

Should Lean Replace Mass Organization Systems? A Comparative Examination from a Management Coordination Perspective

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From a management coordination perspective, this paper compares the relative performance of the lean and mass organization systems under different market environments and organizational operating conditions. Results from an empirically based computer model suggest that the success of

either organization system depends not only on the organization's structural characteristics for management coordination, but also on internal and external environmental conditions. This study calls for caution against rushing into lean management practices.

INTRODUCTION

With the upsurge of the Japanese manufacturing companies in the 1980s, in particular in the auto industry, much attention has been paid to the production techniques employed by these firms. Scholars have referred to them as lean-producing firms, and their system as the lean system (Womack,

Jones and Roos, 1990). Many studies have examined the success of these lean systems in terms of the technical aspect of their production systems, including, among others, just-in-time inventory (Davy, White, Merritt and Gritzmacher, 1992), statistical control processes (Feigenbaum, 1991), and quality control (Reitsperger and Daniel, 1990). Some

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We would like to thank the editor and two anonymous reviewers for their constructive comments.

researchers have claimed that the Japanese originated lean production technique will replace the U.S. originated mass production technique "in all areas of industrial endeavor to become the standard global production system of the twenty-first century" (Womack et al., 1990, p. 278). More fundamentally, some scholars in organization science and international business have come to argue that the lean system presents a new form of organization that can shed light into organizational theory and organizational building (e.g., Ouchi, 1979; Aoki, 1990).

Relatively little research has been conducted on the system aspect of the lean system, however, even though organizational researchers have recognized the importance of comparing organizations and studying organizational effectiveness from a system's perspective (Aoki, 1994; Tannenbaum, 1994). Tannenbaum (1992), for example, highlighted the importance of studying the impact of an organization system on individual members of the organization, whereas the system refers to the larger context within which the individual organization members operate. Aoki (1994) discussed the importance of considering the effectiveness of the Japanese organization system in holistic fashions, by which he refers to the broader contexts of complementary institutional arrangements of both the labor market and the monitoring agent of the banks. It thus appears that to study the relative strength of the lean system over other types of systems, such as the prototypic U.S. system, a systemic rather than a piecemeal view of the two types of systems is required (Aoki, 1994). Yet this is not always accomplished. In the present study, we contrast the lean system with the U.S.

originated mass system in terms of their corresponding management coordination characteristics that integrate the various activities in these production systems (Martinez and Jarillo, 1989, 1991; Daniel and Reitsperger, 1991, 1994). Furthermore, there also exist concerns regarding the true superiority of the lean production technique under all situations (Porter, 1990). Indeed, much evidence for the superiority of the lean production technique has been presented in fragmented forms with exclusive focuses on the technical aspects within closed and narrow settings. As a result, systemic and coherent insights have been lacking regarding how, why and when such production techniques may (or may not) be effective in a globally changing environment.

We believe that the success or failure of the adoption of a production technique does not lie exclusively in the technical aspect itself, and that without effective management coordination, the production technique alone will not succeed (Woodward, 1958). The importance of management coordination for the success of technical production has prompted researchers to look at lean and mass productions as not just two techniques, but as two broadly integrated organization systems with management coordination as an important function of these systems (Scott, 1987; Daniel and Reitsperger, 1991, 1994).

It is the objective of this study to compare systematically the relative performance of the lean and the mass organization systems from an open system's perspective. We build a formal computer model for these two organization systems based on a broad literature review, and examine their performance under various market and internal operating environments. While such a comparison

is inspired by the debate on whether the Japanese originated lean system is truly superior to the U.S. originated mass system, we believe that the essence of this study can also shed light into a much broader range of comparative organizational issues, including the coordination problem in multinational corporations (MNCs) as been explored from different angles (e.g., see Prahalad and Doz, 1987; Roth and Morrison, 1990; Martinez and Jarillo, 1989, 1991).

RESEARCH BACKGROUND

Management coordination and management control have overlapped in meanings, and yet each has referred to different aspects of organizations. Management control has been defined as a process which brings about adherence to a goal or target through the exercise of power and authority (Etzioni, 1965), the sum of interpersonal relations in an organization (Tannenbaum, 1968), and a problem in information flows (Galbraith, 1973). Management coordination has been treated as an enabling process that provides the appropriate linkage between different task units within the organization (Van de Ven, Delbecq and Koenig, 1976; Tuggle, 1978), and administrative tools that help to achieve integration among different units within an organization (Martinez and Jarillo, 1989).

While we recognize that there are distinctions between coordination and control, we have also taken the position of most scholars that control and coordination are not necessarily mutually exclusive (Scott, 1987; Martinez and Jarrillo, 1989, 1991; Hall, 1991; Kumar and Seth, 1998). In the present study, we follow Martinez and Jarrillo's (1989, 1991) conceptualization of management coordination and control. Martinez and

Jarrillo define management coordination as the process of integrating activities that are dispersed across the subsidiaries of an organization. According to Martinez and Jarillo, behavioral and bureaucratic control (Ouchi and Maguire, 1975; Ouchi, 1977; Child, 1972, 1973) is one of the more formal and structural mechanisms of coordination while control through socialization or organizational culture (Pfeffer, 1982; Mintzberg, 1983) is a more informal mechanism of coordination. Martinez and Jarillo have argued that the coordination issue is essential to the study of international management, and have demonstrated the fruitfulness of applying this conceptualization to the study of MNCs. In our study, we examine lean and mass management organizational systems as two coordination systems that can embody multiple mechanisms, including structural and cultural controls.

Management coordination has long been associated with organizational design in organization theory (Mintzberg, 1983; Scott, 1987). Organizations are different from individuals in that they have structures. Organizations assign roles, design procedures, and provide feedback for their members, thus facilitating the coordination of efforts, and enabling the accomplishment of collective outcomes (Coleman, 1990). Organizational design thus serves as an important form of management coordination. Therefore, it is not uncommon for earlier studies on management control (e.g., Egelhoff, 1982; Doz and Prahalad, 1986; Boyacigiller, 1990; Gupta and Govindarajan, 1991) and later research on management coordination (e.g., Martinez and Jarrillo, 1989, 1991) to focus on the structural characteristics of organization systems. More recent research on management coordination,

however, has highlighted the importance of a less formal kind of control than organizational structure (e.g., see Martinez and Jarillo, 1991 for a review; Gencturk and Aulakh, 1995). This less formal kind of coordination includes, among others, organizational culture and the socialization into such cultures. Organizational culture refers in broad terms to the way of doing things, the decision making style, and the objectives and values of the company (Pfeffer, 1982). Thus, organization systems, if they are to be viewed systematically and holistically, should include both formal and informal kind of features. Furthermore, while organizations can design their structures, they also have to operate within the larger context of their environments (Thompson, 1967; Aldrich, 1979; Scott, 1987), and the effectiveness of a particular organization system may have to be evaluated ultimately against the external constituencies of an organization (Aoki, 1994). Organizational environments provide organizations with opportunities and constraints. Thus, functionality of particular structural and organizational cultural characteristics can and need to be examined in terms of their performance under organizational environments with which the organization continuously interacts (Lawrance and Lorsch, 1967; Thompson, 1967; Scott, 1987).

Structural and Problem Solving Characteristics of the Two Systems

The present study compares the lean and the mass organizations in terms of both the formal and informal characteristics of management coordination for information sharing and decision making, and examines their effectiveness in different environmental settings. The formal organization system is examined

in terms of the structural characteristics of the way information is shared and decisions are made in organizations. Structural characteristics (Pugh, Hickson, Hinings, MacDonald, Turner and Lupton, 1963; Weick, 1977; Daft, 1982) have been related to outcomes such as problem solving proficiency of organizations (e.g., Houskisson and Galbraith, 1985; Roberts, 1990; Lin and Carley, 1997), and organizational innovations (Daft, 1982). Of the various structural characteristics examined, complexity, formalization and centralization have been overwhelmingly regarded by organization scholars as fundamental aspects of organizational structure (Pugh et al., 1963; Mackenzie, 1979; Daft, 1982; Robbins, 1993, p. 487). These aspects are important because they capture the fundamental nature of how organizations coordinate and control the activities of members, which in turn can greatly impact the effectiveness and efficiency of organizations (Pugh et al., 1963; Mackenzie, 1979; Scott, 1987).

