A Longitudinal Study of Strategic Choice, Multiple Advantage, Cumulative Model, and Order Winner/Minimum Qualifier Views of Manufacturing Strategy

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Manufacturing strategy is a concept that has developed some complexity over the last decade. To increase understanding of the concept, a longitudinal study of 41 firms in the electronics, aerospace, lumber products, and recreational equipment industries was conducted using data from 1989 and 1999. The data most strongly supported Terry Hill's (1989) order winner/minimum qualifier view of manufacturing strategy. The findings are important because each view of manufacturing strategy suggests a different approach to pursuing strategic objectives. Strategic choice suggests pursuing a single strategic objective. Multiple advantage theory suggests that multiple objectives can be pursued, but the cumulative model and minimum qualifier views offer different approaches for achieving multiple advantages. The cumulative model suggests a prescribed order of priorities with quality first, followed by delivery, then flexibility, then cost. The minimum qualifier view suggests firms must scan the environment for the order of priorities. The results of this research support the more externally focused approach of the minimum qualifier view.

Growing awareness of the concept of manufacturing strategy has led to a richer and more complex development of its meaning over time. It is the purpose of this research to provide comparative empirical evidence of the need for recognizing the multiple views and dynamic nature of manufacturing strategy. With recognition of its complexity and its contribution to a knowledge base of alternative management practices, we can then put forth its implication for practice. First, a review of the manufacturing strategy literature will be undertaken to show how it has changed in recent years. This review will give us four views of manufacturing strategy—namely the "strategic choice" view, the "simultaneous multiple advantage" theory, the cumulative model, and the "order winner/minimum qualifier" view. Past studies will be reviewed for empirical evidence that supports each theory, and then the empirical evidence for this study will be presented. The arguments for differentiating among each of these views of manufacturing strategy will be put forth in the form of implications for management practice.

LITERATURE REVIEW

A substantial amount of literature has been written about manufacturing strategy, and a number of empirical studies have been completed over the last decade to confirm recent theories of manufacturing strategy. Beginning with strategic choice theory, which was developed by Skinner (1969), manufacturing strategy theories developed more

complexity over time as manufacturing techniques and technologies created the opportunity for greater competitiveness. By the 1980s, many technological developments led theorists and practitioners to see the importance of developing competitiveness by avoiding choice and attempting to achieve multiple manufacturing objectives. The major views associated with such an approach are labeled as simultaneous multiple advantage theory, the cumulative model, and order winner/minimum qualifier view. Each of the later theories is a nuanced version of the view which recognizes the importance of achieving multiple strategic advantages.

Strategic Choice Theory

Wickham Skinner first coined the term "operations strategy" in 1969 after reviewing the results of several case studies of manufacturing firms (Skinner, 1969). From the case studies he concluded that the linkage between manufacturing and business strategy was very weak due to a lack of concern about manufacturing on the part of top management. Because of top management's lack of interest, he believed that manufacturing managers were often left with the task of directing their organizations with no overall guiding purpose, other than the management principles in which they had been schooled. That schooling was believed to be distinctly "Tayloristic" in orientation, with an emphasis on efficiency, strict division of labor, and optimization of individual tasks. According to Skinner, manufacturing managers tended to emphasize low cost and efficiency in all competitive situations, to the detriment of overall company performance. To overcome this problem, he recommended that manufacturers make choices about manufacturing strategy that would fulfill the needs of an overall business strategy. This idea was most relevant to the concept of generic business strategies developed by Porter (1980) -- low cost, product differentiation, or focus. With a low cost business strategy, an appropriate manufacturing "strategic choice" would be a mass production facility with standardized products and little radical product development. Conversely, a product differentiation business strategy would emphasize more flexible manufacturing, possibly a job shop with a highly skilled workforce.

With further development of the manufacturing strategy concept, Skinner (1974), emphasized the importance of trade-offs among the strategic objectives of low cost, quality, flexibility, and dependability (sometimes synonymous with delivery). He advised manufacturers to make use of focused factories (Skinner, 1974) which could be devoted to performing a consistent set of tasks. Other theorists reinforced this idea. Abernathy and Wayne (1974) defined "strategic choice" as "balancing the hoped-for advantages from varying degrees of cost reduction against a consequent loss in flexibility and ability to innovate." Much of the manufacturing strategy field extended the idea of trade-offs by defining product vs. process focus (Hayes and Schmenner, 1978) and process life cycle theory (Hayes and Wheelwright, 1979a, 1979b).

