

Environment, Dynamic Manufacturing Strategy, and Performance*

Jidae Kim**

Assistant professor, Department of Business
Administration, Chungwoon University
(jidkim@chungwoon.ac.kr)

Kee Young Kim

Sangnam Professor, School of Business
Administration, Yonsei University
(kykim@yonsei.ac.kr)

Young Soo Chun

President, Young Consulting
(youngmostkr@yahoo.com)

As Bozarth and McDermott(1998) pointed out, studies on changes within in a manufacturing strategy or dynamic manufacturing strategy are very scarce. This study addresses the important research issues that Bozarth and McDermott have suggested: (1) How does a firm move from one type of manufacturing strategy to another one?: (2) Why does it do so?: and, (3) Are there multiple equally viable paths? This study, based on the quantitative and longitudinal analysis of Korean manufacturing industry, empirically identified three types of dynamic manufacturing strategy: (1) Synergistic-Incremental Change(incremental change in a predetermined direction), (2) Simultaneous-Radical Change(radical change in a predetermined direction), and (3) Selective-Radical Change(radical change in a contingent direction). It is found that these three dynamic manufacturing strategies were affected by four contingent factors: two internal ones(size and efficiency of resource utilization) and two external ones(dynamism and hostility). In addition, two kinds of manufacturing action programs(infrastructural and structural) contributed to realizing each dynamic manufacturing strategy in a different way. Performance differences were also found across the three dynamic manufacturing strategies.

1. Introduction

Today's rapidly changing business environment is challenging a lot of manufacturing firms to reconsider their current manufacturing strategies and to prepare for fierce competition. Many manufacturing

companies are being forced to answer the question, "In which direction should our company steer the ship?"(Nakane et. al., 1994). However, in the three decades of research on manufacturing strategy, study on *change* in manufacturing strategy has not gotten the attention it deserves. Extant literature on manufacturing strategy appears

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** corresponding author.

to focus on the static aspects for the current competition climate and pays less attention to the aspects of change in manufacturing strategy.

Bozarth and McDermott(1998) acknowledge that studies on change in manufacturing strategy or *dynamic manufacturing strategy* are very scarce. They also indicate that important issues for research should include: (1) How does a firm move from one type of manufacturing strategy to another?; (2) Why does it do so?; and, (3) Are there multiple equally viable paths? This study attempts to address Bozarth and McDermott's research issues.

It seems that extant studies have some limitations. They are limited in identifying the types of change in manufacturing strategy. Although some studies(Ferdows & DeMeyer, 1990; Noble, 1995; Nakane, 1986; Kim et al., 1997) suggest several cumulative models in the resource-based view, these models are not exhaustive because they focus on incremental change in manufacturing strategy. It is possible that there will be multiple routes of change(Hayes & Pisano, 1996), one of which may be a radical change. Furthermore, from a methodological perspective, those models tend to primarily use cross-sectional analysis techniques or case studies rather than quantitative, longitudinal analysis techniques. As Miller and Friesen(1982) point out, the weakness of

cross-sectional analysis is that it does not take into account the time lag between cause and effect variables. It overlooks the fact that nonlinear relationships among the cause and effect variables can emerge as time goes by.

As for the environmental factors, the strategic management literature argues that both internal and external drivers lead firms to change their business strategies. However, in the manufacturing strategy literature, it is not revealed whether these factors also affect change in manufacturing strategy, or what other driving factors exist.

Skinner(1996a) argues that a timely design of a manufacturing system compatible with changed manufacturing tasks is regarded as a major theme in manufacturing strategy studies. Clark(1996) claims that proper attention should be paid to improving methods to set up a newly chosen manufacturing capability in time. However, determining what actions are required to change manufacturing strategy has not been examined. Finally, although many scholars hold that various static manufacturing strategy types are equally viable across environmental contexts, it has not been tested whether various dynamic manufacturing strategy types are equally viable. Therefore, these research gaps need to be closed.

This study tries to answer the following

research questions: (1) What types of dynamic manufacturing strategies exist?; (2) What drivers affect dynamic manufacturing strategies?; (3) How do dynamic manufacturing strategies differ in terms of manufacturing actions?; and (4) How do they differ in business performance? Addressing this kind of research requires the prominent industry-wide or nation-wide environmental shifts(Zajac & Shortell, 1989). Korea has experienced the fastest economic growth in the world. The dramatic variation in the Korean manufacturing environment during the early 1990s provides an interesting forum for addressing these issues. Therefore, we attempted to answer these research questions by examining the Korean manufacturing data of 1990-1994.

In the subsequent sections, we establish a model, and then propose some hypotheses. Next, we present results from a quantitative-longitudinal analysis. In the final section, we highlight some key findings.

II. Research Model and Hypotheses

2.1 Research model

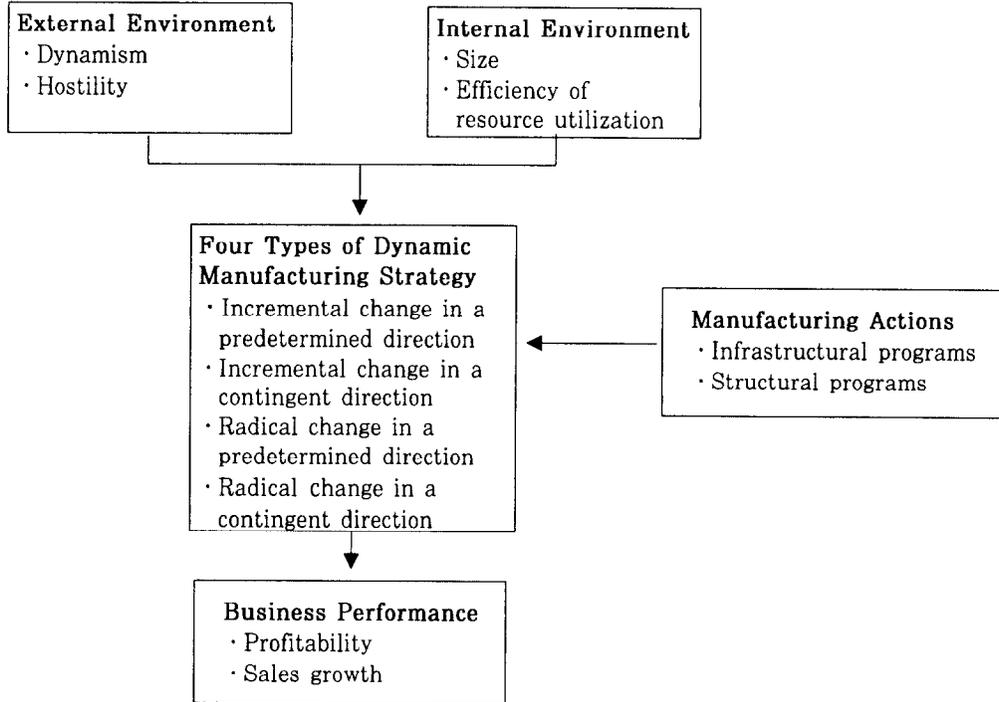
In Strategic Management literature, the concept of strategic change is well-defined as an organizational change over time in

terms of some strategic variables, i.e. organizational structure, decision-making systems, and human resource systems of an organization(Greenwood & Hinings, 1993). Using this model, we define the concept of dynamic manufacturing strategy as a change over time in terms of manufacturing capabilities, i.e. cost efficiency, quality, delivery, and flexibility. Since low performing manufacturers tend not to implement their intended manufacturing strategies(Ward & Duray, 2000), we consider only changes of realized manufacturing strategy. Mintzberg and Waters (1985) have suggested that the realized strategy represents the true strategy of a firm.

Several scholars agree that strategic change is derived from changes in both internal and external environmental conditions (Rajagopalan & Spreitzer, 1996; Van de Ven & Poole, 1995). They also agree that changes in the content of strategy affect organizational outcome. This environment-strategic change-outcome relationship also applies to the configuration process of the dynamic manufacturing strategy.

As presented in Figure 1, we propose that dynamic manufacturing strategies be classified into four types, that they are affected by four contingent variables(i.e., dynamism, hostility, size, and efficiency of resource utilization), that they are realized by manufacturing actions, and that dynamic

(Figure 1) Research model on the configuration of dynamic manufacturing strategy



manufacturing strategies translate into business performance. Based on this model, the subsequent sections will propose specific hypotheses on the types of dynamic manufacturing strategy and their environmental effect, the roles of manufacturing actions for realizing each dynamic manufacturing strategy type, and the differences in business performance across dynamic manufacturing strategies.

2.2 Types of dynamic manufacturing strategy

Types of change in strategy can be identified

in terms of magnitude and direction (Ginsberg, 1988; Rajagopalan & Spreitzer, 1996). Ginsberg (1988) and Miller(1992) suggest that in terms of magnitude, there exist *incremental* and *radical* types of strategic change.

With respect to the direction of change, there are two perspectives in the strategic management literature: contingency and strategic choice. *Contingency* describes firms that cannot choose their environments but must adapt their strategy towards environmental change. Thus, these firms will change their strategy in a contingency-determined direction(Donaldson, 1987), and

they will be more affected by external factors. In contrast, *strategic choice* describes firms that choose not only their organizational structure and strategy but also their environment. Thus, these firms will likely be able to change their strategy in the direction of a predetermined ideal(Doty et al., 1993), and they will be more affected by internal factors. Capabilities-based competition(Stalk & Schulman, 1992; Prahalad & Hamel, 1990), resource-based competition (Wernerfelt, 1984) or lean manufacturing

(Clark, 1996) can be seen as typical examples of the *strategic choice* view, because these strategies depend on more internal factors.