The informal organization system is examined in terms of a salient problem solving characteristic of the two types of organizations (Parsons, 1956; Pfeffer, 1982; Krackhardt and Stern, 1988). With respect to the problem-solving characteristic, we study whether the organizational members' attitude toward problems is proactive or reactive. Organizational operations are none other than problem solving activities (Scott, 1987). Problem solving attitude can influence the way in which organizational members interact with each other, approach problems, and make decisions (Parsons, 1956; Blumberg, 1987; Abramson, Lane, Nagai and Takagi, 1993). Importantly, it has been identified that lean organizations are active in creating an organization cul-

ture that promotes a proactive attitude toward problem solving, whereas mass organizations witness a more reactive attitude toward problem solving (Imai, 1991; Womack et al., 1990).

In the present study, we aim to contrast the lean system with the mass system. Clearly defining the two systems, however, is difficult. In general, the lean organization system is referred to as a Japanese style system because it was originated in the Japanese automobile industry, and the mass organization system is referred to as an U.S. style system originated in the U.S. automobile industry. But both systems have spread worldwide and have incorporated new features over the years. Furthermore, the defining characteristics of the lean system is at best vague in the existing literature. As discussed above, when referring to the lean system, researchers have often focused on different aspects of the production system. For the purpose of this study, lean versus mass systems will be delineated on the basis of the structural and cultural dimensions outlined above, i.e., the levels of complexity, formalization, centralization, and problem solving attitude. We hope this will serve as a first step toward more systematic research on the important issue of management coordination in different cultural and market settings. The characteristics are depicted in Table 1.

Complexity

Organizational complexity has three main elements, namely, "horizontal differentiation, vertical or hierarchical differentiation; and spatial dispersion" (Hall, 1991, p. 53). In this study, we focus on two aspects of organizational complexity: The degrees of vertical and horizontal differentiation that an organi-

zation employs for the control and coordination of work. Vertical differentiation refers to the number of hierarchical levels in the organization (Pugh et al., 1963; Hall, 1991; Robbins, 1993). Horizontal differentiation refers to the degree of lateral separation between units (Pugh et al., 1963; Hall, 1991; Robbins, 1993). A highly complex organization will have high vertical and horizontal differentiation. Specifically, we contend that a mass organization system is more complex both vertically and horizontally than a lean organization system in terms of information sharing and decision making.

One factor that contributes to the lower level of complexity of lean organization systems is their emphasis on "leanness," or no waste (Cusumano, 1988; Womack et al., 1990; Berggren, 1992). Though a few studies suggest that Japanese managers and workers actually prefer firms with high vertical and low horizontal differentiation (Lincoln, Olson and Hanada, 1978, 1981), we argue that such differentiation is often non-functional and that lean producers, in their search to incorporate employee information and opinion into the operation and decision making process, seek to reduce both the vertical and horizontal complexities of an organization. Thus, in general, people observe that lean organizations have more participative-like management, and employee input is required and valued explicitly by upper management. Some argue that, even with the many functional titles in lean organizations in Japan, lean transplants in the U.S. are striving for leaner overall structures. For example, Wakabayashi and Graen (1991) find that in quite a few lean transplants there are only two basic status categories: Manager and associate.

TABLE 1
LEAN AND MASS ORGANIZATION SYSTEMS:
A STRUCTURAL COMPARISON FROM THE LITERATURE

	Lean System	Mass System
<u>Complexity</u>	<u>Low</u>	<u>High</u>
	<ul style="list-style-type: none"> - Emphasizes leanness or no waste in structure (<i>Cusumano, 1988; Womack et al., 1990; Berggren, 1992</i>). - Fewer functional hierarchical levels (<i>Wakabayashi and Graen, 1991</i>). 	<ul style="list-style-type: none"> - Allows complex and redundant structure (<i>Womack et al., 1990</i>). - More hierarchical levels and more differentiated divisions (<i>Cusumano, 1988; Peters, 1988; Womack et al., 1990</i>).
<u>Formalization</u>	<u>Low</u>	<u>High</u>
	<ul style="list-style-type: none"> - Emphasizes teamwork (<i>Womack et al., 1990; Rehder, 1992; Hogg, 1993</i>). - Flexible job responsibilities (<i>Rehder, 1992</i>). - Encourages multiple job skills and expertise (<i>Womack et al., 1990; Rehder, 1992; Hogg, 1993</i>). 	<ul style="list-style-type: none"> - Emphasizes high division of individual labor (<i>Weber, 1964; Rehder, 1992</i>). - Strict rules for individual job responsibilities (<i>Drucker, 1987; Walton & Susman, 1989</i>). - Discourages multiple job skills (<i>Drucker, 1987; Walton & Susman, 1989</i>).
<u>Centralization</u>	<u>Low</u>	<u>High</u>
	<ul style="list-style-type: none"> - Lateral communication is encouraged and decisions are made collectively on a team basis (<i>Maguire & Pascale, 1978; Womack et al., 1990</i>). - Encourages participation from lower-level employees and lateral-level co-workers (<i>Haire, Ghiselli & Porter, 1966; Maguire & Pascale, 1978; Pascale, 1978; Bass & Burger, 1979; Hull & Azumi, 1988; Womack et al., 1990</i>). 	<ul style="list-style-type: none"> - Communication and decision making is based on strict vertical individual command chain (<i>Womack et al., 1990; Zetka, 1992</i>). - Discourages participation from lower-level employees or lateral-level co-workers (<i>Womack et al., 1990; Zetka, 1992</i>).
<u>Problem Solving</u>		
<u>Attitude</u>	<u>Proactive</u>	<u>Reactive</u>
	<ul style="list-style-type: none"> - Workers actively search for problems (<i>Takamiya, 1969; Womack et al., 1990</i>). - Workers are trained to tackle problems (<i>Lorrinan & Kenjo, 1994</i>). 	<ul style="list-style-type: none"> - Workers passively wait for problems to happen (<i>Takamiya, 1969; Womack et al., 1990</i>). - Workers are trained to pass rather than to tackle problems (<i>Womack et al., 1990</i>).

Mass organization systems, on the other hand, represent more complex organizations that involve more hierarchical levels and more redundant communications among more differentiated divisions (Cusumano, 1988; Womack et al., 1990). As Womack et al. (1990, p. 140) have observed, "mass production is designed with buffers everywhere — extra inventory, extra space, extra workers — in order to make it function." Tom Peters (of *In Search of Excellence* fame) also arrived at the conclusion, based on numerous related studies, that North American organizations have too many vertical layers and too many middle managers (Peters, 1988).

Formalization

Formalization has generally been referred to as how jobs are standardized and specified in rules and procedures within an organization (Pugh et al., 1963; Scott, 1987; Hall, 1991; Martinez and Jarillo, 1991; Robbins, 1993). Martinez and Jarillo (1991), for example, defined formalization as "the extent to which policies, rules, job descriptions, etc. are written down in manuals and other documents, generally leading to the establishment of standard routines." According to Hall (1991, p. 63), "formalization involves organizational control over the individual" in making decisions. If an organization has highly formalized jobs, employees will have little discretion over what and how products are processed. Information sharing and decision making of mass producers are more formalized than lean producers. For example, the "prototype" or ideal form of mass producing organizations is a bureaucracy, which is characterized by a high division of labor, clearly defined hierarchies, detailed rules and regulations, and

impersonal relationships (Weber, 1964; Rehder, 1992). Typically, mass producers rely on narrowly skilled workers, and even introduce work rules and job classifications that prohibit workers from mixing their duties (Drucker, 1987; Walton and Susman, 1989). On the other hand, lean producers emphasize cooperative work and multiple job skills and expertise (Womack et al., 1990; Rehder, 1992; Hogg, 1993; Sohal and Egglestone, 1994). Thus, overall, mass producing organizations are more formalized than lean producing organizations.

Centralization

Centralization refers to how decisions are concentrated within an organization (Pugh et al., 1963; Scott, 1987; Hall, 1991; Martinez and Jarillo, 1991; Robbins, 1993). According to Hall (1991, p. 74), centralization fundamentally is about "the distribution of power within organizations." Martinez and Jarillo (1991) also defined centralization as "the extent to which the locus of decision-making lies in the higher levels of the chain of command." Organizations with high centralization tend to be more concerned with hierarchical order and have less participation from lower level employees in making decisions. Mass producing organizations typically involve a strict vertical command chain (Womack et al., 1990; Zetka, 1992). Organizational decisions are made by top level executives and are handed down to the shop floor. Shop floor-level workers are rarely expected to be involved in decision making. Lean organizations, on the other hand, adopt an open command structure. Like mass producers, lean producers still make the most critical organizational decisions at the top executive level. However, lean producers allow shop-floor-level workers

to make decisions that are relevant to how to operate their jobs (Haire, Ghiselli and Porter, 1966; Maguire and Pascale, 1978; Pascale, 1978; Bass and Burger, 1979; Hull and Azumi, 1988; Womack et al., 1990). In addition, lean producers favor a collective decision making approach at both the shop floor level and the managerial level (Maguire and Pascale, 1978; Sohal and Egglegstone, 1994). This "openness" and "team-based approach" of lean producers are perhaps the most important features of their "decentralization." In other words, lean producers are decentralized to the extent that there are more people who can make decisions in the organization. Mass producers, on the other hand, are centralized to the extent that upper management is more keen to make decisions by themselves. Thus, lean producers are less centralized than mass producers.