The first empirical studies of manufacturing strategy were conducted to define content and to test theories about the link between manufacturing and corporate or business strategy. Swamidass (1986) confirmed Skinner's theory that manufacturing strategy is often nonexistent or misunderstood, that business and manufacturing strategies are often

misaligned, and that manufacturing managers emphasize cost and delivery criteria as most important, while CEOs emphasize quality. Schroeder, Anderson, and Cleveland (1986), on the other hand, found some relationship between business and manufacturing strategy, although confusion also existed about the meaning of manufacturing strategy. The four most commonly mentioned objectives of manufacturing strategy corresponded to the manufacturing strategy content defined theoretically in the field. Both studies were a first step in verifying descriptive elements of manufacturing strategy, but each had some methodological problems and called for standardized measures of manufacturing strategy.

A recent empirical study confirmed some of the concepts developed under strategic choice theory. Safizadeh, Ritzman, Sharma, and Wood (1996) confirmed that process choice is an important decision that links operations to business strategy. They found strong support for the process life cycle model developed by Hayes and Wheelwright (1979a, 1979b). Their study showed a strong correlation between process choice, product customization, and competitive priorities. The central feature of strategic choice theory is that trade-offs have to be made among the manufacturing objectives of low cost, flexibility, quality, and dependability. Trying to accomplish all of them leads to inconsistencies and reduced performance. For example, Safizadeh, et al. (1996) found that without part commonality and flexible automation, continuous flow shops that attempt high degrees of customization show poor performance.

Simultaneous Multiple Advantage Theory

By 1981, the impact of "Japanese" manufacturing techniques and flexible manufacturing technology were bringing the notion of trade-offs into question. Wheelwright (1981) illustrated the fundamental difference in how the Japanese viewed the competitive factors of manufacturing strategy and how U. S. theorists viewed them (see Figure 1). The Japanese discarded the notion of trade-offs and used techniques that enabled multiple manufacturing objectives to be achieved simultaneously (Schlie and Goldhar, 1989). This change in thinking about manufacturing strategy came about as a result of manufacturing and technology improvements, particularly through the reduction of work-in-process inventory, set-up times, and parts queues. For example, JIT production, group technology and cellular layouts, design-for-manufacturability, and flexible human resource practices were allowing the Japanese to introduce "mixed model" production into a low-cost continuous flow manufacturing process, thus improving cost, flexibility, and delivery simultaneously (Schonberger, 1982). Furthermore, the use of statistical process control and total quality management principles allowed quality to be improved at a low cost (Garvin, 1983).

The engineering literature in the U. S. was equally optimistic. Achieving multiple manufacturing objectives was possible with the development of computer technology and the introduction of the first commercially viable flexible manufacturing systems. Once again, these systems acquired their benefits through the reduction of WIP inventory, set-up times, and parts queues. The systems accomplished their objectives with the aid of computers. According to Ayres and Miller (1985), the major benefit of flexible

automation is that "the average unit cost of producing a thousand different products could well approach the cost of producing a thousand copies of a single product." They also offer the potential for improved quality through the reduction of human error and the use of automated vision systems and measurement feedback.

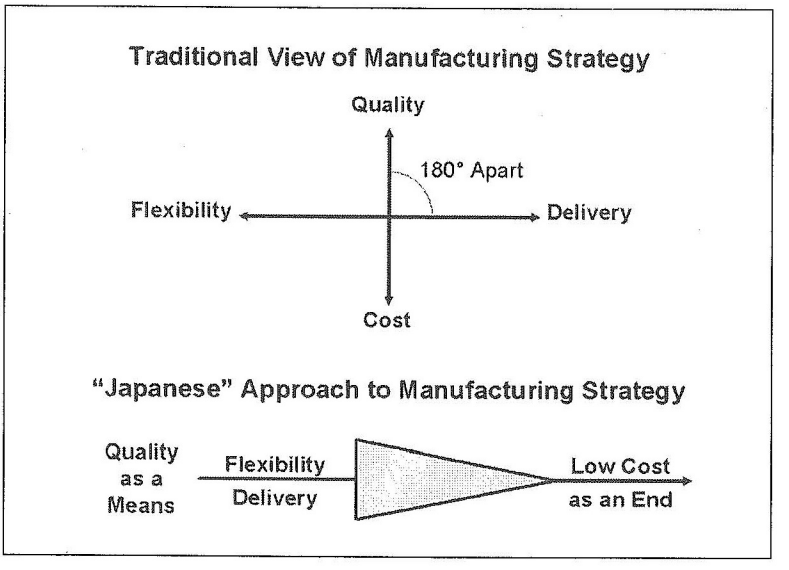

Figure 1. Traditional View of Manufacturing Strategy versus "Japanese" Approach to manufacturing strategy (Wheelwright, 1981).

