SWP 18/95 MANUFACTURING STRATEGY AND PERFORMANCE: A STUDY OF THE UK ENGINEERING INDUSTRY

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ISBN 1 85905 079 4

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ABSTRACT

This paper details the findings of a search for manufacturing "strategic groups" in the engineering industry, that is a set of firms competing within an industry on the basis of similar combinations of business scope and resource commitments.

The research methodology used was to adopt stockturns (excluding work in process), as a measure of manufacturing scope. Manufacturing throughput efficiency was selected as a measure of production engineering resource commitment.

An initial grouping of companies was accomplished by using these two manufacturing performance variables. Comparisons were then made of the manufacturing practices and performances of the firms in the four strategic groups that were formed.

The results obtained show statistically significant differences in the performance of each of the strategic groups formed. They can also serve as benchmarks for the evaluation of manufacturing management performance. The proposed manufacturing strategy and performance matrix provides a practical framework for strategic planning.

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INTRODUCTION

Each year manufacturing companies in the United Kingdom compete for the Management Today - Cranfield School of Management Best Factory Awards. To determine which manufacturing plant qualifies for the award of United Kingdom Best Factory requires a comprehensive understanding of the production methods and the manufacturing performance of each applicant for the award. This information is gathered, in the first instance, by the use of a questionnaire. The aggregation of this survey data, which is performed to protect the confidentiality of individual company information, constitutes a unique set of facts that are to be essential for an empirical study of both manufacturing strategy and manufacturing performance.

The uniqueness of this database is the strategic and the operational information that it holds. The strategic management information collected is the type of customer service that each company strives to deliver to gain a competitive advantage. The operational data gathered are the measurements of current performance for both manufacturing and customer service. The range of manufacturing performance information sought includes data on both the key performance indicators and their principle drivers. For example, information is requested on the total manufacturing lead time of a product and the production lead time of a typical or average component.

This database is a valuable source of information for another reason. A recently published review of empirical studies of manufacturing strategy, carried out by Minor III et al. [1], concluded that even the most carefully planned surveys are adversely affected by lack of response and by lack of standards in reporting financial and manufacturing data. They emphasized that the development of databases for empirical analysis would be a definite contribution to the discipline and for this to happen manufacturing managers must have an interest in the research, or something to gain by making the effort to respond. The data supplied for this empirical research meets this condition for improved data integrity. It is in the interest of those who enter the Best Factory competition to complete the questionnaire as accurately as possible because all factories short-listed as a potential award winner are visited to audit their manufacturing practices and performance. There is also considerable prestige to be gained by winning a Best Factory award.

The Best Factory award survey also complements the empirical research carried out by those responsible for the Manufacturing Futures Survey Project. Miller and Roth [2], in their search for a taxonomy of manufacturing strategies, designed their survey instrument to research the types of competitive manufacturing capabilities that are sought by American manufacturing companies. Their survey also investigated the relative importance of 36 listed key action programmes to improve the effectiveness of production operations and 29 manufacturing performance measures that could be used. The purpose of their research did not require the collection of data on current manufacturing performance and perhaps this is the contribution that this survey can add to that resulting from the Manufacturing Futures survey.

There is a need to research current manufacturing practices and performances. The review of empirical manufacturing strategy studies, carried out by Minor III et al. [3], concluded that relatively few have been made that specifically address the effects of manufacturing strategy upon business performance. One definition of business performance is the quality of customer service delivered and the examination of how manufacturing strategy can affect customer service quality was an important objective of this research project.

PREVIOUS RESEARCH ON THE STRATEGY-PERFORMANCE RELATIONSHIP

Although little research has been carried out on the relationship between manufacturing strategy and business performance, a phenomenon that many strategic management researchers did study, during the nineteen seventies, was the business strategy-performance relationship. An early theory [4] postulated that business performance is a consequence of two variables. These are the effects of the uncontrollable variables on a business, such as the market conditions, and the results of the decisions that are made that manage the controllable business performance variables. This theory was expressed as follows:

$$\text{Performance} = f\ (\text{controllable, noncontrollable variables})$$

Ackoff [5] argued that the managerial decisions that make a significant impact upon business performance are of two types, those made for efficiency or for operations management purposes and those taken to improve effectiveness. It is the latter of these two types of decision making that he considered to be strategic management actions.

To provide an explanation for differences in competitor behaviour and business performance, Hunt [6] postulated the concept of "strategic groups". This concept was further developed by Cool and Schendel [7]. Their research provided a more precise definition of a strategic group and a recommended methodology for its identification. Their definition of a strategic group is as follows [8]:

"A set of firms competing within an industry on the basis of similar combinations of scope and resource commitments".

In their study of the US pharmaceutical industry they concluded that:

"strategic group analysis has significant potential to shed light on important issues of performance, rivalry and conduct" [9].

This previous research seems to have provided a variety of findings that could be used for a study of the relationship between manufacturing strategy and manufacturing performance. Manufacturing performance is often synonymous with business performance through the selection of performance measures that directly affect the quality of customer service provided by a company. An example of such a relationship would be the reliability of delivery performance. It was for this reason that the search for strategic groups and a study of their performances were chosen as the means to gain a better understanding of the affect that the choice of manufacturing strategy has upon manufacturing and business performances.

