. The use of mathematics to quantify performance appears to have a very profound impact upon those responsible for operations management. However, there must be exceptions to this hypothesis because not all performance criterion can be formally and regularly measured. It is therefore the selection of the performance criteria to be measured which is critical and which has been badly executed. An example of poor selection is delivery performance. For a very long time insufficient attention has been paid to this aspect of customer service and only now is this issue being addressed openly at OEM (Other Equipment Manufacturer) supplier's conferences. It is usually the OEM that presents statistics on the delivery performance of both the OEM and its suppliers. Many suppliers see, for the first time, data on the quality of their service to the OEM.

This attitude to the quantification of customer service standards has changed little in the UK over the last twenty years. An initial study of the manufacturing performance of 153 UK companies, carried out in 1975, found that 25 per cent of these firms admitted, in a year economic recession, that they were delivering less than half of their orders to customers on time [16]. Follow up research suggested that this was an over-estimation. The explanation given was that the delivery performance of firms that did not formally measure it was actually significantly worse than management's own assessment of it [17].

A second survey of the performance of 240 UK manufacturing companies was carried out in 1985 and its findings demonstrated that very little had changed. The findings of this survey on the delivery performance of the surveyed companies were as follows [18]:

1. 25 per cent of the companies admitted to delivering more orders late than they deliver on time.

2. Less than half the plants managed to achieve the modest target of 75 per cent on time delivery.

3. Only half the plants had a formal system for monitoring delivery performance.

4. Those plants with a formal delivery monitoring system were twice as good as those without.

The results of this survey clearly demonstrate the need to quantify the performance of the firm particularly for those activities that are critical to its competitiveness. They also show the impact that this has when it is done. The use of maths and not myths is vital.

Why is measurement so critical? It has long been a principle of quality management that:

A. There should be no performance criteria without measurement
B. No measurement with recording
C. No recording without analysis
D. No analysis without action

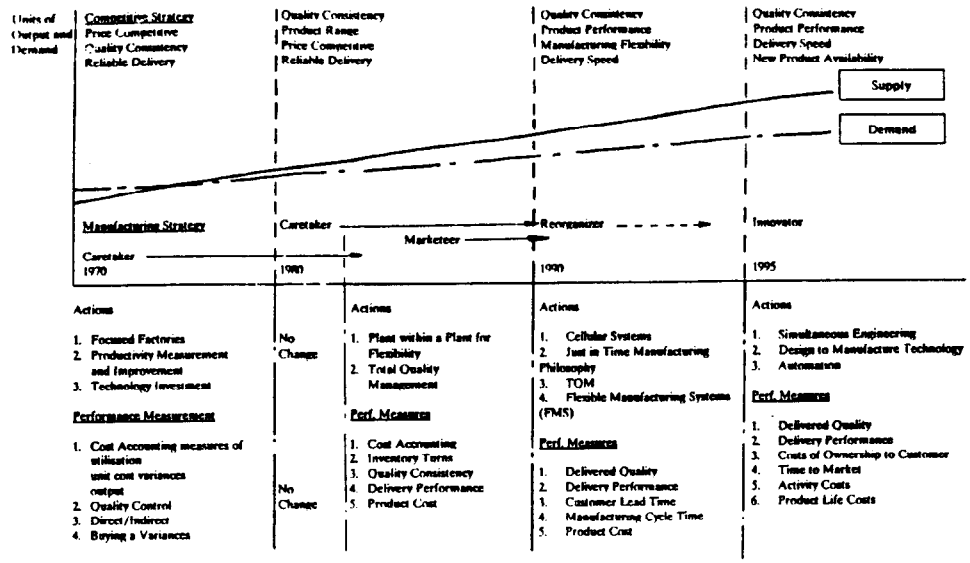
The theory of constraints [19], when applied to manufacturing strategy, provides an explanation for these findings and survey results. Weston [19] suggests that "there will always be a constraint of some type, either internally or externally, that will limit the firm from achieving a higher level of profit". In this example this is the awareness of delivery performance by the senior management in those firms that did not measure the reliability of their firms' deliveries. Those firms that did measure delivery performance appear to have focused on the constraints.