The multiple advantage theory does not negate strategic choice theory, rather it updates it. It acknowledges new capabilities associated with methods and technology that were not invented or well-known in the 1960s. Strategic choice may indeed have been the best practice when job shops, batch production facilities, and mass production assembly lines represented the breadth of manufacturing methods for discrete items. By the end of the 1980s, manufacturing possibilities expanded with the development of new technologies and methods. Mass customization (Lau, 1995), economies of scope (Lei, Hitt, and Goldhar, 1996), and mass personalization (Roth, 1996) are some of the terms used to describe the methods by which multiple objectives are achieved. Several studies verified that firms in the 1990s rated more than a single manufacturing objective as important or performed well on more than a single manufacturing objective. Roth and Miller's (1990) Manufacturing Futures Study showed a pattern where quality, delivery, flexibility, and price were all rated above average in importance by respondents. Work on the Manufacturing Futures Study continued into the latter part of the decade and showed above average importance on multiple manufacturing objectives, although the relative importance of each shifted over time (Kim, 1996). Nemetz's (1990) study of manufacturing measures showed above average performance on multiple manufacturing objectives.

Cumulative Model

According to the cumulative model, strategic capabilities are developed sequentially and are interdependent over time, regardless of intended priorities. Roth indicates that (1996) capabilities accumulate in a progression from quality to delivery to flexibility and then to price leadership during an innovation cycle. Roth (1996) explains this cumulative model by theorizing that each objective lays the foundation for predictability that leads to each succeeding objective. Other theorists agree that manufacturers should pursue a cumulative, pre-specified order for building manufacturing capabilities, but they differ on the order. The order -- quality, dependability, cost efficiency, then flexibility -- is suggested by Nakane (1986), Ferdows, Miller, Nakane, and Vollman (1986), DeMeyer, Nakane, Miller, and Ferdows (1989), and Ferdows and De Meyer (1990). DeMeyer, et al. (1989) found some empirical evidence to suggest various manufacturing strategies are emphasized in different continental regions based on their differing levels of competitiveness. Noble (1995) found support for the cumulative model among data collected in Korea, with varying degrees of support among North American and European manufacturers. Quality was found to be strongly important at the base of the model, and better performing firms showed the ability to compete on multiple capabilities. Anecdotal evidence from Singapore (Hum, 1995) suggests a cumulative order with low cost at the base, followed by quality, then flexibility, then dependability. Wacker (1995), on the other hand, finds empirical support for a model with quality at the base, followed by dependability (delivery reliability first, then short delivery lead time), then flexibility (current product flexibility first, then new product flexibility).

Order Winner/Minimum Qualifier Theory

Terry Hill's (1989, 1994) work on manufacturing strategy offers a dynamic theory in which the relative importance of each manufacturing objective changes in response to changes in the business environment. It establishes the difference between manufacturers "minimally qualified" to be in the marketplace, and those winning orders through superior performance on one of the four manufacturing objectives. According to this theory, products must meet certain minimum qualifications to survive in the marketplace. Even if manufacturers make strategic choices, the performance on any of the four objectives cannot be so substandard that it is well out of the range of competitiveness. For example, an organization choosing to compete on cost may not survive in the marketplace if its quality is so poor that it is not satisfactory to customers.

Simply meeting minimum qualifying criteria at one point in time may not guarantee long-term survival either. For long-term survival, manufacturers must scan the marketplace to determine which criteria are "order winners." Failing to perform well on an order-winning criterion may lead to failure in the long term. Order-winning criteria change over time, and organizations that fail to recognize a change put their performance at risk. To illustrate, Hill gives the following example:

> [W]hen Japanese companies entered the U. K. color television market in the 1970s, they changed the way in which products won orders from predominantly

> price to product quality and reliability. The relatively low product quality and reliability of existing television sets meant that in the changed competitive forces of this market, existing producers were losing orders through quality to the Japanese companies, i.e., existing manufacturers were not providing the criteria which qualified them to be in the market place. By the early 1980's, product quality was raised by those concerned so that they are now qualified to be in the market. As a result, the most important order-winning criterion in this market has reverted back to price (Hill, 1989, p. 44).