Problem Solving Attitude

In this study, we examine the informal organization system in terms of the problem solving attitude that is emphasized, cultivated, and sustained via the organizational culture particularly of the lean system (Scott, 1987; Sohal and Egglegstone, 1994). Specifically, we focus on one type of problem solving characteristic, the proactive or reactive attitude that organization members adopt in approaching problems. A few decades ago, it was suggested that one of the strengths of Japanese managers was their ability to recognize changing environmental factors and devise problem solutions (Takamiya, 1969). More recently, Womack et al. (1990, p. 102) found that "lean production offers creative tension in which workers have many ways to address challenges." Workers in lean organizations are expected to solve, and even anticipate problems that may occur

(Sohal and Egglegstone, 1994). Furthermore, workers' problem solving capabilities are utilized and optimized (Womack et al., 1990; Imai, 1991). This emphasis on a proactive attitude of problem solving is reflected in lean producers' investment in training workers to have technical job knowledge, which has also been considered as one reason for Japan's winning competitive margins in the 1980s and early 1990s (Lorrinan and Kenjo, 1994). Most importantly, workers in lean organizations are socialized to actively pursue ways to prevent problems, to ensure that there is coordination between units. For example, the famous slogan "the next step is my customer" of some Japanese lean organizations highlights the fact that these organizations emphasize internal coordination, besides external coordination (see Imai, 1991). Such slogans serve the important function of creating and sustaining the organizational culture of having a service orientation and serving even those within the organization. Thus, this particular characteristic is an important component of the organizational culture of lean producers, and of how it may implicate the coordination of information and decision making. Mass producers, on the other hand, do not expect their shop-floor level workers to engage in active problem solving. Instead, jobs in the mass organization system are structured in such a way that workers are not expected to possess any broad knowledge, or take any active role in handling problems (Womack et al., 1990).

Organizational Environments

Despite numerous claims that the lean organization system is superior to the mass organization system, whether the lean system can indeed outperform the mass system in different conditions,

such as the market environment, or operating conditions within the organization, remains to be examined. Indeed, consistent with the open systems and the contingency perspective, studies have found that organizational environments impact the functionality of particular organizational structures. For example, Oliver, Delbridge, Jones and Lowe (1994) found in their comparative study of nine Japanese companies and two U.K. companies that Japanese companies perform better only when they have stable market demand and lower absenteeism. The notion that the lean organization system may not be functional for all organizational environments is also reflected in the doubts by some researchers over whether the lean organization system can be adopted universally (Porter, 1990; Ettlie, 1994). Despite some of these criticisms, little effort has been devoted to the systemic conceptualization of the situations under which lean or mass organization systems will be more effective. We think it is necessary to take a more active and systemic approach to incorporate aspects of organizational environments and their relationships with organizational design and effectiveness. In the present study, we focus on three critical aspects of organizational environments that consider external, internal, and time dimensions: The market environment, the operating condition within the organization, and the time pressure. This approach we adopt is also consistent with contingency thinking (Lawrence and Lorsch, 1967; Thomson, 1967; Galbraith, 1977). For example, the contingency approach has been used to study leadership (e.g., Fiedler, 1967), the choice of structure for national unions (e.g., Child, Loveridge and Warner, 1973; Jarley,

Fiorito and Delaney, 1997), how organizations learn (e.g., Shrivastava, 1983; Nevis, DiBella and Gould, 1995), and differential learning styles of organizations across hierarchical levels (Jelinek, 1979).

Market Environment

Organizations must respond to market demands in order to survive. The features of the market environment thus have implications for the effectiveness of a particular organization system. A dimension of the market environment that has received much attention is predictability/unpredictability, which refers to such things as variation of customer demands, market fluctuation, or change in technology. In an unpredictable market environment, multiple types of problems (for example, more variety of customer demand and more competition) often occur, thus the market environment is unstable and non-routine in nature, and is more unforeseeable to the organization. This type of environment can be considered as a dispersed environment and with a wider niche width (Hannan and Freeman, 1977; Carroll, 1984). On the other hand, in a predictable market environment, one type (or only a limited number of types) of products is dominant (e.g., demand for one product is shared by the majority of customers, or one big firm monopolizes the market), thus the environment is more stable, more routine in nature, and is more foreseeable to the organization. This type of environment can be considered as with a narrower niche width (Hannan and Freeman, 1977; Carroll, 1984). The lean organization system, for example, has been praised for its ability as a generalist to manufacture a wide range of products to meet different customer

demands and fend off fierce competition, while maintaining high levels of quality and productivity (Krafcik, 1988).

When an organization performs under a predictable market environment, meaning that workers can perform routine, simple, and familiar tasks, the mass organization system may be more effective than the lean organization system. This is because workers in the mass organization system do not have to be trained to have multiple skills, and thus can be specialized in their respective jobs. On the other hand, when an organization has to perform under an unpredictable market environment, then lean organizations may be more effective than mass organizations because the workers are more versatile and are more keen on team work, thus they are more capable of responding to different challenges posed by the environment. Also, as suggested by researchers, organizations with a more mechanistic or bureaucratic structure may be better suited for predictable environments, while organizations with a more organic and team structure may be better suited for unpredictable environments (e.g., Burns and Stalker, 1961; Emery and Trist, 1965; Courtright, Fairhurst and Rogers, 1989). Thus we have the following proposition:

Proposition 1: The lean organization system is more effective when operating under an unpredictable market environment, but the mass organization system is more effective when operating under a predictable market environment.

Operating Conditions within the Organization

Another important factor that may potentially influence the effectiveness

of a particular organizational structure, but which has received relatively little attention, is operating conditions within the organization. Operating conditions within the organization encompass the internal environment of an organization, and may refer to a wide range of problems. They are, however, more or less under an organization's control, in contrast to the external market environment (Pfeffer and Salancik, 1978; Aldrich, 1979). Oliver et al. (1994), for example, have pointed out the negative effect of turnover on the performance of some Japanese companies. Also, we cannot ignore the importance of communication. Organizations rely on communication to operate (Jablin et al., 1986). Poor communication may sometimes spell disaster (Lewis, 1988). Thus, for the present study, we focus on three operating conditions within the organization: Optimal condition, communication breakdown condition, and turnover condition. An optimal operating condition is a baseline condition in which there is nothing wrong with an organization.

For this study, communication breakdown refers to the intra-organizational situation in which members cannot freely communicate with each other. This may occur under many circumstances. For example, when there are personnel changes involving new recruits, the communication between the old and the new members may break down. Also, when there are interpersonal or inter-departmental conflicts, communication may break down across different levels. The lean organization system relies on team work, which emphasizes frequent communication, thus it may be more susceptible to communication breakdowns. In comparison, the mass organization system is associ-

ated with a high complexity and even redundancy in its communication structure and also a high division of tasks, thus it should be less affected by communication breakdown. This assumption leads to the following proposition:

Proposition 2: The lean organization system is more affected by communication breakdown than the mass organization system.

Turnover is known to have cost implications for an organization (e.g., Mobley, 1982; Wells and Muchinsky, 1985; McEvoy and Cascio, 1987). More interestingly, turnover seems to be a problem that commonly confronts U.S., but not Japanese, organizations. Indeed, lean producers are known to utilize lifetime employment and seniority systems to maintain stability of their work force (Maher, 1985; Sullivan, 1991). Because lean producers have not been seriously challenged by turnover problems, the effects of turnover on the lean organization system have not been examined. To the extent that there are industrial, geographic, and/or political factors that affect the mobility of the work force, turnover may plague lean producers, just as it plagues mass producers. For example, Americans who have strong individualistic values may find it difficult to remain in a lean organization system for a long time, thus Japanese auto transplants in the U.S. may be confronted with a higher turnover rate than they would have been in Japan (Fucini and Fucini, 1990; Patterson, 1990; Beechler, 1994). The mass organization system emphasizes high formalization, such that each worker at the shop level is restricted to handle very simple and routine work; thus, this style of organization should be less affected by

turnover at the shop level. In contrast, the lean organization system relies on the shop-level individuals' versatility, proactiveness, and team work, qualities vital in an environment that is diversified and unpredictable. However, if turnover happens, it would take much more time and far more resources for the lean organization system to select and train a new employee who can fit the team. Thus, the lean organization system may be severely affected by turnover, particularly when the market environment is dispersed and unpredictable. We therefore propose the following proposition:

Proposition 3: The lean organization system is more affected by turnover than the mass organization system.