RESEARCH OBJECTIVES

The objective of this research was to isolate the manufacturing strategy groups that are within the UK engineering industry and to examine the strategy-performance consequences of strategic manufacturing group membership.

A supplementary objective was to examine the homogeneity of these strategic groups with the set of generic manufacturing strategies discovered by the previous research of Miller and Roth [10], De Meyer [11] and Sweeney [12].

Research Methodology

Cool and Schendel [13] postulate that there are two strategy components that distinguish companies which are adopting either similar or different competitive strategies. The two components of strategy that they recommend for strategy grouping are business scope commitments and resource commitments.

The research method adopted for this study was the same as that used by Cool and Schendel for their research on the isolation of strategic groups. Thus the scope commitments and the resource commitments, made by the senior management of the manufacturing function, were employed to identify companies implementing similar manufacturing strategies.

The manufacturing performance indicator used to measure the manufacturing scope commitments of a firm was stockturns. This performance measure was chosen because it can distinguish those companies that manufacture a broad product range from those that have elected to produce a narrow product portfolio. The selection of this performance measure was based upon the hypothesis that different manufacturing strategies are required to competitively manufacture a narrow or a broad range of products [14].

To more clearly identify companies that make a broad range of products from those that choose to produce a narrow product portfolio, work in process inventories were excluded from the stockturn analysis for each company. The identification of manufacturing companies with a narrow product range is more easily accomplished by determining the stockturns of raw materials and finished goods only. These companies usually have defined a more focused manufacturing mission and thus tend to achieve higher stockturns for raw material and finished good inventories.

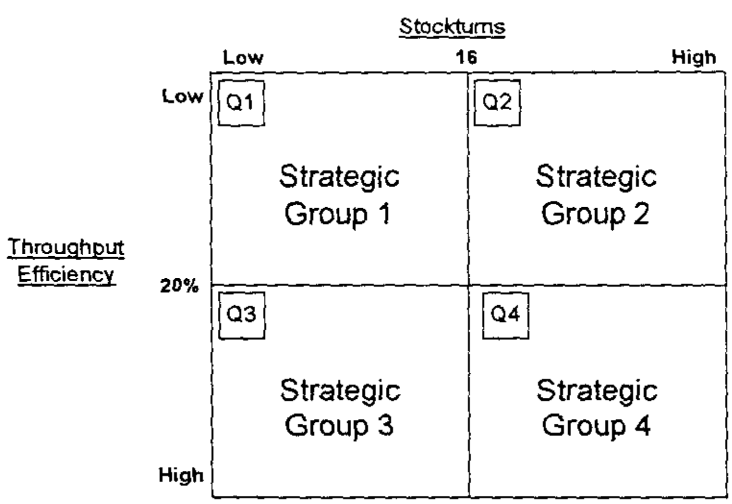
Manufacturing throughput efficiency was selected as the measure of the production engineering resource commitments made by a company. The throughput efficiency of a production operations is defined as follows:

$$\text{Throughput efficiency} = \frac{\text{Total Value adding time to produce a product or a component}}{\text{Total manufacturing throughput time}} \times 100$$

The rationale for the selection of throughput efficiency, as a measure of manufacturing resource commitments, was based upon the hypothesis that the higher the throughput efficiency, the greater the company investments in process design and process engineering.

The strategic manufacturing groups were formed by separating the higher and the lower performers for stockturns and throughput efficiency into four clusters of firms. Each cluster of engineering firms constituted a unique combination of performances for stockturns and throughput efficiency. Thus a manufacturing strategy and performance matrix was created and this is shown as Figure 1.

Figure 1
Manufacturing Strategy and Performance Matrix



The firms in each of the four quadrants of the matrix, shown in Figure 1, are considered to constitute a strategic group. This is because they display similar conduct for key strategic activities. The similarity of this conduct is reflected by their stockturn and throughput efficiency performances.

However, these strategic groups have been created by the use of performance standards only and what remain unclear are the manufacturing policies that are used to achieve the reported standards of performance. Also of interest is what standards of performance for other cost management and customer serving activities have been achieved by the implementation of the manufacturing strategies that position each firm within the strategic groups shown on Figure 1, whether the manufacturing strategy was implemented by design or default.

To find answers to these questions, the information completed by firms competing for the 1993 and 1994 Best Factory Award was used. To compete for this award a manufacturing company must complete a comprehensive questionnaire that requires the provision of information about the competitive strategy of the business, the manufacturing system designed to support that strategy and its performance. Only data obtained from firms with the UK engineering industry were used for this study because, by definition, a firm's business scope and resource commitments, as defined by Cool and Schendel [15], are industry specific. Consequently, the determination of those variables that define strategic groups must also be industry specific.

A total of 138 completed questionnaires constituted the database for this analysis. The statistical analysis performed was the calculation of the mean values of seven manufacturing performance variables for each of the strategic group of firms within the four quadrants of the manufacturing strategy and performance matrix. Differences between the calculated mean values were subject to a t-test.