This view of manufacturing strategy is important because it recognizes the changing competitive forces that encourage product improvements and innovations over time. Also, it establishes the need to simultaneously achieve a satisfactory level of performance on all four criteria, even if a strategic choice must be made to excel on a single objective. Little empirical work has been conducted to verify this theory, but anecdotal evidence (Hill, 1989; Flynn, Schroeder, and Aakakibara, 1995) provides some basis for explaining dramatic strategic shifts within specific industries.

CRITIQUE OF RESEARCH LITERATURE AND RESULTING RESEARCH OBJECTIVES

Substantial progress has been made in the last two decades in defining strategic objectives for manufacturing and providing evidence for various theoretical views. It seems clear that manufacturing strategy has received attention among theorists and empiricists alike. The evidence is fairly strong that strategic choice theory has given way to the notion that firms must compete on a variety of strategic manufacturing objectives. Unfortunately, the evidence remains inconsistent and ambiguous with respect to how each objective should be pursued and weighted for importance, with the cumulative model suggesting a single, pre-specified order of progression and the order-winner/minimum qualifier model suggesting a prioritization based on demands from the business environment. The cumulative model suffers additional ambiguity because there are multiple views of the specific order in which objectives should be pursued. Understanding the differences between the cumulative view and the order-winner/minimum qualifier view is actually very important because of the implications for practice suggested by each. The cumulative view is rather internally-focused, with the suggestion that there is "one best way" to pursue multiple strategic objectives. By following the prescribed order of strategic objectives, the theory proposes that a firm will ultimately reach the apex of high performance as it implements the proper program of improvement at each stage. The order-winner/minimum qualifier theory, by way of contrast, is more externally-focused, with the suggestion that a firm must scan the business environment to determine which strategic objective has emerged as the order winner. It takes the position that firms compete fiercely to achieve satisfactory levels on the order-winning criterion, only to have that criterion change to a minimum qualifier as each competitive firm eventually reaches a satisfactory level. The order winner then changes to a new strategic objective based on the pro-active behavior of a more competitive firm. If, in fact, the order-winner/minimum qualifier model is a more accurate representation of manufacturing strategy than the cumulative model, a firm

could pursue the wrong actions by following the prescribed actions of the cumulative model. For example, a firm stuck at the dependability level of the cumulative model may respond incorrectly if the business environment demands lower cost.

The purpose of this research is to examine if one theoretical view takes precedence over another based on longitudinal empirical evidence. No specific research hypotheses have been developed because it is expected that any or all four views may have relevance in some form. In essence, the research project asks the following questions:

1. Do manufacturing performance results and emphases show that organizations make strategic choices to compete on only one or two of the manufacturing objectives of low cost, quality, flexibility, and delivery?
2. Do manufacturing performance results and emphases show that organizations are capable of simultaneously achieving multiple strategic objectives?
3. Do manufacturing performance results and emphases show that organizations must pursue strategic objectives in a prescribed order to achieve multiple strategic objectives?
4. Do manufacturing performance results and emphases show that organizations must be minimally qualified to compete in the marketplace while excelling on a single strategic objective?

To answer these questions, a longitudinal study was undertaken using data from 1989 and 1999. A wide variation in the presence of advanced technology was present in the sample (some used traditional methods; others used advanced flexible methods). As such, conditions were present for each of the theoretical views to have relevance. In addition to the quantitative measures, lengthy interviews were conducted to gather qualitative information on manufacturing strategy.

METHODS

Sample

Two separate samples were used in this study. The first sample was derived to develop measures for use in a larger research project, including the strategic performance measure used in this study. The sample consisted of 38 firms chosen from a variety of discrete-item manufacturers with more than 100 employees. Fifty-five firms were contacted, and 38 agreed to participate, for a response rate of 69 percent. A pilot study was executed in 1988 by conducting in-depth interviews with two manufacturing managers. The interviews were several hours long and included a review of the initial strategic performance measure developed for the research. As a result of the pilot study, the measure was expanded to include items of relevance suggested by the practitioners. Data for the remainder of the project was collected between 1988 and 1989 using structured questionnaires, open-ended interviews, plant tours, and retrospective questioning based on information in company and local publication (annual reports, employee newsletters, newspapers, etc.). Respondents were middle managers or vice presidents in charge of manufacturing, plant operations, CIM, or computer operations. A first phase of questionnaire administration included 30 firms; 8 firms were added later to correct for a

restriction of range problem on one of the item sets. In thirty-four organizations, two respondents agreed to participate, so a subsample of data was available to test interrater agreement. In addition to these respondents, external respondents provided data for validation of the strategic performance measure.