Time Pressure

Modern organizations are constantly confronted with the challenge of responding in a timely manner to stay competitive. Particularly in highly volatile industries, where supplies have to be adjusted constantly to meet various demands, the time it takes to respond to a problem situation is crucial (Hogg, 1993). For example, Wall Street mutual fund managers or investment bankers have to monitor the market closely and be able to respond immediately to market situations. Manufacturers in the toy industry have to be ready to respond to the latest consumer trends (e.g., the wave of dinosaur toys resulted from the release of the movie *Jurassic Park*).

We argue that the proficiency of the lean versus the mass organization system differs according to the different levels of time pressure. Though mass organizations adopt a centralized and

formalized structure that allows decisions simply to be handed down for execution, they are hampered by the complex, multi-level, and often-redundant structure of their organizations. In contrast, lean organizations adopt a decentralized and less formalized structure that encourages team discussion. This, coupled with a proactive problem-solving attitude, enhances the ability of lean organizations to react to time pressure effectively and efficiently. The advantage of lean organizations may be more obvious as compared to mass organizations when responding to dynamic and diversified challenges of the market under time pressure (Hogg, 1993; Vasilash, 1994), despite the fact that lean organizations may spend much time on group meetings and within-group communications. These points lead to the following two propositions:

Proposition 4: The lean organization system responds to time pressure more effectively than the mass organization system.

Proposition 5: The lean organization system responds to time pressure more efficiently than the mass organization system.

A Theoretical Summary of the Model

This study is an exploratory one on how the structural and cultural coordination mechanisms combine to affect the effectiveness and efficiency of two organization systems in various environmental conditions. The theoretical model is summarized in Figure 1. We started with the notion that management coordination is essential for the effective functioning of organizations, particularly MNCs such as automobile

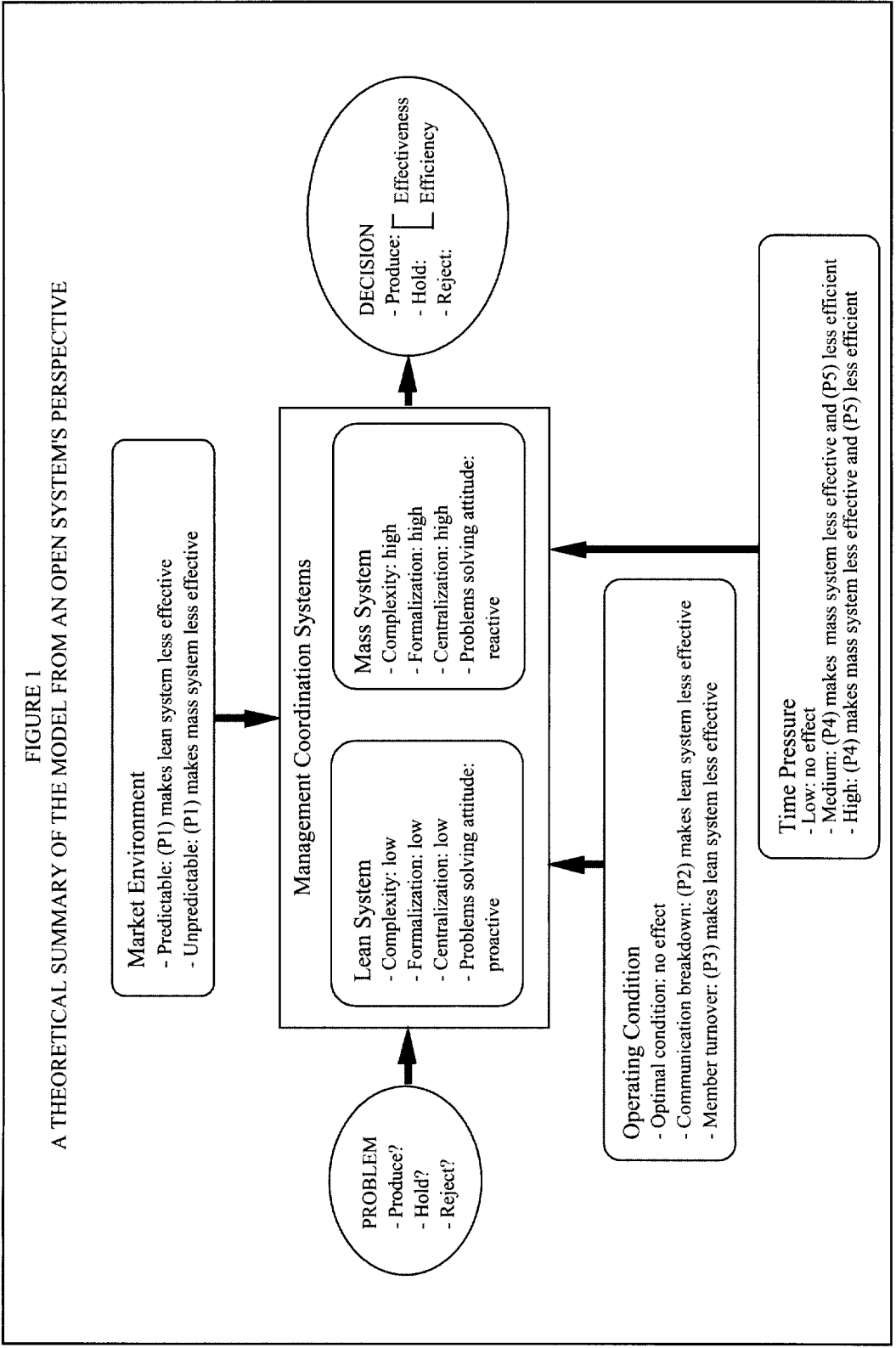
manufacturers. We further argued that the structural aspects of an organization are required to coordinate the various organizational activities and that the cultural aspects serve to coordinate the work orientation of the organizational members. We developed the prototypes for two different organization systems, the lean and the mass systems. The effectiveness and efficiency of each prototype is argued to be contingent upon various environmental conditions, including market environments, time pressure, and internal operating conditions.

As a reminder, it is not our primary purpose in this study to examine how each single aspect of organizational design may have different impacts on an organization's performance. Rather, we would like to examine how two distinctive organization systems perform in different market and internal operating environments. Few studies have examined how different configurations of structural and problem-solving characteristics impact the effectiveness of the overall organization. Thus, our study contributes to an understanding of the interplay between structural design and human propensity to respond in various environments. This is important to the exploration of how organizations, in particular MNCs, may sustain success in both domestic and foreign markets.

MODEL DESCRIPTION

Studies in international business often times rely on archival data or field methodologies. These methodologies have their merits, but no methodology itself can offer a complete picture for the complex real world phenomena under study. For example, archival data rarely captures intra-organizational practices. Hence, researchers on international

FIGURE 1
A THEORETICAL SUMMARY OF THE MODEL FROM AN OPEN SYSTEMS PERSPECTIVE



human resources management design field studies and use questionnaires to collect data (e.g., Rosenzweig and Nohria, 1994). Field studies, however, would have to address the issue of how to enhance response rate from participants (e.g., Jobber, Mirza and Wee, 1991). Jobber and his colleagues found that enclosed incentives in the form of book-marks and nationality of the parent company affected response rate of participants. Studies on international business, however, may benefit from methodologies besides the use of archival data and field surveys. In the present study, we adopt a different methodology — computer modeling. Computer modeling has the advantage of manipulating even complex environmental settings and affording high level of control, which are impossible to accomplish in the real world. Thus, computer modeling can complement results obtained via archival data or field studies and further advance theoretical thoughts by providing a comprehensive and internally coherent model.

In the present study, we model organizations as open systems that are composed of members who can process information with their bounded rationality, but are also constrained by organizational structures and are affected by organizational environments. Through this approach, we can fully control the organizational environment, and generate systemic and precise insights from the model. Due to the page limitation, we will only be able to describe the model mainly at a macro or organizational level. Detailed descriptions of the technical aspects of the model can be found in Lin and Carley (1995, 1997).

Organizational Problems

The problems faced by the organization in this study can be considered as a

series of production decision tasks that require the organization to decide whether to produce, hold, or reject the production of certain products based on information from nine indicators. For example, an auto manufacturer often has to decide whether to produce a new model. The decision has to rely on indicators such as financial status of the company, human resources, technology, customer preference etc. Because of bounded rationality, each member of the organization naturally can only process a limited amount of information, while each one or two single indicators may not provide a complete picture of the situation. Thus, an organization's decision requires coordination among various people who work with different indicators.