Combining the elements of magnitude and direction of change, we suggest four types of dynamic manufacturing strategy: (1) incremental change in a predetermined direction, (2) incremental change in a contingent direction, (3) radical change in a predetermined direction, and (4) radical change in a contingent direction. (Table 1)

(Table 1) Supporting literature for dynamic manufacturing strategy types

Type	Magnitude	Direction	Supporting literature	Argument
1	Incremental	Predetermined	Ferdows & DeMeyer(1990), Noble(1995), Kim et al.(1997), Nakane(1986)	The order of building manufacturing capabilities is cumulative, and prior resource primarily determines the cumulative order, in line with the resource-based perspective.
2	Incremental	Contingent	Hill(1994), Corbett & Wassenhove(1993), Wheelwright & Bowen(1996), Kim & Mauborgne(1997)	The order of building manufacturing capabilities is cumulative. However, market requirements primarily determine the cumulative order that needs to be followed.
3	Radical	Predetermined	Roth & Miller(1992), Flynn et al.(1999), Womack et al.(1990), Bennis(1996)	Building of all manufacturing capabilities, including cost, quality, delivery, and flexibility simultaneously, is recognized as the best strategy, in line with the resource-based perspective.
4	Radical	Contingent	Hayes & Pisano(1994), Skinner(1996a, 1996b), Ward & Rebecca(2000)	Environmental change leads a firm to develop new manufacturing capability and to give up existing ones, in line with the trade-off perspective.

outlines the supporting literature and arguments for each of the suggested dynamic manufacturing strategy types. Here, external factors has a more impact on Type 2 and Type 4 that have contingent directions, while internal factors more on Type 1 and Type 3 that have predetermined directions.

Type 1: Incremental change in a predetermined direction. This type of dynamic manufacturing strategy is supported by the resource-based view(DeMeyer & Pycke, 1996). The resource-based view argues that a firm's resource bases will have a great effect on formulating its next strategy(Wernerfelt, 1984). It was found that an existing manufacturing capability(e.g., quality) could contribute to developing a new manufacturing capability(e.g., cost) (Ferdows & DeMeyer, 1990; Garvin, 1988). In the same way, Hill (1988) reasons that a firm's differential capability would naturally result in enhancing its cost leadership advantage. Schmenner(1997) also comments that a focused factory would eventually increase flexibility. These studies support the idea that a firm will change its manufacturing strategy incrementally, along a predetermined path that is dependent on its prior strategy or resource base. Some evidence for this type can be found. Extant literature were focused on identifying this type. For example, Ferdows and DeMeyer's(1990) sandcone model

empirically identifies the quality-dependability-speed-cost progression. In addition, other cumulative models have been empirically tested (see Noble, 1995, for details).

Type 2: Incremental change in a contingent direction. This type of dynamic manufacturing strategy, similar to Type 1, changes manufacturing capabilities in a cumulative way. However, the cumulative order is not predetermined. Environmental factors, such as market requirements and product life cycle, greatly affect a manufacturing firm's decision re: choosing the manufacturing capability to be built. Type 2 focuses on linking manufacturing strategy to the needs of the marketplace.

Some literature supports the existence of this type. Hill(1994) separates manufacturing capabilities into two criteria: order-qualifying criteria, which are necessary to stay in the marketplace, and order-winning criteria, by which the product wins orders in the marketplace. Corbett and Wassenhove (1993) further assert that order-winning criteria would eventually become order-qualifying criteria as customers' needs gradually increase. Therefore, they suggest that on the top of existing manufacturing capabilities, new manufacturing capabilities should be developed to continually win orders, thus meeting customers' rising demands. Examples of this type of dynamic

manufacturing strategy can be found in the real world. For example, Kim and Mauborgne (1997) found that Compaq's dynamic manufacturing strategy offered unprecedented value to customers by uniquely cumulating manufacturing capabilities according to the stages of product life cycle, as the same as Type 2.

Type 3: Radical change in a predetermined direction. It has been found that some manufacturing firms enhance their competitiveness by radically building multiple manufacturing capabilities (Dess & Davis, 1984). Japanese manufacturers, for example, have led competition by simultaneously achieving many manufacturing improvements in terms of cost, quality, flexibility, and delivery (Hayes & Pisano, 1996). The simultaneous development of manufacturing capabilities can be considered as another predetermined course of change in manufacturing strategy.

As an aid to simultaneously increasing many manufacturing capabilities, much attention in the literature has been given to advanced manufacturing techniques and world-class manufacturing practices (Clark, 1996; Hayes & Pisano, 1996; Flynn et al., 1999). By introducing these advanced manufacturing techniques, a firm can achieve the simultaneous development and integration of all its manufacturing capabilities. The existence

of Type 3 firms is supported by extant studies. Bennis (1996) found that Morine succeeded in radically fostering multiple manufacturing capabilities concerning cost, delivery, and customer service within a two-year period. Roth and Miller (1992) also found that multiple manufacturing capabilities could be developed simultaneously.

Type 4: Radical change in a contingent direction. The fourth type of dynamic manufacturing strategy represents radical change in a contingent direction. Hayes and Pisano (1994) suggest that in a turbulent environment, a company should have the *strategic flexibility* to switch gears, for example, from innovation to cost reduction. Manufacturing firms with this strategic flexibility can radically change their manufacturing strategies to adapt to the changing environment. Skinner (1996b) also argues that environmental change requires a firm to configure new manufacturing strategies while giving up existing manufacturing strategies. Theoretically, these studies support the availability of a Type 4 strategy. Further evidence of Type 4 is suggested in studies by Skinner (1996b) and Hayes and Pisano (1994). Based on this discussion, we hypothesize the following:

H1: A firm's dynamic manufacturing strategy

tegy can be classified as one of the four types—Type 1, Type 2, Type 3, and Type 4.

How can one empirically distinguish the four types? It is reported to be very difficult to distinguish types of strategic change in an empirical way(Ginsberg, 1988). It is even very hard to distinguish strategic adjustment from strategic change (Ginsberg, 1988). However, we, in this study, set some guidelines for empirically distinguishing the four types. As for the direction, we will examine the degree of correlations among manufacturing capabilities. It is known that in the resource-based dynamic manufacturing strategies, like Type 1 and Type 3, a high degree of correlation among manufacturing capabilities is indicated(Noble, 1995; Flynn et al., 1999). Hence, the degree of correlations among manufacturing capabilities can become an important yardstick to discriminate dynamic manufacturing strategies with predetermined directions from dynamic manufacturing strategies with contingent directions.

As for the magnitude, Greenwood and Hinings(1993) regarded the change of interpretive scheme and organizational culture as an important requirement for radical change of strategy. However, changes in manufacturing strategy have a lower possibility of accompanying changes in a firm's

overall culture, values, and beliefs, because it is not as complex as those of corporate strategy due to its limited scope(Ginsberg, 1988). Therefore, we will simply examine the extent of change of manufacturing capabilities to determine the magnitude of each dynamic manufacturing strategy.

Based on the abovementioned guidelines, if an empirically-identified dynamic manufacturing strategy has high degree correlations among the manufacturing capabilities and, its extent of change in manufacturing capabilities is relatively small, it can be classified as Type 1. In the same way, the discriminating criteria for other types are as follows: low degree correlations and small extent of change for Type 2; high degree correlations and great extent of change for Type 3; and low degree correlations and great extent of change for Type 4.

2.3 Environmental drivers

Ginsberg(1988) states that change in strategy occurs when the pressure toward change exceeds resistance. The amount of difference between pressure and resistance determines the magnitude of change in a strategy. For example, high pressure with low resistance will push a firm to make a radically strategic change. In a different way, Miller(1992) argues that environmental and internal fit determine the magnitude of

change in strategy. He found that an internally fitting firm was inclined to make a radical change due to its tight coupling between departments, and that an environmentally fitting firm was inclined to make an incremental change due to its loose inter-departmental coupling.

Therefore, both internal and external environments affect a firm's choice of its dynamic manufacturing strategy. We propose that two external environmental variables (i.e. dynamism and hostility) and two internal environmental ones (i.e., size and efficiency of resource utilization) will have an impact on a firm's choice of its dynamic manufacturing strategy among the four types listed in <Table 1>.

Dynamism: refers to unpredictable and fast change in a firm's external environment (Ward et al., 1995). Firms in a stable environment would incrementally change their strategies, but those in a turnaround environment tend to pursue radical change (Allaire & Firsirotu, 1985; Rajagopalan & Spreitzer, 1996). The reason is that firms under dynamic environmental situation undergo mismatch between their current strategy and external environment and, as a result, they will pursue radical change (Allaire & Firsirotu, 1985; Rajagopalan & Spreitzer, 1996; Miller, 1992). Therefore, it is expected that among the four types in <Table 1>.

Type 4 dynamic manufacturing strategy might be chosen by manufacturers under more dynamic environmental conditions.