To test the questions of interest for this research project, a second sample of firms was drawn from the electronics, aerospace, lumber, and recreational equipment industries. The survey was administered longitudinally at two different time periods. The first phase of the survey was administered to 47 firms in 1989 to 1990. The second phase of the survey was administered in 1998 to 1999. Of the 47 original firms, 41 remained as part of the longitudinal study. Six of the original firms went out of business, changed to an extent that they could no longer be used in the study, or chose not to participate in the second phase. For both phases, two raters were available in 40 of the firms, so interrater reliability could be calculated. Raters were operations managers, plant managers, inventory managers, or IS managers in their respective firms.

Measures

Two measures were used in the study. The first measure determined how each rater judged actual *performance* on a variety of strategic performance indicators in the manufacturing function. The second measure determined how each rater judged the *importance* of each strategic performance indicator to the firm. The instrument was originally built on the work of Swamidass and Newell's (1987) flexibility measure, then modified based on information from the pilot study and other interviews. Multiple items were developed to represent measures of cost, quality, flexibility, and delivery. Ratings were based on a 10-point Likert scale anchored by appropriate indicators; some items were reverse-scored. Respondents were asked to base their ratings on their firm's performance relative to other companies in the industry.

Respondents were asked for objective evidence as a check on their responses. About 75% of the respondents could provide some objective evidence in the form of trade journal comparisons, company product-line brochures, and annual reports to verify some of their responses. In addition, local publications reporting on company performance and/or problems were used to verify responses and elicit elaboration when inconsistencies existed. Most such inconsistencies were resolved during the course of the interviews.

An abbreviated performance instrument was also administered to a subsample of external experts familiar with a firm's products. Items on the abbreviated instrument were omnibus measures of perceived quality, cost, delivery, and product variety. The experts were usually industrial purchasing agents, equipment specification engineers, or commercial users of the products. They were screened for their expertise by a series of questions about their experience, familiarity with other brands, and technical knowledge. The questionnaire was administered to the external experts approximately six months to a year after the internal data collection in order to allow for organizational lag — that is, to allow time for the effects of internal decisions to reach the external environment.

Analysis

Analysis for validation of the measure included principal components analysis with varimax rotation, checks for interrater agreement, and calculations for interrater agreement (Cronbach's coefficient alpha) (Allen and Yen, 1979). Content validity was based on definitions provided in earlier empirical studies (Swamidass and Newell, 1987; Schroeder, et al., 1986) and on information provided by manufacturing managers that participated in the pilot study. In addition, the use of multiple raters, both internal and external, was undertaken to assess the veracity of individual evaluations. These techniques are believed to be appropriate checks on validity as recommended by Venkatraman and Grant (1986).

Analysis used for the longitudinal research purposes included validation based on interrater agreement, one-way analysis of variance to test for industry effect, two-sample t-tests to measure rating differences on the importance and performance of each strategic objective from the first time period to the second time period, and frequency counts to test various questions about the different theoretical views (Allen and Yen, 1979; Kerlinger, 1986). To test for evidence in support of the simultaneous multiple advantage theory, firms were categorized as performing above average on one, two, three, or all four strategic objectives and frequency counts were made of each category. To test for evidence in support of the cumulative model, firms that scored above average on four strategic objectives in time period 2 were examined for their performance in time period 1. Such firms were then categorized on the basis of which objectives were above average in time period 1, and frequency counts were made. To test for evidence in support of the order winner/minimum qualifier theory, the relative rank of each strategic objective was compared from time period 1 to time period 2, and firms scoring above average on all four strategic objectives were categorized to determine how many scored close to average on three of them while scoring much higher on one of them. In addition, means and standard deviations were observed in each time period to uncover patterns in support of each theory.

RESULTS

Measure Validation

Results of the principal components analysis are shown in Table 1. A factor loading of at least 0.50 was the criteria set for including an item in a factor. In general, all but two items loaded as expected. The item "speed in changing production volumes," which might have been a volume flexibility indicator, loaded with two other items to form a delivery factor. No separate volume flexibility factor emerged. One item taken from Swamidass and Newell's (1987) manufacturing flexibility measure failed to load on the flexibility factor for this instrument. The item is "introducing new production processes." There is no reason to expect it to load on what is essentially a product flexibility factor. The item was excluded from further analysis, and each strategic objective measure—flexibility, quality, delivery, and cost—was calculated by averaging the items that loaded on each corresponding factor.