TO ACHIEVE MANUFACTURING-LED COMPETITIVENESS

Two causes were identified previously to explain the end of period despatch crisis, i.e. too great a significance being attributed to cost and management accounting measures of performance and the poor management of production throughput. Organizations that tolerate this manifestation of underachievement cannot establish a manufacturing-led competitive advantage without a step change to their modus operandi. The objective of such a change would be to implement a strategy that is directed to overcoming both of these constraints to increased profitability. Such a strategy is the reorganizer strategy.

One cause of the inability of many manufacturing companies to cope with increased international competition is their continued adherence to their long established manufacturing strategy [20], i.e the default manufacturing strategy described previously. A firm's manufacturing strategy should evolve as markets, products and competitors' strategies evolve and therefore, a business unable to change to exploit opportunities or to counter competitor actions will not survive.

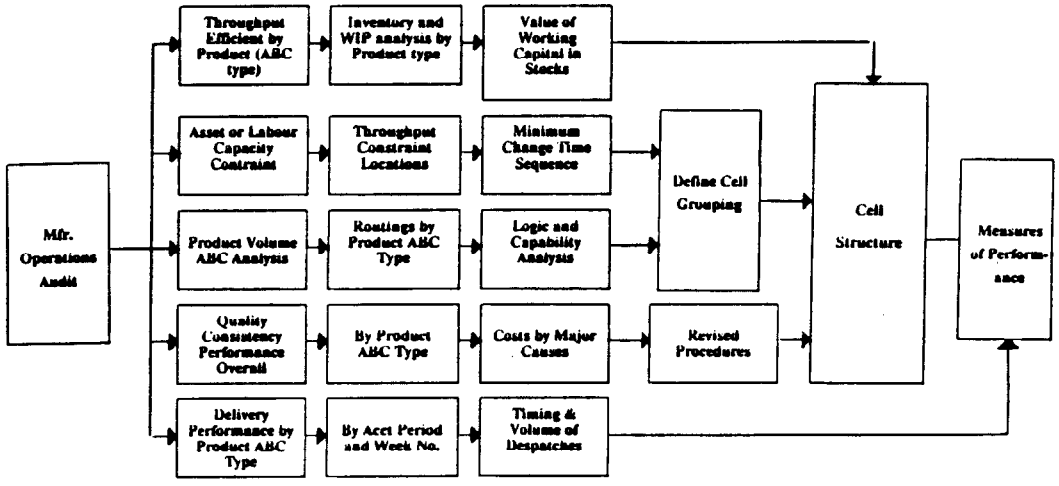
How increased competition has forced organizations to seek new ways of establishing a competitive advantage is shown in figure 5. This figure also details how such changes to competitive strategy have been accommodated by redefining the strategic role of manufacturing. The actions required to establish each type of strategic role are also briefly detailed on figure 5. The figure shows that many companies, during the last decade, have had to increase the number of product types that they were prepared to offer to their customers to remain competitive. Production control problems during this period have significantly increased. Many manufacturing businesses considered that the solution to this problem was to invest in complex management information systems that were designed to process huge quantities of data. An example of this approach is the use of materials requirements planning systems to manage raw materials and parts supply, master production scheduling, load and capacity planning and inventory management. A simplification approach to this problem was not considered to be a solution at that time.



The Evolution of Generic Competitive and Manufacturing Strategies
Figure 5

Manufacturing companies adopting this approach were therefore electing to implement the marketeer manufacturing strategy. Time has demonstrated that such an approach does not reduce the problem of poor throughput management and in many organizations it actually increased the problem. The solution is to improve manufacturing flexibility and the throughput efficiency of the firm. As figure 5 shows these objectives can be achieved by the creation of cellular production systems and the just-in-time philosophy to throughput management.

The analysis required to reorganize the manufacturing resources into quick response units of production is shown in figure 6.



Product and Process Audit Required to Establish Cell Manufacture
Figure 6

An audit of existing operations is a prerequisite to a restructuring of production. Many companies that have implemented a marketeer manufacturing strategy have a high asset value of total inventories and therefore there is considerable working capital tied up in inventories. The release of this capital can provide the funds needed to finance the implementation of the reorganizer manufacturing strategy.