This analysis was carried out on the following manufacturing performance variables:

1. Stockturns
2. Throughput Efficiency
3. Number of products manufactured
4. Delivery Performance
5. Average Component Setup or Changeover Time
6. Customer Returns
7. Percentage Scrap or Percentage below the Ideal Yield Rate

An examination was also made of the manufacturing policies adopted by firms in each quadrant of the manufacturing strategy and performance matrix, that is whether these firms make or assemble to order, make for stock or perform both of these types of manufacturing operation.

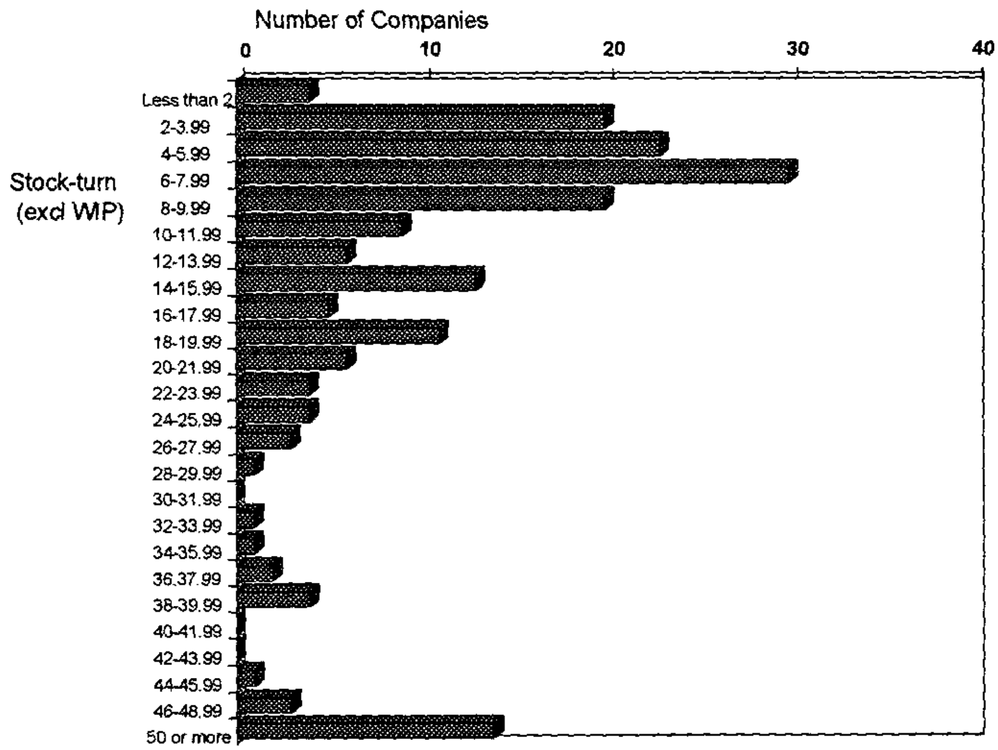
Those firms that compete for the Best Factory Award are also requested to declare their success level at cost management, whether the unit cost of production has increased, decreased or remained the same. The results of this survey were also analysed.

The selection of these performance variables was based upon the need to make a comparison of quality, cost, delivery and flexibility management.

RESEARCH RESULTS AND CONCLUSIONS

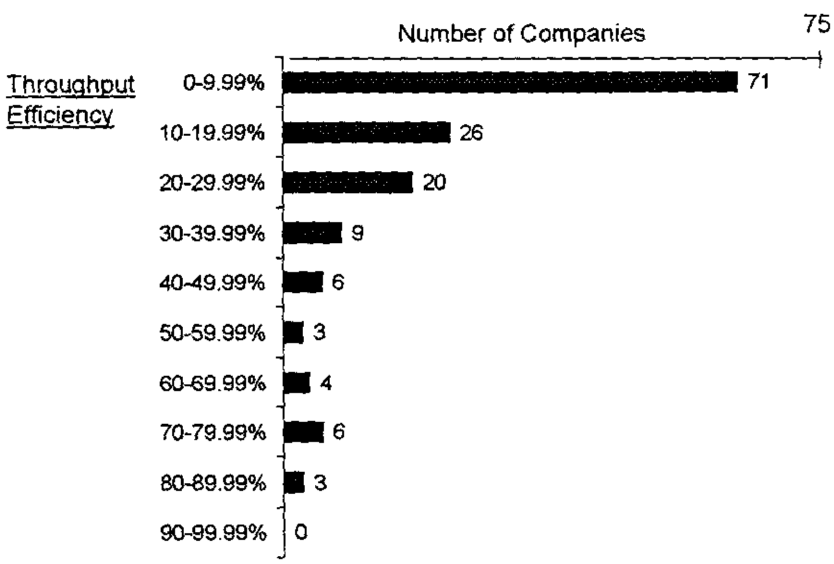
Figures 2 and 3 show the spread of the stockturns, and the throughput efficiency performances for the sample of engineering companies studied. These results were used to set the intermediate limits between the high and low performance standards shown on Figure 1, that is a throughput efficiency of twenty per cent and a stockturn of sixteen.

Figure 2
Stockturns Analysis for the Engineering Industry



The number of companies that completed this section of the questionnaire was 175.