Hostility: refers to the extent to which external environmental conditions impart a negative impact on the growth of organizations. Firms working under hostile conditions face keen competition in local and foreign markets, have low profit margins, and experience declining product demand (Ward et al., 1995). A manufacturer in a hostile environment would choose incremental change in its dynamic manufacturing strategy rather than radical change. The reason is that in this hostile environment the preemption of radical change might be more likely to be eroded by fast following incumbents (Ali, 1994). Hence, it is expected that Type 2 dynamic manufacturing strategy might be chosen by manufacturers under more hostile environmental conditions.

Size: is regarded as a key driver of strategic change (Zajac & Kraatz, 1993). Organizational differences between large and small firms also make each strategic orientation different (Dean et al., 1998; Hambrick, 1995). Since large firms, in general, have such strengths as sufficient installed base and institutional legitimacy, they are able to control the rules of

competition and even to change their environmental conditions into preferred ones (Meyer & Zucker, 1989; Schilling, 1998; Singh, 1990). For this reason, a large firm is likely to seek a predetermined direction. In addition, large firms have abundant financial resources and thus it is more easy for them to make a radical change (Meyer & Zucker, 1989). Therefore, they might pursue radical change as in Type 3 dynamic manufacturing strategy.

Efficiency of resource utilization. High performers, being close to the threshold of highly efficient resource utilization, have tight constraints on resource utilization. Accordingly, it is more difficult for them to change their strategies. In addition, if they want to build new manufacturing capabilities, they have to give up current manufacturing capabilities (Clark, 1996). Hence, highly efficient manufacturers would rather follow predetermined directions than contingent directions, because the contingent directions demand more slack resources. Therefore, highly efficient manufacturers would choose Type 1 as their dynamic manufacturing strategy. In contrast, Type 3 appeals to under-performing manufacturers who are typically inefficient in utilizing their current manufacturing resources, because their major concerns are to catch up with the high performers in the shortest time

(Clark, 1996).

Based on this discussion, we now hypothesize the following:

H2a: Dynamism will have a greater impact on Type 4 dynamic manufacturing strategy.

H2b: Hostility will have a greater impact on Type 2 dynamic manufacturing strategy.

H2c: Size will have a greater impact on Type 3 dynamic manufacturing strategy.

H2d: Efficiency of resource utilization will have a greater impact on Type 1 dynamic manufacturing strategy.

2.4 Roles of manufacturing actions

Manufacturing actions can be dichotomized into two categories: structural action programs and infrastructural action programs (Hayes & Wheelwright, 1984). The structural action programs are concerned with location, capacity, equipment and process technology, vertical integration, etc., and the infrastructural ones with production planning and controlling, quality management, organization, workforce policy, etc.

There has been much debate about which of the two kinds of manufacturing action programs is more effective in building manufacturing capabilities. Several scholars

prefer infrastructural programs(e.g., emphasizing simple procedures, bottom-up decision making, low inventory, and partnership with suppliers) to structural programs(Hayes & Pisano, 1996; Hayes et al., 1988). In contrast, several researchers place a low value on the role of infrastructural action programs because they focus primarily on repairing and revamping the manufacturing system, allowing manufacturers simply to follow the leading competitors(Wheelwright & Bowen, 1996; Skinner, 1996b).

However, we propose that these two kinds of manufacturing action programs each contribute to realizing each of the four dynamic manufacturing strategies in different ways. Clark(1996) claims that simply by employing infrastructural action programs, less-efficient and less-competitive manufacturers can rise to the industrial standards required for competitiveness without investing in new structural action programs. He also argued that highly efficient manufacturers should use structural action programs more than infrastructural action programs for realizing their dynamic manufacturing strategies. Based on this assertion, one can predict that the dynamic manufacturing strategy of low-efficient manufacturing firms(as referred to in Type 3), intent on catching up to leading competitors, might rely on infrastructural action programs more than structural ones. In contrast, the

dynamic manufacturing strategy of high-efficient manufacturing firms(as referred to in Type 1) might rely on structural action programs more than infrastructural ones.

Meanwhile, many scholars(Kim & Lee, 1993; Hayes & Wheelwright, 1984; Kotha & Orne, 1989) recognize that a firm's structural decisions tend to narrow the scope of strategic choices it can make in the future, resulting in reduced strategic flexibility. They assert that in an uncertain environment, the infrastructural action programs would be more effective. Therefore, Type 4 dynamic manufacturing strategy in an uncertain environment might rely on more infrastructural action programs. In contrast, Type 2 dynamic manufacturing strategy in a hostile but less-uncertain environment might rely on more structural action programs.

The above arguments suggest that the roles of infrastructural and structural action programs might differ across the dynamic manufacturing strategies. So we hypothesize the following:

- H3a: Type 1 will rely on more structural manufacturing action programs.
- H3b: Type 2 will rely on more structural manufacturing action programs.
- H3c: Type 3 will rely on more infrastructural manufacturing action programs.

H3d: Type 4 will rely on more infrastructural manufacturing action programs.

2.5 Performance as a result of dynamic manufacturing strategies

Among the dynamic manufacturing strategy types, which type will be the most effective in improving business performance? Research is not clear in identifying the most effective extent of change to be introduced (Clark, 1996; Bozarth & McDermott, 1998). For example, Bennis(1996) and Skinner (1996b) support a radical transformation of manufacturing strategy in order to maintain competitive advantage. In contrast, Wheelwright and Bowen(1996) advise adopting an incremental and frequent change of manufacturing strategy for preventing the chaotic side-effects of radical change.

As for the direction of change, there also seem to be opposing views on choosing which route will outperform the other. Donaldson(1987) shows that the contingency-based change(i.e., change in a contingent direction) is more effective than strategic choice-based change(i.e., change in a predetermined direction shaped by the values of dominant coalition). In contrast, Doty et al.(1993) suggest that strategic choice-based change is superior to contingency-based change, because in their study the former explained more variance of per-

formance than the latter.

This equivocality, it can be thought, happens because there are multiple and equally effective paths of strategic change, i.e. *equifinality*(Bozarth & McDermott, 1998). Organizations would be equivalent in terms of organizational effectiveness, if they have internal consistency among environments, structures, and strategies(Doty et al., 1993). In the previous sections, we premised that each of the four dynamic manufacturing strategy types is aligned with its environmental conditions and manufacturing actions. For this reason, we hypothesize the following:

H4: There will be no difference in business performance among the four types of dynamic manufacturing strategies.

As mentioned above, we have made several hypotheses. In the remainder of this paper, we will test these hypotheses using Korean manufacturing data from the early 1990s.

III. Methodology

3.1 Sample

The data for this study was gathered

from Korean samples in an international manufacturing future project(MFP)(see Miller et al.(1992) for more details). The MFP surveys were conducted internationally every other year from 1983 until 1996. Among others, we chose forty-one Korean manufacturing business units(MBUs) that consistently participated in the 1990, 1992, and 1994 surveys. One of the authors, a Korean partner of the international MFP, was responsible for the management of all the Korean samples from 1988 to 1994. He selected only MBUs from highly ranked(top ten) Korean conglomerates in all the surveys, because small-sized and/or low-performing Korean MBUs did not have the ability to configure their own manufacturing strategies and thus data concerning those would distort the actual characteristics of Korean manufacturing strategies. Therefore, all of the respondents in this paper were MBUs of leading Korean conglomerates, so called *chaebol*, including Samsung, Hyundai, LG, Daewoo, Hyosung, etc. Manufacturing strategies of the sample could be regarded as representative of Korean manufacturing strategies during the early 1990s.

Korean economy is one of the fastest growing in the world, and Korean manufacturing has been the key engine of its success(Kim et al., 1994). Since 1991, Korean manufacturing industry has become competitive in the global market, as its

labor productivity has risen(Hitomi, 2002). Prior to the 1990s, Korean manufacturers' success was due primarily to sweatshop-type low wages, a plentiful and intelligent workforce, hard-working employees, strategic dependence on foreign companies for acquiring technologies, and OEM-based manufacturing with low prices and dependable delivery(Kim et al., 1994). However, in the 1990s, Korean manufacturers were pressed to cope with new business environments. First, many of Korea's traditional markets entered the mature and declining stages of the product life cycle, revealing weaknesses of the low-price strategy. Second, Korea's trade relations with the U.S. and European countries were less amicable than previously, due to regional economic integrations threatening access to the markets in those countries. Third, along with the democratization of Korea, social and labor unrest emerged, resulting in huge wage hikes, lower productivity, lower quality, and less dependable delivery.

These changes in the Korean business environment called for structural adjustments that were incompatible with the Korean manufacturing systems of the 1980s. According to a Korean manufacturing survey(Kim & Chang, 1990), in 1990 Korean manufacturers reported greater improvements in such performance dimensions as flexibility and quality than in measures related to

cost. In the five years after 1990, Korean manufacturers also pursued manufacturing strategies based on consistent quality and delivery capability.

In short, Korean manufacturing in the early 1990s faced a transition from simply maintaining low-cost and high-volume manufacturing strategy to adopting diverse new manufacturing strategies(Kim & Chang, 1990; Kim et al., 1994; Rho & Yu, 1998). Accordingly, the four-year data covering the period 1990-1994 are thought to be sufficient to give a explanation of the dynamic manufacturing strategies of those forty-one Korean manufacturers.

