Implementing the Learning Organization: 
The Application of Systems Thinking Tools to 
Product Development in a Manufacturing Firm

by

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ABSTRACT

This thesis is concerned with the promotion of organizational learning in the context of product development projects. Both rapid product development cycles and increases in the rate of organizational learning will be crucial for corporate success in an economy characterized by shrinking product lifecycles, globalization, and rapid technology transfer and change. Thus, the improvement of learning in product development teams should be an important leverage point for corporate performance.

The work described here was done as part of a broader program of research at the Center for Organizational Learning aimed at investigating how learning and systems thinking can best be fostered in a corporate setting. The research was conducted at a North American manufacturer of consumer durable goods ("Company Z") for publication purposes.

The thesis reviews the literature concerning product development process management and improvement. Then, the unique aspects of the Center's research methodology are described and related to the product development process. The tools and techniques employed are discussed, as well.

In the final section, the project itself is described. As the research is expected to continue for 12-18 months past the data of this publication, the conclusions are necessarily preliminary. Future challenges for this sort of research are examined at the end of the thesis.

Thesis Supervisor: Peter M. Senge
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Implementing the Learning Organization:

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Section 1: Introduction

1.1 Why This Thesis?

This thesis is concerned with the promotion of organizational learning in the context of product development projects. Both the topic of new product development and that of organizational learning have generated much interest recently among academics and managers. As shown below, both areas are also seen as crucial to the improvement of firms' competitive positions. The intersection of the two areas should thus offer an important "leverage point" for improving corporate performance.

My work describes a project carried out at an American manufacturer of consumer durable goods (Company Z for the purpose of publication) as part of a larger program of research conducted by the Center for Organizational Learning. The Center aims to conduct academic research on how to build learning capabilities within organizations while investigating problems that are central to its sponsoring firms' competitiveness. This dual goal translates into the dual focus of this thesis.

In the first section I will emphasize the key role that both product development processes and organizational learning play in determining a firm's success. In the second part, I will examine previous approaches used for the study of product development, with the objective of showing the multiple perspectives that can be taken on the subject. Next, I will describe the methods used in this project, highlighting the unique features of the approach, the body of work upon which it is based, and the reasons why it is appropriate for the analysis of product development in particular. Finally, I will describe the structure of the project at Company Z, and offer initial results showing both the key issues identified and my impressions of the
effectiveness of the research methodology. As the project is ongoing\(^1\) and I have been involved only in the early stages, the data is necessarily preliminary. However, I will also attempt to provide insights into the future challenges for both this project and for similar academic-business research partnerships.

1.2: **Why Examine Product Development**

"Product development," as used here, refers to the process by which an organization designs and markets a new product or redesigns and improves an old one. Typically, three broadly defined functional groups are involved in this process: design engineering, manufacturing, and marketing. The scope and extent of the process vary widely across firms, depending on the complexity of the product involved.

Redesigning the product development process to increase the rate of new product introductions, to improve the quality of products marketed, and to reduce cost throughout a product's lifecycle is a key concern for companies in a wide range of industries. As Professor Kim Clark (1990) has written, "Developing high-quality products faster, more efficiently, and more effectively tops the competitive agenda for senior managers around the world." The importance of product development has also been highlighted by several studies of national "competitiveness."\(^2\) Managers' concerns have been further documented by survey research. Gupta and Wilemon report that 87% of the managers they surveyed felt increased pressure to develop

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\(^1\)It is expected to last for 12-18 months.

new products faster. (1990, p.29) Finally, the story has also been picked up by the business press.

Those who grasp the new calculus, who appreciate the unprecedented advantages of getting new products to market sooner and orders to customers faster, may well hold the principal tool for achieving competitive preeminence in coming years. (Dumaine, 1989, p. 55)

Apple CEO John Sculley has said, "Companies that can quickly get information and ideas through their organizations for discussion and action will have a distinct competitive advantage over others." (Lorenz, 1991, p. 14) Thus, it can be seen that product development performance constitutes a key strategic variable for management.

What forces are driving this need to improve the functioning of the product development process? There are a number of changes in markets, the economic environment, and the nature of competition that provide an answer to this question. First, product lifecycles are shrinking across a broad spectrum of industries. This means that new designs become stale faster and new functionality is rapidly surpassed by competitive introductions. Second, competition is becoming more global. There are both worldwide markets and, increasingly, worldwide competitors. Ohmae (1990) states that in the "interlinked economy" (the world's industrialized and newly industrializing countries) products must be introduced almost simultaneously across the globe. Because customers everywhere are demanding similar quality and functionality, companies no longer have the luxury of extending product lives by pushing old products into new geographic markets. The rate of technological change has accelerated, and the increasing speed of dissemination of technological advances has compounded this effect. As a

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3 Rosenau (Faster New Product Development) provides evidence of this trend which is also confirmed by many other observers.
result more companies can access new technologies faster, and innovations
can be rapidly emulated. This means that advantages based on (currently)
superior technology can be short-lived. (Gomory, 1989) Finally, markets are
becoming more fragmented as marketers identify finer segmentations of
behavior and needs. Such niche markets place greater demands on firms to
develop a higher variety of differentiated products in order to hit more,
smaller targets.