Table 1
Varimax Rotated Factor Loadings of Strategic Objective Performance Variables

	Factors			
	1 Flexibility	2 Quality	3 Delivery	4 Cost
New Product Intro	0.8623	-0.1471	-0.1221	0.0078
New Process Intro	0.0650	-0.0776	-0.0032	0.3598
Product Variety	0.7436	0.0180	-0.0888	-0.3769
Product Features	0.7976	0.1404	-0.0678	-0.3820
Product R & D	0.6114	0.0684	-0.0247	-0.3101
Production Cost	-0.1881	-0.2274	0.1953	0.8692
Efficiency	-0.0029	0.0467	0.3146	0.8654
Product Quality	0.0680	0.9250	0.1761	-0.1363
Delivery Dates	-0.1930	0.1185	0.9287	0.1190
Product Changeover Speed	0.8378	0.1372	-0.1094	0.2201
Product Reliability	0.0820	0.9185	0.1383	0.0285
Lead Time of Orders	-0.1851	0.1324	0.7257	0.1859
Volume Changeover Speed	-0.0664	0.2009	0.8838	0.2569
New Product Develop. Speed	0.8722	0.1116	-0.2036	-0.2447
Workmanship	0.0775	0.9306	0.0932	0.1276
Material Quality	-0.0044	0.9101	0.0364	-0.0742

Evaluation of internal consistency and agreement among raters shows moderate to high statistical validity. Table 2a shows that coefficient alpha and internal interrater agreement all have strong consistency with values between 0.72 and 0.88. Agreement between internal and external raters is lower, but statistically significant ($p < .001$) at values ranging from 0.60 to 0.72. Considering the large number of intervening variables that could influence agreement between internal and external evaluators (persuasive salesman, effect of external distribution systems, etc.) and the differences in the questionnaires administered to the two groups, statistically significant coefficients are important indicators of consistent performance evaluations. To determine if internal evaluations are biased toward more favorable ratings, it is necessary to compare means of the internal and external ratings. The means in Table 2b indicate that external evaluators were consistently more favorable in their evaluations than internal evaluators. This provides evidence that internal evaluators were not biased toward excess favorability in their ratings. Furthermore, the pattern of values is consistent between internal and external evaluators, with cost performance receiving the lowest average rating and quality the highest average rating.

In summary, the measure used for this study appears to be a valid indicator of performance on the strategic objectives of flexibility, quality, delivery, and cost. Validation data was based on assessment of performance, not on assessment of the importance of each item to the firm. For the survey purposes of this research project, each item was used in a second set of survey questions to assess importance by using similar wording for each item and anchoring the scale with appropriate indicators.

Table 2A
Validity and Reliability Coefficients of Measure

Variable	Coefficient Alpha	Internal Interrater Agreement	Internal/External Agreement	
Quality	0.83	0.72	0.60	(p<0.001)
Flexibility	0.81	0.88	0.67	(p<0.001)
Delivery	0.79	0.76	0.69	(p<0.001)
Cost	0.72	0.75	0.72	(p<0.001)

Table 2B
Summary Statistics for Performance Ratings on Measure

		Internal Evaluations		External Evaluations	
	N	Mean	St. Dev.	Mean	St. Dev
Quality	34	8.46	1.39	8.99	1.42
Flexibility	34	6.72	1.49	7.83	2.96
Delivery	34	5.85	2.27	7.45	2.50
Cost	38	4.97	2.17	5.73	3.00

Survey Results

Table 3 lists the interrater agreement for importance and performance ratings indicated at each phase of the study. Agreement on the importance of each item to the firm is very high, and agreement on performance is high as well. The lowest agreement was 0.65 on cost performance in 1989, still a reasonably high number.

Table 3
Inter-rater Agreement for Survey

	1989		1998	
Variable	Importance	Performance	Importance	Performance
Quality	.90	.75	.89	.75
Flexibility	.83	.78	.75	.72
Delivery	.79	.72	.80	.87
Cost	.83	.65	.90	.82

One concern about aggregating the data was that the specific industry might have an effect that dilutes the actual outcome data. Hill (1989) indicates that industries may move in a particular direction as top competitors break out of the minimum-qualifier mold to establish a new order winner. A problem could occur if, for example, one industry shows the new order winner to be low cost while another industry shows quality to be the new order winner. When the data from the two industries is aggregated, the strength of the industry-specific responses may be lost through averaging. Because of this problem, a one-way analysis of variance was undertaken to determine if the effect of industry categorization was statistically significant. Firms were grouped by membership in the electronics, aerospace, lumber, and recreational equipment industries and tested for

differences on each of the four manufacturing objectives. No significant differences were found. Interview data, in fact, shows that performance priorities were more driven by general conditions experienced across industries than by industry-specific actions associated with competitors.