Figure 3
Throughput Efficiency Analysis for the Engineering Industry



The number of companies that completed the sections of the questionnaire needed to calculate their throughput efficiency was 148.

The number of companies that constituted the four strategic groups, using the mean values for stockturns and throughput efficiency as the criteria for their grouping, were as follows:

Quadrant 1 - low stockturns and low throughput efficiency - 66 companies

Quadrant 2 - high stockturns and low throughput efficiency - 27 companies

Quadrant 3 - low stockturns and high throughput efficiency - 31 companies

Quadrant 4 - high stockturns and high throughput efficiency- 14 companies

Questionnaire data from 37 companies were not included in the research database of 175 entries because of incomplete questionnaire submissions. Details of the questions asked to obtain the data used for this research are shown on Appendix A of this paper.

The creation of the strategic groups provided the opportunity to investigate whether they have chosen significantly different business scopes, that is whether there were substantial differences in their product range offerings. Table I details the results of this analysis.

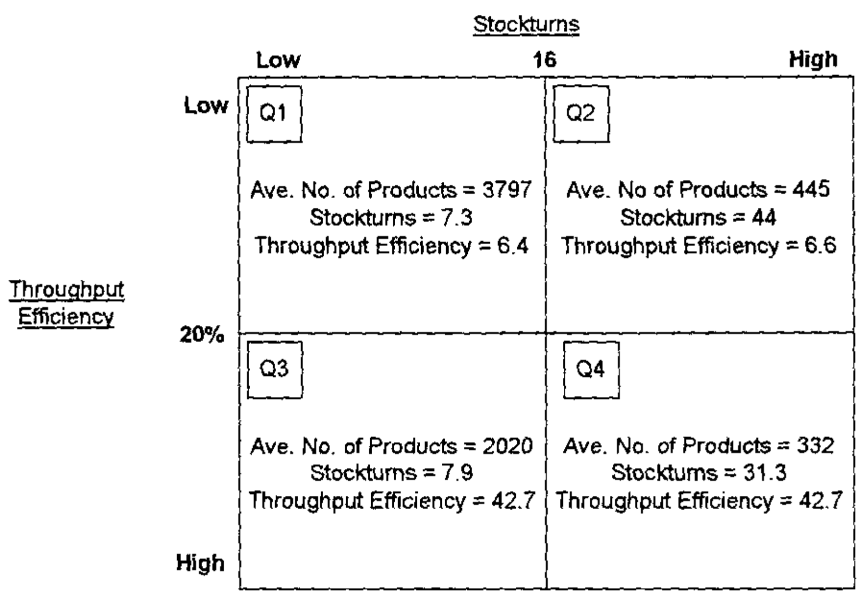
Table I An Analysis of the Number of Products Produced

Quadrant	Mean Value	N	t-test Significance Results		
				p result	significant
Q1	3797	66	Q1 and Q2	p = 0.001	yes
Q2	445	24	Q1 and Q3	p = 0.1	no
Q3	2020	31	Q1 and Q4	p = 0.001	yes
Q4	332	14	Q2 and Q3	p = 0.005	yes
			Q2 and Q4	p = 0.966	no
			Q3 and Q4	p = 0.004	yes

It is clear from these results that firms within strategic groups 2 and 4 have chosen to implement a different product strategy to those within strategic groups 1 and 3. There is therefore a distinctive difference between the product manufacturing missions between the two sets of strategic groups.

An analysis of the mean values of the number of products produced, stockturns and throughput efficiencies of the firms in each of the four manufacturing strategic groups was carried out. The results of this analysis are shown in Figure 4.

Figure 4
Manufacturing Strategy and Performance Matrix Stockturns



The stockturns analysis shows significantly different performances for stock management by the firms in strategic groups 2 and 4 to those of strategic groups 1 and 3. In a similar manner, the management of the speed for the throughput of products, once they have entered the production process, is significantly different in firms in strategic groups 3 and 4 to that in firms in strategic groups 1 and 2.

The combination of these results show that the manufacturing capabilities of the companies in each of the four quadrants of the matrix are different. Whether this constitutes the implementation of different manufacturing strategies is dependent upon the validity of using stockturns and throughput efficiency as the identifiers of strategic groups.

Further data analysis was needed to determine the causes of the significant differences in manufacturing performance shown on Figure 4. One possible explanation, given the large number of products offered by these companies to their customers, could be their product supply policy, that is whether they make for stock or to order. The results of this analysis are shown on Table II.

Table II
An Analysis of the Manufacturing Policy Mix

	QUAD 1	QUAD 2	QUAD 3	QUAD 4
Percentage of companies making or assembling to order only (MTO/ATO)	23%	63%	26%	64%
Percentage of companies making for stock only (MFS)	2%	0%	0%	7%
Percentage of companies making both for stock and to order	75%	37%	74%	29%
Total Number of Companies	66	27	31	14

The most interesting finding of this analysis is how the majority of companies in quadrants 2 and 4 are implementing a different manufacturing policy to that adopted by firms in quadrants 1 and 3. It has been well understood for some time that the manufacturing management procedures required for a make for stock operation differ substantially from those needed to control making to order. The emphasis of making for stock rests upon planning activities and to make to order requires good manufacturing control procedures. To attempt to perform both activities, without a separation of these two disparate manufacturing operations, will prohibit the achievement of excellence in either activity.