The selection of the performance measurements to use for this strategic role for manufacturing are obviously more related to competitive edge criteria, as figure 5 shows. Whereas a caretaker strategy requires almost 100 per cent of performance data to be provided by the management accountant, the percentage used to manage a reorganizer strategy is less than 50 per cent. Examples of the performance measurements used by companies that have implemented the reorganizer manufacturing strategy are:

1. Percentage achievement of plan
2. Manufacturing throughput time
3. Manufacturing throughput efficiency
   i.e. $\frac{\text{total value added time}}{\text{total manufacturing throughput time}}$
4. Work in process level
5. Other inventory levels
6. Percentage quality consistency
7. Cost of poor quality
8. Delivery performance
9. Unit cost of production in cell or business unit
10. Total cell or business unit overhead costs
11. Total value of output produced

For those companies that have established an innovator manufacturing strategy, the percentage of performance evaluation data originating from the organization's management accountant is even smaller, as figure 5 shows.

CONCLUSIONS

To achieve manufacturing excellence requires a vision of how the strategic role of manufacturing should be developed. A clear insight of the appropriate changes needed to both the manufacturing process and its infrastructure is necessary. In addition, the influence of performance measurement methods must not be overlooked. Their use can be either constructive or destructive.

A manufacturing-led competitive advantage is possible by implementing the reorganizer manufacturing strategy. A detailed study of current and future demand and an audit of the extend that manufacturing is a constraint to increased profitability are necessary before a decision is made about the type of generic manufacturing strategy that should be implemented. The funds needed to finance a change to manufacturing strategy can often be raised by releasing working capital tied up in inventories. However many of the old manufacturing performance measures should be discarded when the reorganizer manufacturing strategy is used. Figure 7 shows how some companies that have changed from a caretaker or a marketeer strategy have chosen to discard some of the performance measures that are familiar and valued. These have been replaced by others that emphasize an interest in customer service performance rather than the introspective emphasis of those that they replaced. The results, shown in figure 7, were obtained in response to the question "How do you monitor performance, before the introduction of cell manufacture, and after introduction of cell manufacture?" [21]

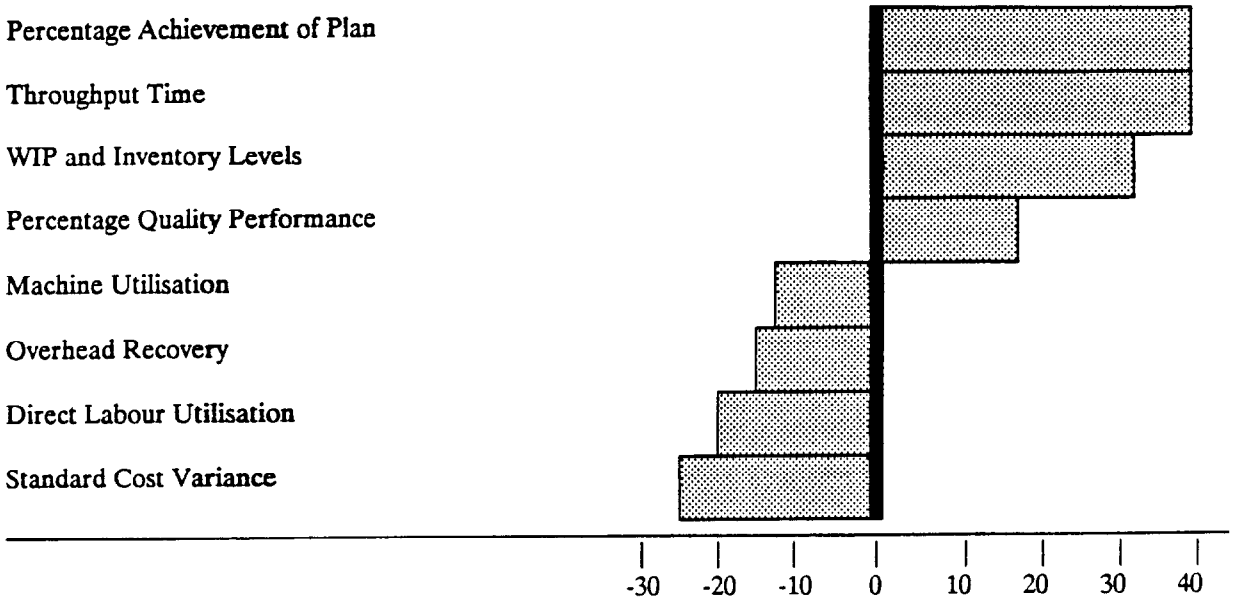


Figure 7
Percentage Swing

Further research is required to evaluate whether activity based costing could improve the quality of the cost performance measures needed to manage quick response manufacturing systems.

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