Most respondents belonged to the machinery

and electronics industries, as shown in <Table 2>. The average annual sales revenue during 1990-1994 was 217 billion won, and the average number of employees was 1,871. It has been reported that the characteristics of Korean manufacturing are not significantly different by industry, in contrast to U.S. and Japanese manufacturing(Noble, 1995). The result of ANOVA test also reveals that the responses of each of the industries are not significantly different at the level of $p < .10$. Therefore all the respondents, regardless of industry types, have been aggregated into the subsequent analysis. The survey questionnaires were completed by persons in top management, such as the

<Table 2> Respondent Profile Statistics

Industry Mix	
Machinery	36.6%
Electronics	34.1%
Consumer	4.9%
Industrial	4.9%
Basic	19.5%
Types of Manufacturing Unit Types	
Entire Company	14.6%
Division/group	46.3%
Plant	39.0%
Average annual sales revenue(1990-1994)	217 billion won
Annual sales revenue(1990)	143 billion won
Annual sales revenue(1992)	211 billion won
Annual sales revenue(1994)	271 billion won
Average number of employees(1990-1994)	1,871
Number of employees(1990)	1,693
Number of employees(1992)	1,728
Number of employees(1994)	1,918

Vice President or the Director of Manufacturing. All respondents were very cooperative, because survey results and useful benchmarking data were promised to be reported and explained to them.

3.2 Instruments

Data for manufacturing capabilities, internal environments, manufacturing action programs, and business performance of the forty-one Korean manufacturers were provided by the 1990 survey(for 1989-1990), by the 1992 survey(for 1991-1992), and by the 1994 survey(for 1993-1994). External environment characteristics were examined in the 1992 survey. The instruments measuring the constructs were taken from the international MFP questionnaires(Miller et al., 1992)(see the <Appendix 1>).

3.2.1 Manufacturing capabilities

Among the manufacturing capability measurement items in the international MFP questionnaire, twelve items were extracted, and they were divided into four manufacturing capability dimensions: low cost (one measurement item), quality(four items), delivery(two items), and flexibility(five items). The measurement items of each manufacturing capability dimension are listed in the <Appendix 1>. They were measured on

a seven-point, self-anchoring scale, rating an MBU's relative strength against the best competitor in the marketplace where 1="very weak" and 7="very strong." The assessment of the relative strength of each measurement item was done in the 1990, 1992, and 1994 surveys.

In addition, we assessed whether the manufacturing capabilities were intentional, by examining the degree of importance each measurement item received. The importance was measured on a seven-point, Likert-type scale(1=least important, 7=most important). If the importance for a manufacturing capability is over "4", that capability can be regarded as intended.

Most respondents answered that the importance of low cost, quality, delivery, and flexibility rated over 4 in all the survey years, indicating that all of them were intended. Only two respondents assessed the importance of cost below 4(not intended) in the 1990 and 1992 surveys. It reveals that the Korean manufacturers pursued all of the manufacturing capabilities, although they may have failed to achieve their strategic intents. Therefore, in the subsequent analysis of classifying dynamic manufacturing strategy types, we simply used the relative strengths of the four manufacturing capability dimensions.

All reliability coefficients of the measurement items for each manufacturing capability

indicated that they were internally consistent (Cronbach's Alphas were all over .70)(see the <Appendix 1>). In addition, the confirmatory factor analysis supported that each of the four manufacturing capability dimensions had discriminant validity(see the <Appendix 2> for details). The overall fit measures displayed good fit of the hypothesized measurement model with the data($\chi^2=50.71$ at 38 df, $p=.081$; RMR=.14, GFI=.81, AGFI=.60, NFI=.85, NNFI=.92, and CFI =.95).

Thus, the means of these measurement item values could represent the competitive levels of those four manufacturing capabilities in each survey year. Specifically, the following twelve constructs were used in the subsequent analysis: Cost90, Quality90, Delivery90, Flexibility90, Cost92, Quality92, Delivery92, Flexibility92, Cost94, Quality94, Delivery94, and Flexibility94. For example, Quality92 represents the quality strength measured in 1992.

3.2.2 Manufacturing action programs

The number of manufacturing action programs covered in the MFP surveys differed by survey year: twenty-eight in 1990, thirty-eight in 1992, and thirty-one in 1994 year. Therefore, we extracted the twenty-three manufacturing action programs that were all investigated in each of the 1990, 1992,

and 1994 surveys. The chosen manufacturing action programs consist of twelve infrastructural action programs and eleven structural action programs, as listed in the <Appendix>.

The pay-offs of the action programs emphasized during 1989-1990, 1991-1992, and 1993-1994 were respectively measured on a seven-point, self-anchoring scale, where 1="very low" and 7="very high." To see if the manufacturing action programs were intended, we questioned whether they had been emphasized or not(see the <Appendix>). This study, in the subsequent analysis, considered only the performances of the manufacturing action programs that had been emphasized and tried out by the responding MBUs. Each manufacturing action program has three different performance levels measured in the 1990, 1992, and 1994 surveys, respectively. For example, CAM(computer-aided manufacturing) has the following three performance levels: CAM(90), CAM(92), and CAM(94).

3.2.3 Environment

Internal environments or organizational contexts are operationalized as efficiency of resource utilization and size. Efficiency of resource utilization was measured by using a proxy variable, i.e. the average direct labor productivity - which was calculated

by dividing the average amount of sales by the average number of employees during 1990-1994. If direct labor productivity increases, resource utilization can be thought to become more efficient. Size was measured objectively by the average total number of employees during 1990-1994.

We operationalized external environments as dynamism and hostility. Dynamism was assessed subjectively by using three measurement items, patterned after Duncan (1972), and hostility also by three measurement items with the help of Ward et al.(1995)(see the <Appendix 1>). These measures were measured on seven-point internal scale, where 1=very negative and 7=very affirmative, in the 1992 survey year. The reliability coefficient of the measurement items of dynamism is .8463, and the reliability coefficient of the three measurement items of hostility is .5854. All reliability coefficients exceeded .5, which is conventionally asserted as a cutoff in exploratory studies(Narasimhan & Das, 1999).

The confirmatory factor analysis supported that each of the two external environment constructs had discriminant validity(see the <Appendix 3> for details). The overall fit measures displayed excellent fit of the hypothesized measurement model with the data($\chi^2=9.46$ at 8 df, $p=.30$; RMR=.070, GFI=.93, AGFI=.81, NFI=.88, NNFI=.96, and CFI=.98).

3.2.4 Business performance

Business performance was measured objectively by profitability(pretax profit \div total sales \times 100), and sales growth rate. These business performance measures were examined in 1990, 1992, and 1994, respectively. Accordingly, six business performance measures were used: profitability(90), sales growth(90), profitability(92), sales growth(92), profitability(94), and sales growth(94).

IV. Analysis and Results

4.1 Identifying dynamic manufacturing strategy types

Miller and Friesen(1982) suggest that the cluster analysis technique is well-suited to classifying types of change in strategy. They also add that the clustering criteria should be the amount of change in strategy occurring in a specific time interval. As for the time interval, they recommend a short time interval to understand the causal relationships between variables.

Relying on Miller and Friesen's suggestion, we classified dynamic manufacturing strategy types. As clustering criteria, we used strength changes of the four manufacturing capabilities. In this study, eight strength-change scores

for the four manufacturing capabilities were developed: Cost(92-90), Quality(92-90), Delivery (92-90), Flexibility(92-90), Cost(94-92), Quality (94-92), Delivery(94-92), and Flexibility(94-92). For example, Quality(92-90) indicates the 1992 quality strength minus the 1990 quality strength. In the same way, Quality (94-92) represents the difference between strengths of quality measured in 1992 and 1994, respectively.

For determining the number of clusters, Ketchen and Shook(1996) advise the use of a hierarchical method(Ward's method). They state that the agglomeration coefficient in the hierarchical method is of great value in determining the optimal number of clusters (see Ketchen & Shook(1996) for details).

Subsequently, they recommend the use of a non-hierarchical method(K-means or iterative method) to optimize the final solution clusters for within-cluster homogeneity and between-cluster heterogeneity. Following this suggestion, we discovered that clusters numbering three are not congenial to one another and that three would be the optimal number of clusters. In the second step, we extracted three mutually exclusive, meaningful, and interpretable clusters by applying the non-hierarchical method.

As seen in <Table 3>, we labeled the three types of dynamic manufacturing strategy: (1) Selective-Radical Change, (2) Synergistic-Incremental Change, and (3) Simultaneous-Radical Change. They are analogous to Type 4, Type 1, and Type 3, respectively. Of

<Table 3>Three types of change in manufacturing strategy

Clustering Variables	Three Types of Change			F-value(sig.)
	Selective-Radical Change (n=14)	Synergistic-Incremental Change(n=17)	Simultaneous-Radical Change (n=10)	
Strength Change for 90-92^a				
Cost92-90	.05	.06	-.18	.161(.851)
Quality92-90	-.57	.78	-.63	10.541(.000)
Delivery92-90	-.76	1.06	-.75	21.858(.000)
Flexibility92-90	-.32	.39	-.18	2.968(.064)
Strength Change for 92-94^b				
Cost94-92	-.65	-.12	1.18	8.650(.001)
Quality94-92	.36	-1.27	1.65	30.847(.000)
Delivery94-92	.02	-.90	1.50	20.552(.000)
Flexibility94-92	.21	-1.31	1.88	45.879(.000)

a) This value indicates the standardized 1992 cost strength minus the standardized 1990 cost strength.

b) This value indicates the standardized 1994 cost strength minus the standardized 1992 cost strength.

the four dynamic manufacturing strategy types listed in <Table 1>, we identified only three.