Tables I and II provide an insight into the complexity of the manufacturing operations management task that is a consequence of the chosen product and manufacturing policies of the firms in each of the four quadrants of the manufacturing strategy and performance matrix. Their success at managing the complexity of their production activities can partially be evaluated by their reported delivery performances. These data are shown in Table III.

Table III - An Analysis of Delivery Performance

Quadrant	Mean Value	N	t-test Significance Results		
				p result	Significant
Q1	86.8%	45	Q1 and Q2	p = 0.553	No
Q2	83.9%	19	Q1 and Q3	p = 0.689	No
Q3	85.3%	28	Q1 and Q4	p = 0.0001	Yes
Q4	97.7%	9	Q2 and Q3	p = 0.807	No
			Q2 and Q4	p = 0.013	Yes
			Q3 and Q4	p = 0.0001	Yes

The only significant difference in delivery performance was achieved by the firms in quadrant 4. The reason for their excellent record for on time delivery is perhaps their focused product strategy, which was helped reduce the complexity of manufacturing planning and control. This strategy and the flexibility of their operations, which is exemplified by their higher throughput efficiency and stockturns, seem to be the enablers of good delivery performance.

The firms in quadrant 4 have been able to achieve a high throughput of product even though most of the firms make to order only. This better throughput management capability distinguishes them from those firms in quadrant 2. This must be the key to how they achieve a better delivery performance because in all other strategic management characteristics they appear to be similar.

A most disturbing finding is the very high proportion of engineering companies that only achieve a mean delivery performance of approximately eighty five percent. The causes of poor delivery performance have been well understood for some time and the findings of this study seem to show that more corrective action is required. It would seem that most companies in the engineering industry are still searching for an appropriate strategy to eradicate this damaging customer service failure.

Another unexpected finding is that the companies in quadrant 3 are as poor at delivery performance as those firms in quadrant 1 and 2. These firms report a higher throughput efficiency and so it would seem that it is how firms in quadrant 3 plan production, rather than their throughput control, that is the cause of their poor delivery performance. The analysis of the make for stock or to order policies used by the firms in this quadrant seems to support this conclusion. Many make for stock and to order and hold high levels of stock (see figure 4) in order to supply a wide range of products. It is perhaps their complex production scheduling and parts supply problems that make it difficult to achieve a high delivery performance record.

Their ability to deliver on time will be dependent upon the responsiveness of their supply chain, the accuracy of their forecasting of raw material and components needs and the decision rules that they use for the batch sizing of products that they make for stock.

Another manufacturing capability of interest to the researchers was manufacturing flexibility, a quintessential competence required by a company manufacturing a wide range of products. One measure of manufacturing flexibility is the speed of changeover from one product or component to another. For this reason an analysis of the changeover time required to switch manufacture from one product to another was made. The results of this analysis are detailed in Table IV.

Table IV An Analysis of Average Component Set-up Time

(In minutes)

Quadrant	Mean Value of Set-up Time	Size of Sample
Q1	77	63
Q2	44	25
Q3	58	30
Q4	91	13

The statistical analysis carried out on mean set-up times showed no statistical significance between the mean times for the firms that are in each quadrant of the manufacturing strategy and performance matrix (see figure 4). This was an unexpected finding.

A number of comments can be made. The mean values for changeover and set-up times for all four quadrants seem excessive. However, some companies manage to achieve a high throughput efficiency even though they report lengthy changeover and set-up times. The times reported are therefore unlikely to be for bottleneck activities or processes.

Another key performance indicator of manufacturing management is unit production cost. In the best factory questionnaire the respondents were requested to specify the level of cost reduction or increase achieved during the last two years.

An analysis of these cost management results showed that the management of factories in quadrants 2 and 4 were the more accomplished at this critical task. The analysis seems to confirm the axiom that increasing the complexity of manufacturing operations usually increases the unit cost of production. These results are shown in Table V.

<u>Table V An Analysis of Unit Cost Management</u>

Change in Unit Cost	QUAD 1	QUAD 2	QUAD 3	QUAD 4
Reduced Unit Costs	53%	59%	45%	62%
Costs remained the Same	8%	11%	10%	0%
Increased Unit Costs	39%	30%	45%	38%
	N=66	N=27	N=31	N =13

Overall, the results of the study of the cost management achievements show that a high proportion of companies are still suffering from increases to the unit cost of production when many others have achieved reduced costs. At a time of low inflation, the results seem to provide evidence that some companies have still to fully exploit cost reduction activities such as preferred supplier relationships and in-company productivity improvement.

A major contributor to an increase or a reduction to the unit cost of production is an improvement of yield or scrap rate. To assess the reliability of the manufacturing processes that enable production at least cost, an examination of scrap rates was made. The results of this analysis is shown in Table VI.