Tables 4 and 5 show the results of t-tests performed from time period 1 to time period 2. Table 4, which shows means and standard deviation for the importance of each strategic objective in each time period, indicates a statistically significant difference for delivery ($t = 7.38$, $p < .01$) and cost ($t = 4.27$, $p < .01$) from time period 1 to time period 2. Both delivery and cost were rated as significantly more important in 1999 than in 1989. Table 5 shows statistically significant differences on quality performance ($t = -3.33$, $p < 0.05$) and delivery performance ($t = 2.39$, $p < 0.05$) from 1989 to 1999, with quality performance moving closer to industry average and delivery performance emerging as above average. Averages are close to or above industry average for all firms reporting on the importance of and performance on each strategic objective. Such ratings are consistent with Hill's (1989) order-winner/minimum qualifier theory, in which firms must perform at a reasonably high threshold minimum just to survive. It should also be noted that each strategic objective was generally rated as higher in importance than actual performance. Such a difference is an indicator of the performance gap experienced by each firm as they sought improvements in highly competitive environments.

Table 4
Summary Statistics and T-tests for Importance Ratings of Strategic Objectives

	1989			1998		
	N	Mean	Std. Dev.	Mean	Std. Dev.	t
Quality	41	8.74	0.90	8.89	0.754	0.797
Flexibility	41	7.27	1.60	6.84	1.34	-1.29
Delivery	41	7.24	1.41	9.13	0.84	7.38**
Cost	41	6.96	1.83	8.48	1.33	4.27**

** $p < 0.01$

Table 5
Summary Statistics and T-tests for Performance Ratings on Strategic Objectives

	1989			1999		
	N	Mean	Std. Dev.	Mean	Std. Dev.	t
Quality	41	7.91	1.434	6.97	1.172	-3.22*
Flexibility	41	6.42	1.840	6.27	1.64	-0.38
Delivery	41	5.91	2.380	7.06	1.96	2.39*
Cost	41	5.04	2.237	5.20	1.967	0.33

* $p < 0.05$

Table 6 shows the shift in strategic objective priorities from 1989 to 1999. In 1989, the priorities ranked from quality, to flexibility, to delivery, then to cost. By 1999, the priorities had shifted, with delivery as most important, followed by quality, cost, and then flexibility. Such a shift in priorities is once again consistent with Hill's (1989) order-winner/minimum qualifier theory, and tends to refute the cumulative theory model. On this particular point, qualitative data from interviews might help to focus the reasons for the change in priorities. Many firms in 1989 indicated that the major factor driving their strategic priorities was competition from Japanese firms, which had a clear quality advantage in their minds. By 1999, many firms indicated that the major factor driving their strategic priorities was the overheated economy, in which keeping up with orders became a major difficulty.

Table 6
Strategic Objective Importance Rankings from Highest to Lowest

1989	1999
Quality	Delivery
Flexibility	Quality
Delivery	Cost
Cost	Flexibility

Table 7 lends some credibility to the simultaneous multiple advantage theory, in that it shows a large number of firms (30) rated their performance as above average on 3 or 4 strategic objectives. The number of such firms increased by 9 from 1989 to 1999, thus showing dramatic improvement in the use of those technologies and techniques that allow multiple advantages to be achieved. By 1999, no firms were competing on just a single objective, indicating that strategic choice is increasingly outdated.

A last test was performed to examine if firms achieving high performance ratings on three or four strategic objectives in 1999 showed a particular pattern of change from 1989 to 1999. Each such firm was examined for the performance ratings in 1989 to see if a particular order of performance ranking was consistently found among the firms. Twenty-eight of the thirty firms that reached above average performance on three or four strategic objectives in 1999 showed very high above average quality performance in 1989. However, the second-ranked objective for each such firm in 1989 did not show consistency. Fourteen firms rated flexibility as the second highest performance rank, while twelve firms rated delivery as the second highest, and two rated low cost as the second highest. Furthermore, there was no consistent pattern in the rankings of each strategic objective in the 1999 data. If the cumulative model had been supported, it would have been expected that a majority of firms followed the same pattern of performance prioritization. Instead, it appears that performance was more often driven by general economic conditions that created strategic priorities.