Selective-Radical Change. Of the forty-one manufacturers, fourteen are classified as changing in a selective-radical way. As shown in <Table 3>, during 1990-1992, these manufacturers increased strength of cost, while decreasing strength of quality, delivery, and flexibility. In contrast, during the next period, 1992-1994, they increased strength of quality, delivery, and flexibility, while decreasing the strength of cost, shifting from a low-cost-based-competition to a differentiation-based one. This reflects that their manufacturing strategy is radical and selective.

This shift toward focusing on differential capabilities(i.e., quality, delivery, and flexibility) seems to be associated with the manufacturers' adaptation to the Korean

business market trends mentioned earlier. The correlation matrix of manufacturing capabilities also shows that among all possible correlation coefficients, only eight were statistically significant(see <Table 4>), revealing that the direction of change in manufacturing strategy was contingent. Therefore, this dynamic manufacturing strategy can be regarded as radical change in a contingent direction, Type 4.

Synergistic-Incremental Change. Seventeen manufacturers are classified as using synergistic-incremental change. As shown in <Table 3>, during the first period, they significantly increased strengths of quality, delivery, and flexibility, while keeping the increment of cost strength very small. During the second period, they greatly reduced strengths of quality, delivery, and

<Table 4> Correlation matrix of manufacturing capabilities for Selective-Radical Change

	1	2	3	4	5	6	7	8	9	10	11
1. Cost90											
2. Quality90	-.224										
3. Delivery90	-.070	.385									
4. Flexibility90	.309	.513*	.630**								
5. Cost92	.305	.121	-.069	.347							
6. Quality92	.122	.029	-.462	-.179	.337						
7. Delivery92	.491*	.030	.325	.230	.132	.403					
8. Flexibility92	.275	.109	-.142	.301	.099	.469	.384				
9. Cost94	.480*	-.095	-.265	.080	-.025	.388	.525**	.394			
10. Quality94	-.447	.064	.198	-.061	-.395	.260	.332	.027	.310		
11. Delivery94	.028	-.091	.313	-.129	.043	-.136	.346	-.244	.218	.285	
12. Flexibility94	-.019	-.089	-.174	.138	.118	.622**	.250	.356	.599**	.580**	-.002

*: p<0.1. **: p<0.05, two-tailed significance.

flexibility, while keeping the reduction of cost strength very small. The result of comparing cost strengths reveals that their cost strengths(cost90, cost92, and cost94) were all above the mean values of the total sample in each survey year. The standardized values of their cost strengths by survey year were 0.103, 0.163, and 0.011, respectively, supporting that they kept on cost leadership. It appears that they tried to maintain a cost advantage at all times while allowing other manufacturing capabilities to be changed. Thus, this strategy is not radical.

The result of correlation analysis shows that about fifty percent of the sixty-six correlation coefficients were statistically significant(see <Table 5>). This indicates the existence of strong synergies among the manufacturing capabilities in such a way

that one manufacturing capability contributes to building other manufacturing capabilities. For example, <Table 5> shows that the 1990 quality capability(Quality90) was highly correlated with the 1992 quality, delivery, and flexibility capabilities. In particular, Cost90 was significantly correlated with Flexibility90, and Cost92 was significantly correlated with both Cost90 and Flexibility92. Cost94 was also significantly correlated with Quality92, Cost92, Flexibility92, Delivery94, and Flexibility94. This result shows that the manufacturers could maintain cost leadership by capitalizing on other differential manufacturing capabilities like flexibility. These results support the argument that these manufacturers changed their manufacturing strategies in the resource-based perspective, and thus the direction of change

(Table 5) Correlation matrix for Synergistic-Incremental Change

	1	2	3	4	5	6	7	8	9	10	11
1. Cost90											
2. Quality90	.100										
3. Delivery90	.292	.670***									
4. Flexibility90	.429*	.503*	.761***								
5. Cost92	.420*	.196	.101	.144							
6. Quality92	.278	.685***	.659***	.448*	.327						
7. Delivery92	.031	.437*	.510**	.472*	.297	.570**					
8. Flexibility92	.395	.774***	.797***	.628***	.518**	.660***	.402				
9. Cost94	.352	.421*	.131	.343	.596**	.349	.358	.439*			
10. Quality94	-.017	.372	.297	.120	-.033	.424*	.245	.336	-.134		
11. Delivery94	.501*	.304	.252	.253	.499**	.488**	.492**	.392	.636**	.190	
12. Flexibility94	.098	.689***	.392	.427*	.289	.542**	.329	.615**	.547**	.507**	.298

*: p < 0.1, **: p < 0.05, ***: p < 0.01, two-tailed significance.

was predetermined. Accordingly, their dynamic manufacturing strategy is more likely to be an incremental change in a predetermined direction, Type 1.

Some might argue that these manufacturers do not belong to Type 1, because the strengths of all of manufacturing capabilities were reduced during 1992-1994, and this result do not support the synergistic and cumulative relationships among the manufacturing capabilities. However, we believe that their dynamic manufacturing strategy belongs to Type 1. The reasons are as follows. First, these manufacturers, as mentioned above, at least sustained cost leadership in 1994. Considering the manufacturing action programs of these manufacturers(to be discussed in a later section), any manufacturing action programs did not function for sustaining their cost leadership during 1992-1994. This implies that their cost leadership in 1994 could only be preserved with synergies provided by other manufacturing capabilities(see <Table 5>). Second, considering environmental effects (to be discussed in a later section), this dynamic manufacturing strategy was more affected by efficiency of resource utilization, as stated in the hypothesis(H2d)(efficiency of resource utilization will have a greater impact on Type 1 dynamic manufacturing strategy). This result supports that this dynamic manufacturing strategy belongs to

Type 1. Third, As seen in <Table 8>, this strategy relied on more structural manufacturing action programs, as predicted in the hypothesis(H3a)(Type 1 will rely on more structural manufacturing action programs). This result also supports that this dynamic manufacturing strategy belongs to Type 1. Fourth, the reduction of cost strength during 1992-1994 might be attributed to the relative measurement of strengths of manufacturing capabilities. As discussed earlier, this study led the respondents to rate relative strengths of manufacturing capabilities against the best competitor in the marketplace. As a result, a MBU could assess its current relative strengths of manufacturing capabilities low, even though it has improved them. For this reason, we guess that if cost strength had been measured in an absolute way, the 1994 cost strength of these manufacturers would have been not worse than the 1992 cost strength, because the difference(Cost94-92), as shown in <Table 3>, was very small between the relative strength of the 1992 cost capability and that of the 1994 cost capability.

Simultaneous-Radical Change. Ten manufacturers are classified as having undertaken simultaneous-radical change. As seen in <Table 3>, they experienced an abrupt loss of competitiveness in all manufacturing capabilities for 1990-1992. However, they

<Table 6> Correlation matrix for the Simultaneous-Radical Change

	1	2	3	4	5	6	7	8	9	10	11
1. Cost90											
2. Quality90	-.046										
3. Delivery90	-.018	.633**									
4. Flexibility90	.764***	.056	-.048								
5. Cost92	.342	.245	.340	.328							
6. Quality92	.307	.634**	.216	.659**	.100						
7. Delivery92	-.146	.601*	.793***	-.223	.461	.038					
8. Flexibility92	.238	.026	-.070	.658**	.101	.578*	.058				
9. Cost94	-.057	-.018	.405	.098	.276	.000	.009	-.139			
10. Quality94	-.381	.357	.335	.045	.065	.318	.455	.520	.266		
11. Delivery94	.224	.450	.451	.295	.764***	.308	.290	-.074	.675**	.193	
12. Flexibility94	.140	.534	.519	.450	.056	.606*	.303	.379	-.066	.271	.028

*: $p < 0.1$, **: $p < 0.05$, two-tailed significance.

drastically succeeded in building low cost, quality, delivery, and flexibility during the following period, 1992-1994. Thus, this dynamic manufacturing strategy is radical.

The correlation matrix in <Table 6> shows that eleven correlation coefficients were statistically significant. Although only a small number of correlation coefficients proved to be statistically significant, we believe the direction of this dynamic manufacturing strategy was predetermined, not contingent. The reasons are as follows. First, the number of significant correlation coefficients in this dynamic manufacturing strategy is greater than in the case of the selective-radical change. Second, considering the manufacturing action programs of these manufacturers (to be discussed in a later section), we surmise that their purpose in changing

was not to preemptively lead competition, but to simply reduce the widening competitive gap behind the leading competitors. Third, among the four environmental drivers, only size affected these manufacturers in a significant way (as shown in <Table 7>).

This result reveals that their dynamic manufacturing strategy were not driven by external environments. Therefore, this dynamic manufacturing strategy can be referred to as a radical change in a predetermined direction, Type 3.