Table VI An Analysis of Scrap Rates

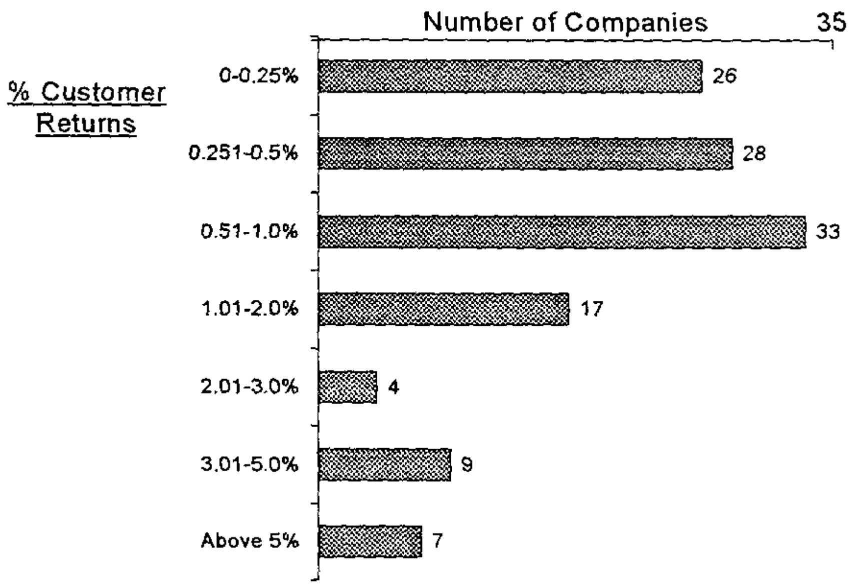
Quadrant	Mean Value	N	t-test Significance Results	p result	Significant
Q1	3.84	47	Q1 and Q2	p = 0.213	No
Q2	2.3	17	Q1 and Q3	p = 0.249	No
Q3	2.65	27	Q1 and Q4	p = 0.001	Yes
Q4	1.08	7	Q2 and Q3	p = 0.663	No
			Q2 and Q4	p = 0.043	Yes
			Q3 and Q4	p = 0.012	Yes

These results perhaps partially explain why a high percentage of companies in quadrant 4 achieve a reduction of the unit cost of production. They also demonstrate that the companies in quadrant 4 have the best control over their manufacturing operations because they achieve high stockturns, throughput efficiency and delivery performance and low scrap rates.

The most common high priority customer service objective is quality consistency. It could be deduced that this is expected by customers and thus it should not give a competitive advantage and should be considered as a hygiene factor of customer service. Figure 5 shows that although quality consistency may be expected, it is not delivered.

Figure 5

Customer Returns Analysis for the Engineering Industry



Because this study of the quality of delivered product found a marked variability of performance, an analysis of the quality consistency reported by the factories in each quadrant of the manufacturing strategy and performance matrix was carried out. Table VII shows the results.

Table VII An Analysis of Customer Returns

Quadrant	Mean Value of % Customer Returns	Size of Sample
Q1	1.40	49
Q2	1.58	22
Q3	3.95	26
Q4	1.77	10

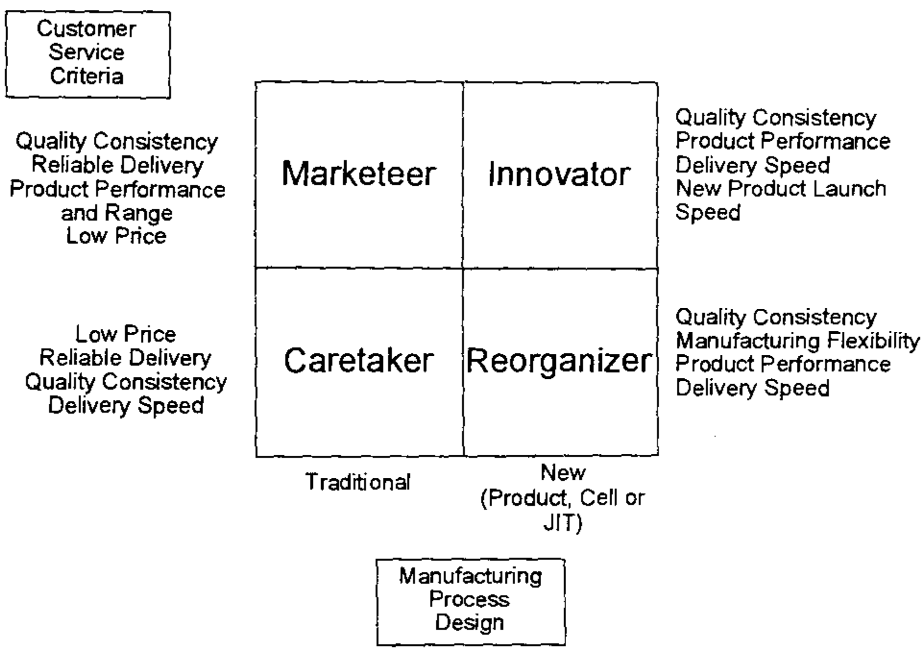
A statistical analysis of these results showed no significant differences between the mean values of customer returns for all four strategic groups. The reasons for better quality consistency are probably to be found in the design of work systems and the human resource management policies of factories. These are the production management activities that Krafcik and MacDuffie [15] have recommended should also be examined to explain manufacturing performance.