Market Environment

In the real world, the correctness of the decision to produce or not can be judged by the market reaction. In this study, we use the advantage of computer modeling and build the true state of each problem in an independent formula, thus we can know the correct decision for each problem situation. With this mechanism, we have the baseline against which an organization system's performance can be compared. In this model, we pre-define two types of market environment. The formula is as follows:

$$\Sigma = T1 + T2 + T3 + T4 + T5 + T6 + T7 + T8 + T9$$

In the formula, each T_i refers to one specific indicator that can take an integer value ranging from 1 to 3, with a bigger number representing a more positive indication toward the decision to produce. By varying all possible values

of nine indicators, the computer model can create a market environment that has a total of 19,683 different combinations of problems. To make the model more concrete, the task of the model can be to determine whether a particular product has the potential to contribute to the overall growth of the company. Each product has nine attributes that are manipulated by the computer program. These nine attributes can be interpreted as factors that include the strategic match with company, growth rate, total investment, cash flow, available technology, available manpower, customer preference, competition, and profitability. For the predictable market environment we define the true state of the problem in such a way that if $\Sigma \leq 13$ then the true decision should be to reject, if $\Sigma \geq 18$ then the correct decision should be to produce, and if other values then the true decision should be to hold. Following this formula, the market environment contains 625 problems whose true decision should be to "reject" (meaning not pursue), 7,647 problems whose true decisions should be to "hold" (wait before pursuing), and 11,411 problems whose true decisions should be to "produce." With the domination of one type of problems whose true state is to "produce." the organization is facing a more certain environment, and may have a less chance of making a mistake if it decides to produce.

For the unpredictable market environment, we use the same formula, but we define the true decision as "reject" if $\Sigma \leq 16$, as "produce" if $\Sigma \geq 20$, and as "hold" if otherwise. With this manipulation, we have a market environment that regards one third of decisions of "reject" as correct, one third of decisions of "hold" as correct, and one third of deci-

sions of "produce" as correct. In this case, the organization may have a tougher time to make the correct decisions when faced with a particular problem because of increased uncertainty.

The manipulations of the market environment are modeled independently and are not known to organizations. Because the organization has no knowledge of the market environment, and the organization's final decision is through coordination of individual members' judgments based on their partial knowledge of each problem, there is a chance that a decision made by the organization can be incorrect with regard to the true state of the problem. Because of such manipulations, we will then be able to examine whether such market environment manipulation has an effect on organizations of different designs.

Organizational Design

Based on the literature review and the objective of this study, the lean organization system is modeled in such a way that it has two levels of hierarchy, with the bottom level composed of three work teams and the top level composed of a management team. Each member in the work team is in charge of making expert judgments based on information from two indicators. Each member first processes the information and selects a middle unbiased value as the individual judgment of the problem, which is also called an operational rule. He/she then communicates the judgment with other members in the same team. A team-level decision is made through a majority vote of all members and is reported to a designated manager. After receiving the team's recommendation, each manager discusses with other managers in the management team. The organiza-

tion's decision is then made through a majority vote of all managers. During the problem solving process, all members in the organization actively look for and process information, and communicate with other members whenever possible (Figure 2).

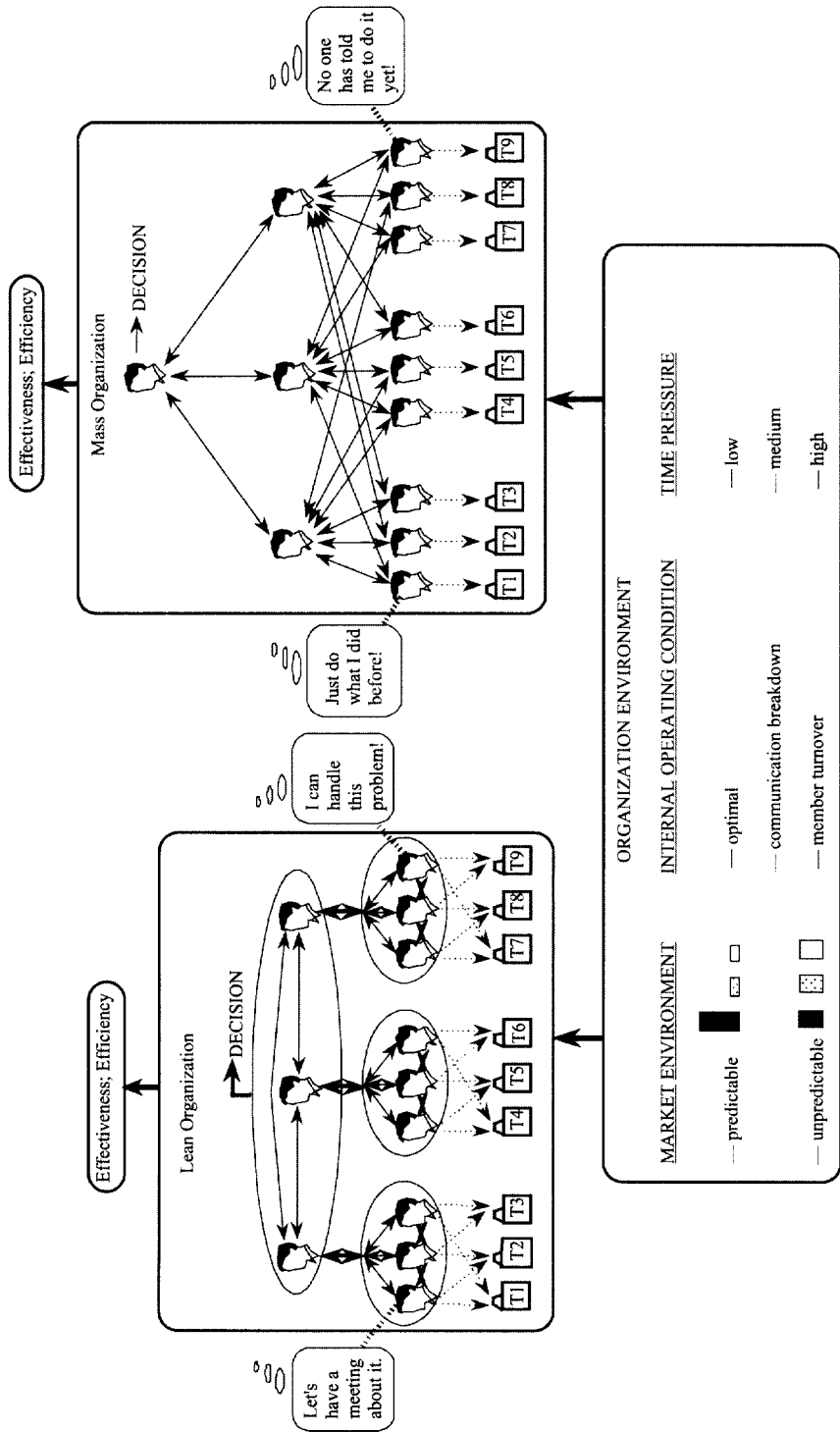
For the mass organization system, three command levels are built. At the bottom level there are nine members working in three small groups/divisions. At the middle level there are three middle-level managers who supervise respective divisions. Between the bottom level and the middle level there are also some overlapped communication linkages between members and managers. At the top level there is one CEO. Each member in the division only processes one component from the market environment. Each member first makes his/her individual judgment using an experiential rule, which is based on aligning the current set of information with a judgment that he/she has been trained to apply for similar sets of information in the past. For example, if he/she sees a piece of information as 1 (high tendency to reject), and his/her previous training tells that given this situation the product actually should hold (2), he/she will then always report a 2. Each member then passes on the judgment to designated manager(s) directly, with no interaction within divisions. Each middle-level manager processes the information received, and makes an individual decision in a similar fashion before reporting his/her judgment to the top-level manager. The top-level manager alone makes the organization's final decision also using an experientially trained rule. During the problem solving process, each member in the organization always passively waits for superi-

ors to give orders before taking any action.

Mass and lean organization systems are thus modeled according to their different structural and problem solving characteristics as described in the literature. The mass organization system is more complex than the lean organization system given its higher levels of vertical and horizontal differentiation in the structure than the lean organization system. The mass organization system is also more formalized than the lean system, in that each member has access to only one task component. In addition, each member in the organization only follows the method that he or she is most familiar with, which has been trained by the organization, and makes decisions purely based on how a similar problem was handled previously. Thus members are restricted by the past experience, and have very limited alternatives and autonomy. In the mass organization system, centralization is high as decisions are concentrated as levels go up. At each level, members of the organization make decisions individually, with the top-level manager making the ultimate organizational decisions. Problem solving attitudes in mass organization system are reactive, in that members in the organization tend not to address problems or engage in problem solving processes until being asked or forced by circumstances (such as time is running out).