We identified three (Type 1, Type 3, and Type 4) of the four dynamic manufacturing strategy types in <Table 1>, but Type 2 (incremental change in a contingent direction) could not be found in this study. As a result, we could not test the hypotheses that Type 2 is related with, such

<Table 7> Environmental characteristics of the three types

Variables	Types of Change			F-value (sig.)
	Selective- Radical Change	Synergistic- Incremental Change	Simultaneous- Radical Change	
<i>Internal environment</i>				
Efficiency of resource utilization ^{a)}	1.125	1.615^{c)}	1.198	2.145(.100)
Size(# of employees)	1.715	800	3.754	2.896(.069)
<i>External environment</i>				
Dynamism ^{b)}	4.28	3.77	3.29	2.260(.099)
Hostility ^{b)}	4.36	4.88	3.70	7.193(.002)

- a) This value was calculated by dividing the average amount of sales(100 million won) by the average number of employees during 1990-1994.
- b) These variables were measured on a 7-point scale, where 1=very negative and 7=very affirmative.
- c) The bold values proved to be significantly greater than other values at the p=0.10 level or better by the Duncan Range Test.

as H2b and H3b. It is possible that Type 2 is less applicable to manufacturing firms than other types, or that Korean manufacturers did not have the capability to implement Type 2. We guess that Korean manufacturers could not take Type 2 into consideration in the early 1990s, because Type 2(focusing on leading the competition by incremental change) was not appropriate for both their surrounding environment and their capability. We predict that Type 2 could be empirically identified in a more advanced economy. We hypothesized that a firm's dynamic manufacturing strategy can be classified as one of the four types- Type 1, Type 2, Type 3, and Type 4. As each of the three dynamic manufacturing strategies identified here can be interpreted as one of

the four types, respectively, this hypothesis can be supported, thus accepting H1.

4.2 Environmental effects

We proposed the hypotheses that each of the four contingent variables - dynamism, hostility, size, and efficiency of resource utilization - would affect the configuration of dynamic manufacturing strategy. The result of ANOVA test in <Table 7> supports this. <Table 7> shows that each dynamic manufacturing strategy has different environmental characteristics.

Those manufacturers using selective-radical change(Type 4) perceived their external environments as more dynamic. Those pursuing synergistic-incremental change(Type 1)

internally had higher direct labor productivity and thus utilized their resources more efficiently, and the manufacturers using simultaneous-radical change (Type 3) were large-sized, having larger number of employees. This result reveals the following relationships between the environmental variables and dynamic manufacturing strategies: dynamism is related to Type 4; size to Type 3; and efficiency of resource utilization to Type 1, thus accepting H2a, H2c, and H2d.

4.3 Roles of manufacturing action programs

We proposed that the roles of infrastructural and structural manufacturing action programs would be different according to the types of dynamic manufacturing strategy. The result in <Table 8> suggests that the manufacturing action programs implemented by the three dynamic manufacturing strategies are different.

<Table 8> shows performance changes of manufacturing action programs across the three types and also shows what kinds of manufacturing action programs played a decisive role in realizing each dynamic manufacturing strategy. Performance changes during 1990-1992 were calculated by subtracting the 1990 performance level from the 1992 performance level of each manufacturing action program; in the same way,

performance changes during 1992-1994 were measured by subtracting the 1992 performance level from the 1994 performance level. For example, worker training(94-92) represents the 1994 performance level minus the 1992 performance level of worker training.

In the selective-radical change strategy (Type 4), computer-aided manufacturing contributed to building low cost capability during 1990-1992; empowerment, activity-based costing, quality function deployment, and investing in an improved production/inventory control system contributed to building quality, delivery, and flexibility during 1992-1994. <Table 8> shows that Type 4 employs very selective manufacturing action programs and, of those, relies more on infrastructural action programs than structural ones. Also, the scope of the implemented action programs is cross-functional. This characteristic is essential for supporting the strategic flexibility of this Type 4, because large investments in structural action programs may ultimately cause problems of strategic rigidity the next time. This result supports H3d.

The synergistic-incremental change strategy (Type 1), for cumulating differentiation-related capabilities upon cost capability during 1990-1992, made great use of structural action programs such as reconditioning physical plants, investing in improved production/inventory control systems, computer-

<Table 8> Performance changes of manufacturing action programs for the three types.

Manufacturing Action Programs	Types of Change			F-value (sig.)
	Selective- Radical Change	Synergistic- Incremental Change	Simultaneous- Radical Change	
Performance Change during 1990-1992^{d)}				
<i>Structural action programs</i>				
Reconditioning physical plants(92-90)	2.182 ^a (11 ^b)	3.571 ^c (14)	1.333(9)	4.601(.018)
Investing in improved production system(92-90)	.100(10)	1.889(9)	-.167(6)	3.777(.039)
Computer-aided manufacturing(92-90)	.400 (5)	.750 (8)	-2.000(4)	2.630(.109)
Computer-aided design(92-90)	1.750(8)	2.857(8)	-.200(5)	2.257(.135)
Developing new process for old products(92-90)	.7143(7)	2.700(10)	-.333(6)	4.277(.028)
Performance change during 1992-1994^{d)}				
<i>Infrastructural action programs</i>				
Empowerment(94-92)	.500(10)	-.786(14)	1.571(7)	5.640(.009)
Worker training(94-92)	-.667(9)	-.833(12)	.778 (9)	2.636(.090)
Management training(94-92)	-.231(13)	-.143(14)	1.000 (8)	1.993(.153)
Supervisor training(94-92)	-.077(13)	-.429(14)	1.000 (8)	1.840(.175)
Value analysis(94-92)	-.667(9)	-.154(13)	1.125 (8)	2.240(.125)
Activity based costing(94-92)	.375 (8)	-1.143(7)	.833 (6)	4.713(.023)
Statistical quality control(94-92)	-.900(10)	-.818(11)	.429 (7)	1.870(.175)
Quality function deployment(94-92)	.400 (10)	-1.182(11)	.250 (8)	2.455(.106)
Just in time(94-92)	-.231(13)	-1.167(12)	.750 (8)	5.415(.010)
Design for manufacture(94-92)	.000(11)	-.455(11)	.899 (9)	1.684(.204)
Cross-functional teams(94-92)	-.636(11)	-.167(12)	1.222 (9)	3.465(.045)
<i>Structural action programs</i>				
Information system in manufacturing(94-92)	.300(10)	-.917(12)	1.125(8)	4.071(.028)
Reconditioning physical plants(94-92)	-.091(11)	-.882(17)	1.375(8)	6.492(.004)
Investing in improved production and inventory control system(94-92)	1.250 (12)	-1.364(11)	1.120 (8)	6.696(.004)
Computer aided design(94-92)	.154(13)	-.818(11)	1.250 (8)	2.979(.067)
Flexible manufacturing system(94-92)	.375(8)	-.714(7)	2.143 (7)	7.259(.005)
Developing new process for new products(94-92)	.091(11)	-.923(13)	.375 (8)	2.025(.150)
Developing new process for old products(94-92)	-.200(10)	-.846(13)	1.750 (8)	6.231(.006)

a) The value was calculated by subtracting the 1990 performance level from the 1992 performance level of the focal action program, where 1 = very low, 7 = very high.

b) The value in parenthesis indicates the number of MBUs that emphasized the focal manufacturing action.

c) The bold values proved to be significantly greater than other values at the p=0.10 or better by the Duncan Range Test.

d) Only the performance changes of manufacturing action programs that were significantly different are presented. During 1990-1992, the performance changes of all infrastructural action programs were not statistically different across the three types.

aided manufacturing, computer-aided design, and developing new processes for old products, as seen in <Table 8>. However, no action programs functioned for sustaining cost capability during 1992-1994. This implies that the synergistic-incremental change strategy initially invested in more structural action programs for cumulating new differential capabilities, and then did not invest further for maintaining cost capability.

How could this strategy sustain cost capability without any investments? <Table 5> shows that Cost94 was positively correlated with Quality90, Cost92, and Flexibility92. Therefore, the 1994 cost capability could only be preserved with synergies provided by other manufacturing capabilities. It shows that Type 1 requires only structural investments at the initial stage, and then needs no further major investments at the next stage, because manufacturing capabilities support each other in a synergistic way. This result supports H3a.

In the simultaneous-radical change strategy (Type 3), performance variations in each action program were not notable during 1990-1992. This was closely related to the steep reduction of the strength of all manufacturing capabilities for the same period. However, great increases in performance results of both infrastructural and structural action programs occurred during 1992-

1994. As a result, it enabled the manufacturers to enhance all manufacturing capabilities. This result indicates that Type 3 requires investments of various kinds of manufacturing action programs, structural as well as infrastructural. As a result, H3c is partially accepted.

4.4 Comparison of business performance

We proposed the hypothesis that business performance would be equally viable across different dynamic manufacturing strategies. However, the result in <Table 9> shows that this hypothesis(H4) should be rejected. The result indicates that radical change (selective-radical change and simultaneous-radical change) performed slightly better than incremental change(synergistic-incremental Change). The selective-radical change strategy (Type 4) recorded higher sales growth in 1994. It can be interpreted that the enhanced capabilities(quality, delivery, and flexibility) this dynamic manufacturing strategy fostered for 1992-1994, directly elevated their sales growth.