The results of this analysis show that the four strategic groups achieve very little differences in quality consistency performances and therefore, these are little differences between their design of work systems and their human resource management policies. If Krafcik and MacDuffie are correct, the reported poor standards of quality management demonstrate a need for improvements to how quality consistency is to be built in the manufacturing methods used. Changes to the design of work systems and human resource management policies are needed by all strategic groups.

The Study Findings and Contemporary Theory

For some considerable time researchers have striven to develop practical concepts and frameworks for the strategic management of manufacturing operations. From the previous research of Miller and Roth [16] and De. Meyer [17], Sweeney [18] has developed a framework that links competitive strategy with a taxonomy of complementary generic manufacturing strategies. The classifications for the types of generic manufacturing strategies observed by Sweeney were similar to those identified by research carried out by Bolwijn and Kumpe [19]. This model is shown in Figure 6.

Figure 6
A Conceptual Framework Linking Generic Competitive and Manufacturing Strategies



The objective of this study was to use manufacturing performance measures to create manufacturing strategy groups, to examine the manufacturing policies of the firms in these groups and to compare their standards of performance. How homogeneous these isolated strategic groups are with the generic manufacturing strategy groups discovered by previous research was a supplementary purpose of the study.

An analysis of the details of each firm in each of the strategic groups provided an insight into the similarities of both the manufacturing strategy/performance (figure 4) and the competitive/manufacturing strategy (figure 6) matrices. The companies grouped in quadrant 2 of the manufacturing strategy and performance matrix included a number of capital goods manufacturers, all designing to a customer specification and making to order. Each manufactured product required an innovation to a standardized product design.

As table II shows, the majority of the companies that comprise strategic group 4 also only make or assemble to order. It would seem that this manufacturing policy is common to both strategic groups 2 and 4. This finding and the nature of the manufacturing capabilities of these two groups, for example the manufacturing flexibility of strategic group 4, seems to suggest that the firms in group 2 are implementing the innovator manufacturing strategy and those in group 4 are deploying the reorganizer generic manufacturing strategy.

Strategic groups 1 and 3 also have a common characteristics. This is that a very high percentage of them make both for stock and to order. A more detailed breakdown of the split of these two activities shows that, on average, a greater percentage of product output is made for stock.

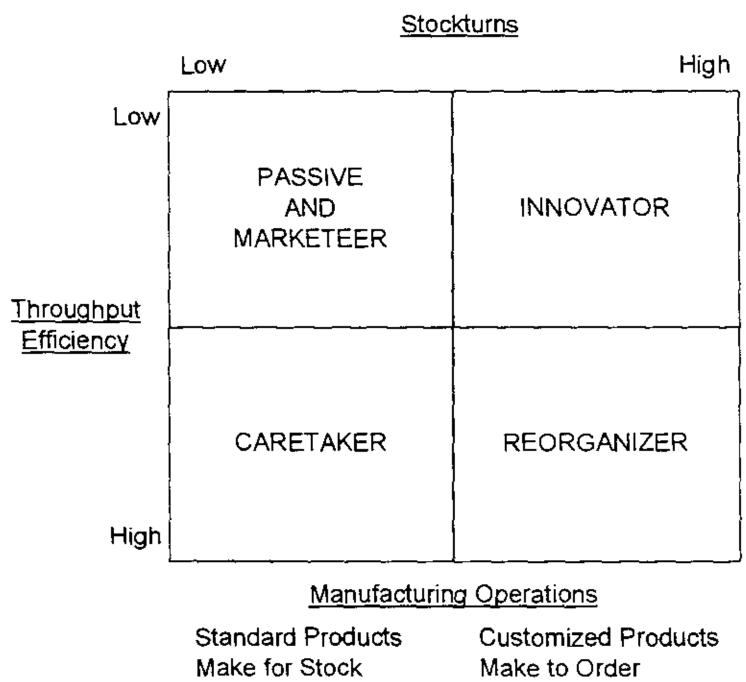
The high throughput efficiencies achieved by companies in strategic group 3 would suggest that a more continuous process design is used by firms in this strategic group for the throughput management of their products. These companies tend to display some of the capabilities of caretakers, in particular their propensity to invest in high levels of stock to enable off the shelf supply.

The largest strategic group is in quadrant 1 of the manufacturing strategy and performance matrix. Firms in this strategic group appear to be the least strategically managed of all. It would not be an overstatement to consider their strategic approach to manufacturing management as passive. It is quite possible that there are two types of strategic group that are indistinguishable in this single cluster of firms, that is those without strategic vision and marketeers that have a strategic vision to produce, by making for stock and to order, a very broad range of products.

The breadth of the product ranges for both strategic groups 1 and 3 suggests the presence of marketeers in both strategic groups with the majority as members of strategic group 1. Further analysis is required before this deduction can be confirmed or denied.

This search for strategic groups, the analyses of their composition and their operating performances leads to a conclusion that there is homogeneity between the manufacturing strategies detailed on the matrices that link manufacturing strategy with performance, (figure 4) and competitive strategy with generic manufacturing strategy (figure 6). The integration of these two matrices is shown in figure 7.