Table 7
Number of Firms that Performed Above Industry Average on One and More than One Strategic Objectives

No. of Strategic Objectives Scored Above Average by Raters	1989 No. of Firms	1999 No. of Firms
1	4	0
2	16	11
3	18	17
4	3	13

In summary, this longitudinal research project most strongly supported the order-winner/minimum qualifier view of manufacturing strategy. The quantitative data, along with qualitative data from interviews, suggest that firms compete on a variety of strategic objectives, with a changing order winner emerging as economic and competitive conditions evolve. Above-average ratings on more than one strategic objective show that multiple advantages can be simultaneously achieved and that strategic choice is less relevant than in the past. The quantitative data did not support the cumulative model, nor did the interview data. Some firms reported that they took a step-by-step approach to performance improvement, but others reported a one-time dramatic overhaul of their technology to attain improvement in all strategic objectives simultaneously. No firm indicated that the change occurred quickly, but some indicated that a very long term plan, when finally put into place after many preparations, resulted in fairly quick performance improvements.

DISCUSSION

The results of this research show that simultaneously pursuing multiple advantages is possible, and the best method for accomplishing the task is not limited to a single approach. The research supports Terry Hill's (1989) order winner/minimum qualifier prescription of scanning the environment for competitive priorities. The cumulative model, in which a prescribed order of pursuing multiple strategic objectives is recommended, was not supported by the data. Also, pursuing a single strategic choice was not shown to be a prevalent method of competing. The results are not only important for substantiating appropriate theoretical development, but also because the practical prescriptions associated with each theoretical view are different and must be tested for usefulness.

One consequence of presenting the cumulative model as the appropriate one to be followed in practice is that it suggests a "one best way" approach to achieving multiple advantages. Pursuing the "one best way" prescribed by Frederick Taylor (1911) in the 1920s was believed to be a mistake by the 1970s; the same mistake should not be made by prescribing the cumulative model if it is not an accurate representation of strategic behavior in the marketplace. While interview data suggests that a few firms pursue multiple advantages by beginning with a program of quality improvement and moving to programs that improve delivery next, most did not indicate they made changes to achieve

manufacturing objectives in a specific order. In fact, some firms began programs of improvement by using group technology to change layouts, reduce work-in-process inventory, and improve throughput. Such programs were believed to show simultaneous improvements in delivery, cost, and flexibility. Other firms began programs of improvement by completing the foundation work for adding new technology like flexible manufacturing systems and integrated material control systems. Such programs were also thought to result in multiple improvements simultaneously. However, in a few cases, a dramatic change in the business environment caused a firm to respond by prioritizing new strategic objectives. For example, as the U. S. economy grew rapidly in the 1990s, some firms found a need to dramatically increase delivery performance while keeping up with a high volume of orders. Such an approach is the result of shifting from an emphasis on internal improvements to an emphasis on external priorities. One particular firm was especially emphatic about stating that priorities had changed in the middle of its improvement program, and it had to improve deliveries in order to maintain market share in the face of extreme competitive pressure from other firms with quick delivery.

The cumulative model may have more relevance at a macro level; that is, it may be indicative of regional economic development in which regional manufacturing firms learn to compete in a systematic order of priorities. Most studies on the cumulative model, in fact were tested in various regions, with Asia showing the most comprehensive development as described by the cumulative model (Nobel, 1996). Recent underperformance of the Asian economies, however, brings into question the success of following such a model. Perhaps becoming too internally focused, even for purposes of improvement, does not create the conditions for long term success in highly competitive environments of rapid change.

Another interesting finding from interview data is that all firms indicated they had made dramatic manufacturing improvements in the past 10 years. Yet many rated their performance close to or slightly above others in the industry on a number of strategic objectives. The industry average corresponds to a rating of 5.5 on the questionnaire. The highest mean for performance in comparison to others in the industry was 7.06 for delivery performance, while cost had a mean rating of 5.20, which is below industry average. Such results are indicative of the extraordinary level of competition in the economy. The results strongly indicate that firms achieved performance levels equivalent to minimum qualifying standards for some strategic objectives. In the face of dramatic internal improvements over the last decade, many firms were simply keeping up with the competition.

In conclusion, it seems wise to avoid prescribing a single approach for improving performance on multiple strategic objectives. Rather, firms must remain externally-focused and highly responsive to changing needs. Future research work should focus on strategic scanning and making improvement choices associated with specific performance gaps, as suggested by Upton (1996). It seems clear that firms must perform well on many strategic objectives, but it is not always clear what choices are available for improving to the degree necessary to close the performance gap. Now that a substantial amount of work has been developed to help firms understand strategic objectives, the

next step should be identifying and studying the variables that lead to superior performance on the objectives.

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