However, the synergistic-incremental change strategy(Type 1) did not have any surpassing business performance in any survey years. The simultaneous-radical change strategy (Type 3) enjoyed faster sales growth in 1990 and higher profitability in 1992. Unexpectedly, it did not show better

<Table 9> Business performance of the three types^{a)}

Business Performance	Types of Change			F-value (sig.)
	Selective-Radical Change	Synergistic-Incremental Change	Simultaneous-Radical Change	
<i>Performance in 1990</i>				
Profitability(90)	.256	-.097	-.212	.517(.602)
Sales growth(90)	-.271	-.159	.645^{b)}	2.761(.077)
<i>Performance in 1992</i>				
Profitability(92)	-.331	-.155	.719	2.885(.075)
Sales growth(92)	.182	-.285	.166	.846(.439)
<i>Performance in 1994</i>				
Profitability(94)	.023	.049	-.102	.062(.940)
Sales growth(94)	.426	-.394	.092	2.293(.118)

a) The value was standardized(mean=0, standard deviation=1).

b) The bold values proved to be significantly greater than other values at the $p=0.10$ or better by the Duncan Range Test.

performance in the process of recovering strength in all manufacturing capabilities for 1992-1994.

V. Discussion and Conclusions

Compared to the studies on static manufacturing strategies, efforts to configure the dynamic manufacturing strategies have not been significant. In this context, we have asked four research questions. The first question was: "What types of dynamic manufacturing strategy exist?" This study identified three types of dynamic manufacturing strategies in Korea: Synergistic-Incremental

Change(incremental change in a predetermined direction), Simultaneous-Radical Change(radical change in a predetermined direction), and Selective-Radical Change (radical change in a contingent direction). Although the three types were identified in the early 1990s, evidence suggests that they are being used by manufacturers even in the early 2000s. Specifically, Lee et al.(2001) in their case study, found that today's leading Korean firms tend to have dynamic manufacturing strategies of either radical change in a predetermined direction or radical change in a contingent direction. This means that the radical types can be replicated in Korea.

The extant literature has focused on

incremental change, paying less attention to other types of change. This study identified the two radical types. Of the two, Selective-Radical Change is characterized by abruptly shifting from low-cost-based competition to differentiation-based competition. This dynamic manufacturing strategy can be recognized as standing for the traditional trade-off view on manufacturing strategy which argues manufacturing capabilities are mutually exclusive and firms cannot offer all things to all people(Hayes & Wheelwright, 1984). In contrast, the Simultaneous-Radical Change, building all manufacturing capabilities at once, stands for the lean manufacturing view which argues manufacturing capabilities are mutually supportive and firms can offer all things to all people(Clark, 1996). Hence, it can be also said that there are two contrasting perspectives in configuring the radical type of dynamic manufacturing strategy.

The second question was: "What drivers affect dynamic manufacturing strategies?" This study found that dynamism, hostility, size, and efficiency of resource utilization are significant. The internal environment drivers, i.e. size and efficiency of resource utilization, affected only the Synergistic-Incremental Change and Simultaneous-Radical Change strategies, both of which have predetermined directions. On the contrary, the external environment driver,

dynamism, affected only the Selective-Radical Change strategy, which has a contingent direction. This result implies that the internal drivers would have a great impact on predetermined directions, and the external drivers on contingent directions. The other noteworthy finding is that sixty percent of the forty-one Korean manufacturers chose the radical types rather than the incremental one for coping with the fast changing economic trends. This indicates that a country's common economic situation could also affect a firm's dynamic manufacturing strategy. Another key finding is that hostility significantly affected the Synergistic-Incremental Change, which is characterized as incremental. It implies that hostility would determine only the magnitude of change in manufacturing strategy rather than the direction.

The third question of this study was: "How do the dynamic manufacturing strategies differ in terms of manufacturing actions?" It has been found that the roles and scope of manufacturing action programs were different according to the three types. The slower the rate of change, the more structural action programs were used; the faster the rate of change, the more infrastructural action programs were used. Garvin(1993) asserted that the traditional trade-off view is too static to proactively respond to rapidly changing markets.

According to this assertion, radical change in a contingent direction would never be made by any firms in a dynamic environment. However, as described earlier, we identified the Selective-Radical Change strategy; that is, a radical change in a contingent direction. The Selective-Radical Change strategy could be realized by very selective and cross-functional manufacturing action programs. This result sheds some valuable insight into how the trade-off-based dynamic manufacturing strategy can be realized.

The final research question was: "How do the dynamic manufacturing strategies differ in business performance?" It has been found that the two radical types(Simultaneous-Radical Change and Selective-Radical Change) were a little superior to the incremental one (Synergistic-Incremental Change) in the early 1990s Korean situation. This result is opposite to the *equifinality* standpoint. It also implies that national environment would have a moderating effect on performance difference among the dynamic manufacturing strategies. The other finding is that the Simultaneous-Radical Change(radical change in a predetermined direction) failed to achieve the expected business performance during 1992 - 1994. This indicates the existence of a time lag between the changing of manufacturing strategy and business performance improvements. In addition, the

result supports the negative aspects of the lean manufacturing view, which have been commented on by some researchers(Hayes & Pisano, 1994, 1996; Skinner, 1996b; Stalk & Schulman, 1992; Wheelwright & Bowen, 1996). They pointed out that lean manufacturing is focused on the current manufacturing problems of a bottleneck issue, and on the reduction of the competitive gap with the best firms. Therefore, they thought that lean manufacturing would not provide firms with enough competitive advantage to preempt competition. Interestingly, Skinner(1996b) expressed this as "three yards and a cloud of dust"; Kim (1994a) also called it "competitive gridlock." For this reason, the Simultaneous-Radical Change, which is based on lean manufacturing view, might not get as great a business performance improvement as expected.

Practitioners can make some implications from the results. First, there are diverse routes to changing a manufacturing strategy, so they have to carefully choose dynamic manufacturing strategies that are congruent with their environmental conditions. For example, if their local environment is rapidly changing, a radical change in manufacturing strategy in a contingent direction is recommended. Second, appropriate manufacturing action programs should be implemented for the chosen dynamic manu-

facturing strategy. Some useful guidelines are as follows: infrastructural and cross-functional action programs are appropriate for more radical change, and structural action programs more so for incremental change.

This study gives some insights into the strong relationship among environmental conditions, dynamic manufacturing strategies, manufacturing action programs, and business performance. However, it has some limitations. First, like the Greenwood and Hinings' (1993) research, it requires more longitudinal and broader data. The scope of the data of this study does not allow for a complete understanding of dynamic manufacturing strategy. Second, it is not known whether the results are applicable to manufacturers in other countries. A lot of replicating research would be needed for validating the results. In particular, it is needed to empirically identify Type 2 (incremental change in a contingent direction). This study failed to empirically identify this type and as a result this study could not test H2b and H3b, both of which are directly related with Type 2. We guess that this type might emerge in another economy. Finally, further research is needed to take into account other driving factors for strategic change in manufacturing and the interacting effects of these. We hope these problems will be addressed by subsequent studies.

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Environment, Dynamic Manufacturing Strategy, and Performance

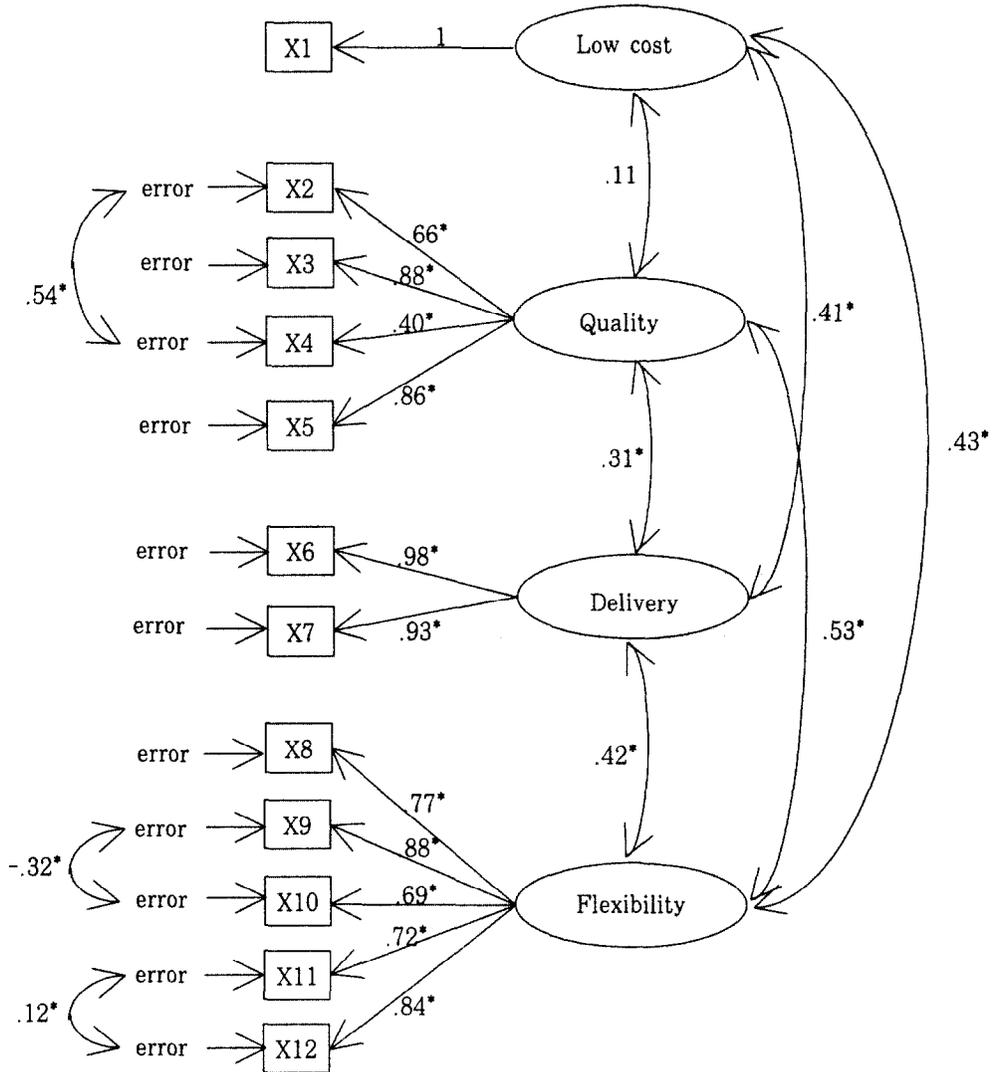
<APPENDIX 1> Questionnaire used in each of the 1990, 1992, and 1994 MFP surveys