Figure 7
Generic Manufacturing Strategies and Performance
Manufacturing Operations



Further Research

The Best Factory Award questionnaire includes enquiries about the future customer service actions plans to be undertaken to obtain a competitive advantage and for product development. The next phase of this research is to use clustering techniques to search for the use of the generic manufacturing strategies, as detailed in Figure 6 and 7, by firms within the UK engineering industry.

Acknowledgement

The Authors would like to thank Professor Colin New for permission to use the UK Best Factory Award database. The Authors are however responsible for the analysis and interpretation of the data and for the conclusions drawn from its use.

REFERENCES

1. Minor III, E. D., Hensley, R. L. and Robley Wood Jr., D.,"A Review of Empirical Manufacturing Strategy Studies", *International Journal of Operations and Production Management*, Vol. 14, No. 1, 1994, pp.5-25.

2. Miller, J. G. and Roth, A., "A Taxonomy of Manufacturing Strategies", Boston University Manufacturing Roundtable Research Report, 1989 and recently published in *Management Science*, Vol. 40, No. 3, March 1994, pp. 285-304.

3. Minor III, E. D., Hensley, R. L. and Robley Wood Jr., D., 1994, op. cit.

4. Schendel, D. and Hatten, K., "Business Policy or Strategic Management: A Broader View of an Emerging Discipline", *Proceedings*, Academy of Management National Meeting, Minneapolis, MN, 1972.

5. Ackoff, R.L., *A Concept of Corporate Planning*, Wiley-Interscience, New York, 1970, pp.10.

6. Hunt, M., "*Competition in the Major Home Appliance Industry, 1960-70*", Ph.D. dissertation, Harvard University, 1972.

7. Cool, K. and Schendel, D., "Strategic Group Formation and Performance: the Case of the U.S. Pharmaceutical Industry, 1963-1982", *Management Science*, Vol. 33, No. 9, 1987, pp. 1102-1124.

8. Cool, K. and Schendel, D., 1987, op. cit.

9. Cool, K. and Schendel, D., 1987, op. cit.

10. Miller, J.G. and Roth, A., 1994, op. cit.

11. De Meyer, A., "An Empirical Investigation of Manufacturing Strategies in European Industry", *Manufacturing Strategy Process and Content*, Voss, C.A. (Ed.), Chapman and Hall, London, 1992,

12. Sweeney, M. T., "Strategic Manufacturing Management: Restructuring Wasteful Production to World Class", *Journal of General Management*, Vol. 18, No. 3, Spring 1993, pp. 57-76.

13. Cool, K. and Schendel, D., 1987, op.cit.

14. Sweeney, M.T., "Towards a Unified Theory of Strategic Manufacturing Management", *International Journal of Operations and Production Management*, Vol. 11, No. 8, 1991, pp. 6-22.

15. Krafcik, J. F. and MacDuffie, J. P., "*Explaining High Performance Manufacturing: the International Automotive Assembly Plant Study*", paper presented to the IMVP International Policy Forum, Pierre Marques, Acapulco, 7-10 May, 1989.

16. Miller, J.G. and Roth, A., 1994, op.cit.

17. De Meyer, A., 1992, op.cit.

18. Sweeney, M.T., 1993, op.cit.

19. Bolwijn, P.T. and Kumpe, T., "Manufacturing in the 1990s - Productivity, Flexibility and Innovativeness", *Long Range Planning*, Vol. 23, No. 4, August 1990, pp. 44-57.

Appendix A

The following questions were asked in the 1993 Best Factory Awards Audit questionnaire and are the source of the information used for the statistical analysis detailed in the article.

1. Number of Products

How many different item records or currently 'live' (in use) within the plant?

At product level (as sold to customers) ________________

2. Manufacturing Task Mix

What proportion of the plants' total output (at manufacturing cost) is supplied to customers:

Off the shelf (ex finished goods stock)	%
On a quoted lead time less than the actual manufacturing lead time	%
On a lead time equal to or greater than the actual manufacturing lead time (through backlog or engineering design work for example)	%
	100%

3. New Product Launch Time

How long does it typically take to bring a major product innovation to market (from start to detail design to market launch) __________ Months

4. Average Component Setup or Changeover times

How long does a typically average changeover between products or batches take:

In Component manufacture ______ Minutes

5. Unit Cost

How has the unit cost for the product which has the largest output (at manufacturing cost) changed over the last two years:

Unit Cost has (please tick one box only)

Decreased by	More than 20%	☐
	10-19%	☐
	5-9%	☐
	Less than 5%	☐
Remained the Same		☐
Increased by	Less than 5%	☐
	5-9%	☐
	10-19%	☐
	More than 20%	☐

6. Customer Returns

Please give the current level of customer returns for quality reasons ______ %

7. Scrap

Please give the current level of % scrap or % below ideal yield rate ____________ %

8. Delivery Performance

For items supplied on quoted lead times.

Please give the current level of % Delivery 'on time' ____________ %

Source: Best Factory Awards Audit Questionnaire