In contrast, the lean organization system is modeled to be less complex and less formalized. Problem solving is also not a specialized activity for top management. In the case of the lean system, organizational decision is through the majority vote of the three top-level managers, with all having equal weight. Thus, members share their opinions and

FIGURE 2
ORGANIZATIONAL DESIGNS OF LEAN AND MASS MANAGEMENT COORDINATION SYSTEMS UNDER ENVIRONMENTAL CONDITIONS



have more alternatives and autonomy than that in the mass system. In this system, centralization is low as evidenced by the majority rule. Problem solving attitudes in this system are proactive, in that members in the organization tend to address problems and engage in problem solving processes whenever they see them.

Time Pressure

For each problem we assign certain number of time units that force organizations to make decisions before the

time expires. Time pressure is inversely related to the number of time units. We categorize such that the organization is under low time pressure if it has more than 40 units of time, under high time pressure if it has less than 20 units, and under medium time pressure if it has more than 20 and less than 40 units.

Each member of an organization can take one of the five actions at any time: Asking for information (1 time unit), reading information (the number of time units equals the number of pieces of information), making a decision (the

TABLE 2
A SUMMARY OF POSSIBLE MEMBER ACTIONS IN
DECISION MAKING PROCESSES

<u>Action</u>	<u>Pre-required Action</u>	<u>Time Units</u>	<u>Note</u>
A1: Ask for information		1	Bottom-level members do not need to ask for information as they have no subordinates and have direct access to information.
A2: Read information	A1	I	
A3: Make a decision	A2	2I	For experiential rule.
		I	For operational rule (or take-the-middle-value rule).
		3M	For team majority voting, which includes communicating with members, processing information, and making a team judgment.
A4: Pass up a Decision	A3	1	
A5: Wait		1	Once a member chooses to wait, he or she must wait through the whole time unit.

Note: I = Number of pieces of information. M = Number of members in a team.

number of time units depends on both the number of pieces of information and the decision rule), passing up a decision (1 time unit), and waiting (1 time unit). Certain actions cannot be taken without pre-required actions, and one member's action may depend on the action of another member. For example, in order to make a decision a manager must have first read the information, which depends on whether his or her subordinates have passed up their decisions. This is also summarized in Table 2. Micro-level technical details are beyond the scope of this paper, and can be found in Lin and Carley (1995).

The estimate of time units for each action has been based on studies by Carley and Prietula (1992) and Carley, Prietula and Lin (1998) involving human subjects. In their decision-making experiments, each subject's keyboard actions were recorded, and then the time spent on each action was calculated. Each subject processed 120 problems in about 40 minutes, which is about 20 seconds for each problem. For every problem, a subject read three pieces of information in about six seconds, made an experiential decision in about 12 seconds, and passed the decision to his or her superiors in about one to two seconds. For our study, we consider two seconds as one time unit because if we let x as the number of seconds in each time unit, we have $3x + 6x + x = 20$, or $x = 2$. We use Carley and Prietula's (1992) estimates because the nature of our task is very similar to theirs. We hope this will serve as an empirically based starting point for understanding the effect of time pressure.

Operating Conditions Within the Organization

The third major aspect in the model is the operating conditions that can be

faced by the two organizations. We model three operating conditions within the organization: Optimal condition, communication breakdown condition, and member turnover condition. Under the optimal operating condition, there is nothing wrong within the organization. All information is available and correct, all communication channels are functioning, and all members are doing what they are supposed to do. This condition serves as a baseline against which the effect of sub-optimal conditions can be measured. Under the communication breakdown condition, three randomly chosen communication channels from the operator level to middle manager level are not working, or are completely absent. Thus, three bottom-level operators are unable to report to their superiors designated by the communication structure. Under the member turnover condition, there are three randomly chosen operators who leave the organization and are replaced by three new operators who have received little training. In the lean organization system, new operators will have to make individual decisions based on hunches. In contrast, in the mass organization system, new operators simply report any information they receive to their supervisors without referring to any pre-defined procedure.

Organizational Outcome

We have built functions into the model that can record both effectiveness and efficiency of each organization. Both are important indicators of performance (Williamson, 1980). We first assess the quality or accuracy of the decision, which is an indicator of effectiveness. Accuracy of the decision indicates how well the organization can correctly make decisions as pre-defined by

the market environment. It is measured as the percentage of total correct decisions made by the organization given the total number of problems presented to the organization.

We then evaluate the efficiency of the decision. Efficiency of the decision is represented by the number of rounds of decisions made by the organization for each problem within the given time limit. Because of the dynamic process in the organizations, an organization that can make more rounds of decisions has more chances to choose a final decision.

Summary

The basic framework of the computer model can be summarized in the following function:

$$\text{PERF} = F(\text{ORG}, \text{MAKT}, \text{TIME}, \text{COND}),$$

where PERF is the organizational level outcome, including effectiveness and efficiency; ORG is the organizational design, which can be either for lean or mass organization system; MAKT is the type of market environment, which can be either predictable or unpredictable; TIME is the level of time pressure, which can be low, medium, or high; and COND is the operating condition within the organization, which can be normal condition, communication breakdown condition, or member turnover condition.

Simulation Experiment

To generate the results for testing the propositions, we conducted a series of simulation experiments. We first let each organization go through a training period for one type of market environment, say the predictable one. During this training period, the organization

encounters all 19,683 possible problems in the market environment, and learns from the feedback provided to them. Also, during this period, the organization is in a situation that has optimal operating condition and no time pressure.

After the training period is over, we then immediately put the two organizations in real time situations. Each organization is faced with 1,000 randomly drawn problems while in the same market environment, a specific level of time pressure and a specific internal operating condition. We then present another 1,000 problems to the two organizations with a different level of time pressure and a different internal operating condition. During the performing period, no more feedback is provided to the organizations, and organizational decisions are recorded and compared with the market defined true state.

We do this for both predictable and unpredictable market environments respectively. Through this experimental design, we would have the results of each organization's performance in 18 different situations.

RESULTS

To test the propositions, we look at how the lean organization system and the mass organization system perform under different internal and external conditions. Table A1 of Appendix A lists the problem solving accuracy of both lean and mass organization systems across the market environment (2), operating conditions (3), and time pressure (3), in a 2 x 18 form. In each cell of the table, the percentage of correct decisions and standard deviations are listed so that comparisons across different cells can be readily made. To address our propositions, we focus on specific

cells, and use the t-test as our statistical method, because our main purpose is to compare the two organization systems in different settings.

Market Environment

Let us first look at the results under different market environments (Table 3). The results show that when the market environment is predictable, the mass organization system outperforms the lean organization system in terms of accuracy of decisions regardless of operating conditions within the organization. The differences are all significant ($p < 0.05$). In contrast, when the market environment becomes unpredictable, the lean organization system generally outperforms the mass organization system. The differences are significant under optimal and communication-breakdown conditions ($p < 0.05$). This result supports Proposition 1.

This suggests that the mass organization system can rely on its highly centralized and formalized structure to tackle a market environment that is sta-

ble and is dominated by few dimensions. For example, mass producers saw their biggest successes in the early years of manufacturing when competition was sparse and customer demands were scant. In contrast, the lean producers can use their more active team approach and their members' versatile expertise to cope with a more unpredictable and diverse market environment. This is demonstrated by the fact that the lean organization system became more successful than the mass organization system during the 1980s, when customers' demands for manufacturing products became increasingly diversified, and when global competition became increasingly fierce.

Operating Conditions Within the Organization

We further look at how mass and lean organization systems perform under different operating conditions. We find that certain sub-optimal operating conditions such as communication breakdown (three simultaneous occurrences),

TABLE 3
EFFECTIVENESS COMPARISONS ACROSS MARKET ENVIRONMENTS AND ORGANIZATIONAL OPERATING CONDITIONS UNDER LOW TIME PRESSURE*

<u>Market Environment</u>	<u>Operating Condition</u>	<u>Mass System</u>	<u>Lean System</u>
Predictable	optimal	0.599(0.490) ^{c**}	0.414(0.493) ^a
	comm-down ^{***}	0.616(0.486) ^c	0.412(0.492) ^a
	turnover	0.599(0.490) ^c	0.411(0.492) ^a
Unpredictable	optimal	0.465(0.499) ^b	0.542(0.498) ^c
	comm-down	0.451(0.498) ^b	0.549(0.498) ^c
	turnover	0.465(0.499) ^b	0.458(0.498) ^b
* The mean value in each cell represents the proportion of correct decisions made by the organization for 1,000 problems. Standard deviations are in parentheses.			
** Means having different superscripts (a, b, c) are significantly different at $p < 0.05$.			
*** Comm-down = communication breakdown.			

have virtually no effect on the mass organization system (Table 3). In a predictable market environment, the accuracy of the mass organization system even shows signs of a slight increase when there is communication breakdown. This suggests that the reason why the mass organization system's performance is less successful than that of the lean organization system in dealing with diversified challenges may be partly due to the excessive complexity and redundancy of its formal and rigid communication structure.