Manufacturing capabilities	Degree of importance						Degree of strength							
	least important	2	3	4	5	6	7	much weaker	2	3	4	5	6	7
Low Cost														
Ability to profit in price competitive markets(X1)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Quality (averaged $\alpha = .7598$)														
Ability to offer consistent quality with low defects(X2)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Ability to provide reliable and durable products(X3)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Ability to provide high-performance products(X4)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Ability to customize products to individual customer's needs(X5)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Delivery (averaged $\alpha = .8466$)														
Ability to provide fast deliveries(X6)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Ability to provide dependable deliveries(X7)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Flexibility (averaged $\alpha = .8150$)														
Ability to make rapid design changes(X8)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Ability to introduce new products quickly(X9)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Ability to make rapid volume changes(X10)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Ability to make rapid product mix changes(X11)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Ability to offer a broad product line(X12)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Manufacturing action programs														
	Emphasis(past two years)						Pay-off(past two years)							
	no	yes					little	great						
Infrastructural action programs														
Giving workers a broad range of tasks and/or more responsibility	0	1					1	2	3	4	5	6	7	
Worker training	0	1					1	2	3	4	5	6	7	
Supervisor training	0	1					1	2	3	4	5	6	7	
Management training	0	1					1	2	3	4	5	6	7	
Value analysis	0	1					1	2	3	4	5	6	7	
Activity based costing	0	1					1	2	3	4	5	6	7	
Statistical quality control	0	1					1	2	3	4	5	6	7	
Quality circles	0	1					1	2	3	4	5	6	7	
Just in time	0	1					1	2	3	4	5	6	7	
Design for manufacture	0	1					1	2	3	4	5	6	7	
Cross-functional teams	0	1					1	2	3	4	5	6	7	
Quality function deployment	0	1					1	2	3	4	5	6	7	

(APPENDIX 1) Questionnaire used in each of the 1990, 1992, and 1994 MFP surveys(계속)

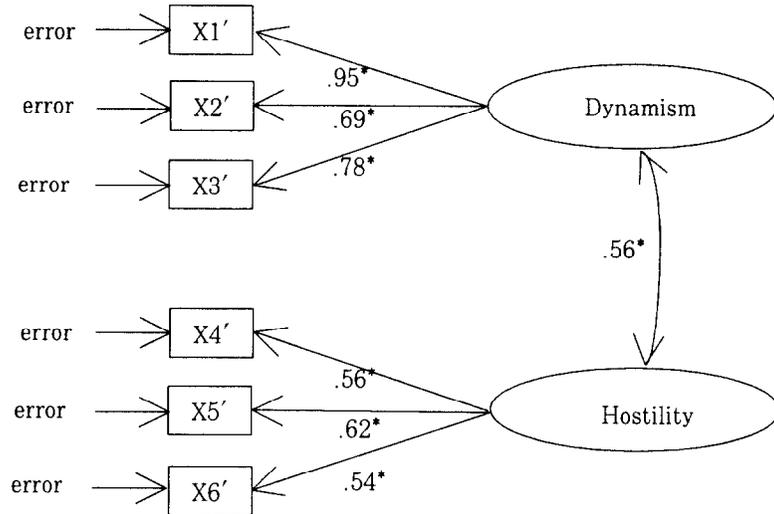
Manufacturing action programs	Emphasis(past two years)		Pay-off(past two years)						
	no	yes	little						great
Structural action programs									
Integrating information systems in manufacturing	0	1	1	2	3	4	5	6	7
Integrating information systems across functions	0	1	1	2	3	4	5	6	7
Reconditioning physical plants	0	1	1	2	3	4	5	6	7
Investing in improved production-inventory control systems	0	1	1	2	3	4	5	6	7
Computer-aided manufacturing	0	1	1	2	3	4	5	6	7
Computer-aided design	0	1	1	2	3	4	5	6	7
Robots	0	1	1	2	3	4	5	6	7
Flexible manufacturing systems	0	1	1	2	3	4	5	6	7
Developing new processes for old products	0	1	1	2	3	4	5	6	7
Developing new processes for new products	0	1	1	2	3	4	5	6	7
Closing or relocating plants	0	1	1	2	3	4	5	6	7
Business performance									
Net pretax profit ratio against total sales for the last fiscal year			() %						
Growth rate in dollars(percent increase over previous fiscal year)			() %						
Internal environments									
Size:	Total number of employees								
Efficiency of resource utilization:	Sales ÷ total number of employees								
External environments(only included in the 1992 Korean survey)									
			Degree of affirmation						
			very negative					very positive	
Dynamism ($\alpha = .8463$)									
Speedier introduction of new products is required in the market.(X1')			1	2	3	4	5	6	7
It is more difficult to predict customers' fast changing needs.(X2')			1	2	3	4	5	6	7
The industry is experiencing a great change technologically.(X3')			1	2	3	4	5	6	7
Hostility ($\alpha = .5854$)									
There are a lot of competitors in the market.(X4')			1	2	3	4	5	6	7
Competitive strategies are very heterogeneous among competitors.(X5')			1	2	3	4	5	6	7
Suppliers are unreliable and opportunistic.(X6')			1	2	3	4	5	6	7

(APPENDIX 2) Confirmatory factor analysis of manufacturing capabilities



- note: 1) The content of each of the measurement items(X1 ~ X12) can be seen in the (Appendix 1).
 2) The value of each of the measurement items was calculated by averaging the strengths measured in the 1990, 1992, and 1994 surveys, respectively.
 3) * Statistically significant($p < .05$)
 4) $\chi^2=50.71$ at 38 df, $p=.081$; RMR=.14, GFI=.81, AGFI=.60, NFI=.85, NNFI=.92, and CFI=.95
 5) All the interfactor correlations were significantly different from 1.0, providing evidence of discriminant validity(Narasimhan & Das, 1999).

〈APPENDIX 3〉 Confirmatory factor analysis of external environments



- note: 1) The content of each of the measurement items(X1' ~ X6') can be seen in the 〈Appendix 1〉.
 2) * Statistically significant($p < .05$)
 3) $\chi^2=9.46$ at 8 df, $p=.30$; RMR=.070, GFI=.93, AGFI=.81, NFI=.88, NNFI=.96, and CFI=.98
 4) The interfactor correlation was significantly different from 1.0, providing evidence of discriminant validity.

환경, 동태적 생산전략, 그리고 성과

김지대* · 김기영** · 전영수***

Abstract

Borzarth와 McDermott(1998)가 지적하였듯이, 생산전략의 변화, 즉 동태적 생산전략에 관한 연구는 매우 희귀하다. 본 연구는 Borzarth와 McDermott가 제시한 3가지 연구 이슈들을 다루었다 - (1) 기업은 어떠한 형태로 생산전략을 변화시키는가? (2) 왜 그렇게 하는가? 그리고 (3) 생산전략을 어떻게 변화시키든 성과는 같은가?

본 연구는 계량적이고 종단적인 연구방법을 사용하여 우리나라 제조업을 분석한 결과, 실증적으로 다음과 같은 3가지 유형의 동태적 생산전략 유형을 발견하였다 - (1) 선택적-급진적 변화(변화의 방향은 상황에 따라 다르고 급진적으로 변화시킴), (2) 시너지적-점진적 변화(변화의 방향은 사전에 결정되어 있으며 점진적으로 변화시킴), 그리고 (3) 동시적-급진적 변화(변화의 방향은 사전에 결정되어 있으며 급진적으로 변화시킴).

이들 동태적 생산전략들은 네 개의 상황요인들 - 2개 내부 요인(기업규모, 자원활용의 효율성)과 2개 외부 요인(외부환경의 동태성, 적대성) -로부터 영향을 받은 것으로 나타났다. 또한, 두 가지 종류의 생산활동 프로그램(하부구조적 활동과 구조적 활동)은 각자 동태적 생산전략을 실현하는 데 다르게 기여한 것으로 나타났다. 마지막으로 3가지 동태적 생산전략들간에 성과 차이가 난 것으로 나타났다.

Key words: 생산전략, 변화, 환경, 생산활동 프로그램.

* 청운대학교 경영학과.

** 연세대학교 경영대학.

*** 영 컨설팅.