As for the lean organization system, when the market environment is predictable, sub-optimal operating conditions do not significantly impact performance either. This suggests that in the lean organization system, limited communication breakdown may be compensated by intensive team work. Overall, the above results do not support Proposition 2.

However, we find that when there are turnovers (three simultaneous occurrences), and when the market environment is unpredictable, the lean organization system becomes much more susceptible and its performance drops dramatically ($p < 0.05$) (Table 3). This suggests that the lean organization system has its own limitations related to the large costs associated with turnover. From the analyses, we also see that the mass organization system is not affected by turnovers. This is because the mass organization system does not rely on sophisticated expertise or team work of its members, and thus can replace low-level workers without adversely affecting quality. The lean organization system, however, depends on team work and sophisticated expertise of its members, and thus places more demands on new members to fit in the high quality

problem solving processes. That may also explain why the lean organization system has become most successful in Japan where a long-term employment policy is practiced.

Table 3 also shows that when the market environment is predictable, turnover does not have a significant effect on either the lean or mass organization systems' performances. This is partly because under the predictable market environment, the lean organization system's performance is already fairly low, and thus may not be as sensitive to the negative effects of turnover. Overall, the results support Proposition 3.

Time Pressure

We now look at how mass and lean organization systems perform under different levels of time pressure (Table 4). Our results show that both mass and lean organization systems are susceptible to time pressure ($p < 0.05$). When the market environment is predictable, the lean organization system is less susceptible to the change of time pressure from low to moderate than is the mass organization system, but the performance of the lean organization system drops significantly with a shift from moderate to high levels of time pressure ($p < 0.05$). In addition, the lean organization system is still outperformed by the mass organization system under each level of time pressure ($p < 0.05$). This does not support Proposition 4.

When the market environment is unpredictable, the lean organization system outperforms the mass organization system under moderate and low levels of time pressure ($p < 0.05$), but not under high levels of time pressure. Both lean and mass organization systems are still susceptible to time pres-

TABLE 4
EFFECTIVENESS COMPARISONS ACROSS MARKET ENVIRONMENTS AND
LEVELS OF TIME PRESSURE UNDER OPTIMAL ORGANIZATIONAL
OPERATING CONDITIONS*

<u>Market Environment</u>	<u>Level of Time Pressure</u>	<u>Mass System</u>	<u>Lean System</u>
Predictable	Low	0.599(0.490) ^{e**}	0.414(0.493) ^c
	Moderate	0.459(0.498) ^c	0.437(0.496) ^c
	High	0.301(0.459) ^a	0.274(0.446) ^a
Unpredictable	Low	0.465(0.499) ^c	0.542(0.498) ^d
	Moderate	0.367(0.482) ^b	0.419(0.493) ^c
	High	0.346(0.476) ^b	0.338(0.473) ^b
* The mean value in each cell represents the proportion of correct decisions made by the organization for 1,000 problems. Standard deviations are in parentheses.			
** Means having different superscripts (a, b, c, d, e) are significantly different at $p < 0.05$.			

sure ($p < 0.05$). The results suggest that the lean organization system can survive better under time pressure than the mass organization system only when the market environment is unpredictable. This partly supports Proposition 4.

The superiority of the lean organization system is thus only evident under an unpredictable market environment with low or moderate pressure. This may partly explain the success by Japanese style lean producers, who favor low centralization, low formalization, and active team work, when the world manufacturing competition started to become fiercer and more time sensitive during the 1980s. However, the results also suggest that Japanese style lean producers may lose their advantages when the time pressure becomes too high for effective team work.

Efficiency

Finally, we look at the efficiency of the mass organization system and the lean organization system (Table 5). Before discussing the table, we first look

at the minimum number of time units each organization system takes for making a complete round of non-pressured decisions as constrained by its organizational design. According to our model, in the mass organization system, the top-level manager takes one time unit (1) to ask for information when receiving the problem. A middle-level manager takes one unit (1) to read the order from the top-level manager and then another unit (1) to ask for information. A bottom-level operator takes two time units (2) to read orders from two middle-level managers, then one unit (1) to read one piece of information, two units (2) to process information and make judgment, and one unit (1) to pass up the result. A middle-level manager then takes six time units (6) to read results from the six operators under his/her supervision, twelve units (12) to process and make a decision, and one unit (1) to pass up the decision. The top-level manager takes three time units (3) to read decisions from three middle-level managers, six units (6) to process information and make a decision, and one

unit (1) to pass up the decision. In total, the mass organization system will need at least 38 time units to make the first round of organizational-level decisions.

In the lean organization system, there are only two levels in the hierarchy. A top-level manager takes one time unit (1) to ask for information when receiving the problem. A bottom-level operator takes one time unit (1) to read the order from the top-level manager, two units (2) to read two pieces of information, two units (2) to make an initial personal decision using the operational rule (take-the-middle-value rule), nine units (9) to communicate with team members, process information and make a team judgment, and one unit (1) to pass up the result. A top-level manager then takes one unit (1) to read the passed-up decision, one unit (1) to make an initial personal decision, nine units (9) to communicate with other top-level managers, process information and make a team decision, and one unit (1) to pass on the decision. In total, the lean organization system will need at least 28 time units to make the first round of decisions.

The results in Table 5 show that when time pressure is high, both mass and lean organization systems can only make one round of decisions for the final organization decision, which is basically a random guess. The mass organization system, because of its reactive problem-solving attitude, tends not to pursue problems actively. Thus, it will stop at making one round of decisions for the final organization decision until a new problem forces it to make another decision.

When time pressure is moderate, the lean organization system can process an average of 1.45 rounds of decisions to reach a final decision. When time pres-

sure is low, the lean organization system becomes much more efficient than the mass organization system, as the lean organization system can process 3.11 rounds of decisions for each final decision ($p < 0.05$). The analyses suggest that the lean organization system may be more successful than mass organization system when time pressure is low, because the lean organization system is more efficient and has more chances to review the options before making final decisions. The results support Proposition 5. This may also provide supporting information regarding why the lean organization system can adopt a just-in-time mode of operation system, which demands timely responses.

Summary

The results have presented some support for the propositions we have listed, except Proposition 2. Our analyses have demonstrated that the lean organization system's advantage over the mass organization system is situation specific. Though the lean organization system can generally perform better than the mass organization system when the market environment is unpredictable, and when the time pressure is not too high, it suffers more from member turnover. The mass organization system, on the other hand, shows its advantages when the market environment is predictable. It is also resilient to either communication disruption or member turnover.

DISCUSSION

Our study represents a first step toward generating theoretical understandings of lean and mass organization systems – two important types of organizations originated from two different cultural environments – from a manage-

TABLE 5
EFFICIENCY COMPARISONS IN TERMS OF THE NUMBER OF ROUNDS OF
DECISIONS ACROSS LEVELS OF TIME PRESSURE UNDER OPTIMAL
ORGANIZATIONAL OPERATING CONDITIONS*

<u>Level of Time Pressure</u>	<u>Mass System</u>	<u>Lean System</u>
High	1.00(0.00) ^{a**}	1.00(0.00) ^a
Moderate	1.00(0.00) ^a	1.45(0.95) ^b
Low	1.00(0.00) ^a	3.11(0.95) ^c

* The mean value in each cell represents the average round of decisions made by the organization for 1,000 problems. Standard deviations are in parentheses. The number of rounds of decisions is constant across different market environments.

** Means having different superscripts (a, b, c) are significantly different at $p < 0.05$.

ment coordination perspective. With the modeling of organizations of intelligent members, we demonstrate the importance of considering the effects of the different structural characteristics between mass and lean organizations on their problem solving proficiencies and how the market environment and the operating conditions within the firm interact to affect the relative effectiveness of lean and mass organization systems. We particularly find that some of the common perceptions regarding the superiority of the lean organization system may be misplaced. Our study calls for organizations, in particular those MNCs, to understand better various environments of today's world before rushing into the lean production, as different personnel, market and cultural conditions can pose different challenges. This study has general implications not only for lean and mass organization systems, but for other similar forms of organizations as well.

Our study suggests to organizations, especially mass producers, that they should first have a clear understanding of the market environment they are facing before abandoning their traditional design and jumping onto the bandwagon

of the lean design. When the environment is predictable, meaning that it is not diversified or complex and that it requires little interaction between workers, the mass organization system, which is designed with strict hierarchical structure, high division of labor, and rigid decision making procedure, can still be fairly effective. Indeed, the mass organization system was designed to handle decomposable, simple, and repetitive tasks, and there is no wonder why mass production is still the predominant production method (Womack et al., 1990). However, as customer demands become more varied and tasks become more unpredictable, the lean organization system enjoys distinct advantages over the mass organization system in terms of problem solving proficiencies. This is because the lean organization system emphasizes team based majority voting procedure and more versatile skills of members. It is designed more as a generalist system for a more widely defined niche (Hannan and Freeman, 1977; Carroll, 1984). Each member's individual experience is no longer as important. Instead, the collective effort of the team or the entire organization becomes the primary drive for

effective decision making, as confirmed in other cross-cultural studies (Hofstede, 1984; Triandis, 1989). This gives the organization the leverage to handle more diverse types of problems.

The result that the lean organization system can fend off disruptions of limited communication breakdowns suggests that organizations should be aware that they do not always have to design a complex structure to deal with today's diversified and unpredictable environment. As long as such communication disruptions can be limited to a small scale and a low level, a simpler and thus less costly design may be just as beneficial. Of course, as organizations vie for economies of scale, their sizes may increase dramatically, and structures will become much more complex. This increasing trend toward larger organizations may also result in more communication barriers between the different sectors of an organization, and in turn result in more communication breakdowns with which the organization may not be able to deal effectively (Perrow, 1984). The benefits of a simpler design would, however, have to be balanced against the high selection, socialization and training costs of lean organizations. Lean producers are known to invest heavily in selecting the right person, retaining the right people for a long time if not for life, and socializing and training the employees (Imai, 1991). This may pose a new challenge to management researchers and practitioners, especially when decisions begin to bear increasingly severe consequences to an organization's survival (Roberts, 1990; Rochlin, 1991).

That turnovers may affect lean producers more than mass producers may not be good news for lean producers. This suggests that the lean organization

system, which has a strong reciprocal interdependence among members, may have to endure a larger cost associated with member turnover. The mass organization system, though it may be outperformed by the lean organization system in an unpredictable market environment, is more tolerable of member turnovers, given its high division of labor and rigid decision procedures. This may partly explain why mass producers still hang on to their more traditional production methods given the fierce competition of today, and why the lean organization system has also witnessed some integration of mass production methods. Our study has thus pointed out that it may be very important for organizations to consider the tradeoff of having a lean design, especially if the labor market is not stable and the turnover rate is high, because such an environment may require organizations to have a highly efficient but often costly training program for their employees as well.

Our study has also suggested that organizations should pay attention to time pressure by further training and increasing the efficiency of their operations, because as time pressure increases, the advantage of having a lean design may disappear quickly. This problem may, however, be alleviated in real world situations as lean organizations do not use teams for all decisions. For example, in emergency situations, or when time pressure mounts, lean organizations may enhance efficiency by being more centralized.

The performance of the lean and mass organization systems under different situations in the present study has implications for real world organizations. For example, we can suggest to mass producers that to succeed in a competitive

and diversified global market, a decentralized hierarchy in structure and a proactive attitude toward problems may enhance their learning and adaptation capabilities. This has been demonstrated in the recent comebacks by the big three automakers in the U.S.

Our study has also indirectly addressed the issue of slack resources (Aoki, 1990; Ludwig, 1993; Song, 1995). Both lean and mass organization systems face the task of slack resource management. While lean organization systems encompass slack resources through the training of multi-skilled members and team decision, the mass organization system focuses more on using redundant complex structures. As a result, they yield different results when facing different types of environments (Ludwig, 1993; Clark, Varadarajan and Pride, 1994).

A related theoretical point deals with the boundary of lean and mass organization systems. As discussed above, we define lean and mass organization systems in a way that may be less satisfactory than most people would like to see. This is particularly the case if there are variations in the structural characteristics of the two prototypes. As distinct and different as Womack et al. (1990) would like to portray lean and mass productions, it is not entirely easy to treat lean and mass organizations as having mutually exclusive characteristics. Womack et al. coined the term lean because they suggest that the lean production requires less of everything than the mass production. But in practice, lean organizations invest heavily in their employees. Thus, we would not argue that lean and mass productions are mutually exclusive, even though they have very different philosophy and practice in some areas of management.

Rather, we treat lean and mass producers as two prototypes of organizations differentiated on their structural and problem solving characteristics. We believe that by comparing these prototypes across different environments, we would gain more insight into how these two types of organizations function, thus generating implications for a broader range of organizational issues in international management. Furthermore, such an examination will also shed light onto other similar forms of organizations.

Among other things, the present research demonstrates the utility of computer modeling techniques in studying management issues and helping build organizational theories. With the ability to model the structural and problem solving characteristics of lean and mass organization systems using a meso-approach, we have shown how the two organization systems perform in different situations. Computer simulation has been used extensively in many areas, but far less, perhaps, in the area of international business and management. Computer simulation as an extension of human cognition can grasp the fundamental nature of human information processing behavior (Simon, 1973). Compared with natural language and mathematics, computer simulation offers an alternative tool with both the power and flexibility for studying complex, interdependent, and dynamic social systems (Hanneman, 1988; Ostrom, 1988). With continued efforts by various scholars, we believe we can achieve more success with the application of this powerful tool in the studies of international business.

While we have learned much from the new insights in this study, we must also remind ourselves of the limitations.

For example, we have confined our model to an extreme case of two traditionally distinctive organizations, while there may be cases where some features from both lean and mass organization systems can co-exist within one system. This will require our additional fine-tuning of the model to better resemble the real world organizations. We have also limited ourselves to a narrow set of performance indicators and ignored some of the potentially important ones, such as job satisfaction and product quality. The results from this model should be further tested in empirical studies, which in turn can provide additional guidance for the improvement of the model. Furthermore, because the present study is an exploratory one on how the structural and the cultural coordination mechanisms combine to affect the effectiveness and efficiency of two organization systems in various environmental conditions, we have not examined directly how each aspect of management coordination affects organizational effectiveness and efficiency. Future research may continue to examine this issue on a more microscopic level. Different types of coordination mechanism may be better suited for different functions and environments. Thus, there may be differential contributions of individual aspects of the coordination mechanisms at the subsystem level, besides the system level. Future research may assess how the system and the mechanisms function together to affect organizational effectiveness.

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APPENDIX A

TABLE A1
EFFECTIVENESS FOR MASS AND LEAN ORGANIZATION SYSTEMS ACROSS
TYPES OF MARKET ENVIRONMENTS, LEVELS OF TIME PRESSURE, AND TYPES
OF OPERATING CONDITIONS WITHIN THE ORGANIZATION*

<u>Market Environment</u>	<u>Time Pressure</u>	<u>Operating Condition</u>	<u>Mass System</u>	<u>Lean System</u>
Predictable	Low	Optimal	0.599(0.490)	0.414(0.493)
		Comm-down **	0.616(0.486)	0.412(0.492)
		Turnover	0.599(0.490)	0.411(0.492)
	Moderate	Optimal	0.459(0.498)	0.437(0.496)
		Comm-down	0.450(0.497)	0.413(0.492)
		Turnover	0.459(0.498)	0.379(0.485)
	High	Optimal	0.301(0.459)	0.274(0.446)
		Comm-down	0.290(0.454)	0.330(0.470)
		Turnover	0.301(0.456)	0.351(0.477)
Unpredictable	Low	Optimal	0.465(0.499)	0.542(0.498)
		Comm-down	0.451(0.498)	0.549(0.498)
		Turnover	0.465(0.499)	0.458(0.498)
	Moderate	Optimal	0.367(0.482)	0.419(0.493)
		Comm-down	0.385(0.487)	0.415(0.493)
		Turnover	0.367(0.482)	0.370(0.483)
	High	Optimal	0.346(0.476)	0.338(0.473)
		Comm-down	0.309(0.462)	0.319(0.466)
		Turnover	0.346(0.476)	0.375(0.484)
* The mean value in each cell represents the proportion of correct decisions made by the organization for 1,000 problems. Standard deviations are in parentheses.				
** Comm-down = communication breakdown.				