What are the implications of these trends? The opportunity costs of
being late to market can be very high. A recent analysis by McKinsey & Co.
showed that "high-tech products coming to market six months late but on
budget earn 33% less profit over five years. In contrast coming out on time
but 50% over budget cuts profits only 4%." (Gupta and Wilemon, p.25.)
Globalization forces firms to be ready to roll out new products on a wide scale.
It also means that firms must monitor a larger, more disparate group of
competitors and markets. They must understand the requirements of buyers
in multiple countries in order to decide whether or not to tailor product
designs to local needs. Rapid technological change, the free flow of
information, and the growth of niche markets place a premium on firms'
ability to rapidly introduce incremental product changes that maintain
differentiation and match features to changing customer preferences.
Management commentator Tom Peters (1991) advocates the view that
"Whoever you are, you're increasingly in the fashion business." Peters sees
several imperatives for success in such an environment. "Sluggish"
functional units must be broken into self-contained teams focused "on the
fragile, fleeting task at hand." Channels for free information flow must be
opened both within the firm and in the company's "extended family" of
suppliers, distributors, and customers. Blame and risk aversion must be
overcome in order to encourage experimentation and rapid decision making. This sort of rewiring is required to build an organization capable of coping with the new, chaotic environment.

These changes in markets place great pressures on product development organizations to move quickly, process vast quantities of information, and restructure themselves. If they succeed in meeting these challenges, however, great rewards are available. Stalk and Hout (1990) list a number of advantages of shorter development cycles:

- Higher margins due to premium pricing opportunities
- Lower development costs due to reduced rework/delay
- Faster realization of cost reduction opportunities and more rapid introduction of new component technologies as old models are turned over faster
- Improved quality due to better design integrity
- Ability to set standards and lock up leading-edge customers
- Improved, more challenging work environment for development team members
- Improved "sense of control over one's destiny" as "vicious cycles are broken" and "customer needs can be forecast over a shorter time horizon." (Stalk and Hout, pp. 133-134.)

Companies that can transform product development into a competitive weapon by iterating rapidly and consistently through the design cycle have created an important corporate capability. Writing recently, Stalk, Evans, and Shulman (1992) advocate the concept that such capabilities will be the key determinant of competitive advantage. They emphasize that, in light of the environmental shifts discussed above, how a firm competes is more strategically significant than where it competes (whereas the reverse was assumed in the "industry structure" focused model of competition that has been the dominant strategic paradigm). Thus, a strong link can be established between superior performance in product development and superior

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corporate performance. This is why enhancing product development capabilities has proven to hold a strong interest for the sponsoring firms of the Center for Organizational Learning.

1.3: Why Examine Organizational Learning?

Ray Stata, CEO of Analog Devices, has attempted to define organizational learning through a comparison with individual learning. Like individual learning, organizational learning involves "new insights and modified behaviors." (Stata, 1989, p. 64) Yet, there are several key differences. One lies in the fact that organizational learning is necessarily a group process, relying on "shared insights, knowledge, and mental models." The second is that instead of human memory, the firm must make use of "institutional memory" to retain insights. Institutional memory mechanisms include "policies, strategies, and explicit models." Stata believes that such learning mechanisms are so crucial that he has said, "... I would argue that the rate at which individuals and organizations learn may become the only sustainable competitive advantage, especially in knowledge intensive industries." He also argues that learning accumulates as a function of time, not of cumulative volume. Thus, only by making structural and behavioral changes that accelerate the rate of learning can a firm which is behind catch a leader in accumulated knowledge.6 It is also important to note that, under this view, rapidly learning competitors are much harder to spot on a firm's "radar scope" since they are not necessarily found as market share leaders.

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5Emphasis added.
6Note that "knowledge" here is broadly defined, incorporating not merely "facts" but other forms of learning such as a "tacit" understanding of processes and markets.
Like the product development cycle, organizational learning has merited much attention from both management practitioners and researchers. Arie De Geus, former head of planning for Royal Dutch/Shell has stated that the "critical question" in the practice of corporate planning has become,"Can we accelerate institutional learning?" (De Geus, 1988) Shoshana Zuboff, has stated, "... learning becomes the axial principle of organizations. It replaces control as the fundamental job of management." (Stewart, 1992, p .94) This echoes the position Peter Senge (1990c) expressed in his article "The Leader's New Work: Building Learning Organizations." Hayes, Wheelwright, and Clark (1988) also cite learning (as an output of continuous improvement processes) as "the one common denominator in high-performance plants" and the key to the revitalization of American manufacturing industries.

As demonstrated by these statements, in the rapidly shifting economic environment faced by firms today, learning is crucial both to cope with day-to-day fluctuations and to adapt to significant environmental changes. This type of learning is needed for survival and is wired into the routines and standard operating procedures of the firm. Yet, Senge has defined a "learning organization" not as one increasing its capacity "merely to survive," but as one "that is continually expanding its ability to create its own future." (1990a, p.14) This ability requires a different type of learning, "generative learning." Generative learning "enhances out capacity to create." (p. 14) It allows people to "see more deeply how their actions can influence their reality."(1989b, p. 5) It is to enhance generative learning capability which requires the converging
skills found in all of Senge's "five disciplines," that is primary objective of the research I will describe below.

While much has indeed been written about the importance of learning in organizations, little field research has been conducted on the implementation of mechanisms to promote learning. This is one of the key motivations behind the creation of the Center for Organizational Learning at the MIT Sloan School. If corporations and other organizations are to realize the benefits that learning holds, a better understanding of how to build learning capacity is needed. This, then, was the driving force behind the choice of the research goals for this project.

1.4: Understanding Product Development As A Learning Process

A number of authors have described product development as a learning process or discussed it in the language of learning. For example, Adler, Wheelwright, and Riggs (1989) have cited support for learning as a "top priority for management" in enhancing product development capabilities. They characterize development projects as "opportunities for team member learning, project management learning and, perhaps most important, organizational learning."

Maidique and Zirger (1985) have developed a model of the "new product learning cycle" that involves three types of learning, each with a different locus. "Learning by using" takes place in the customer base as buyers gain experience with a product. "Learning by doing" occurs and as the firm

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7See Section Three for a brief description of the disciplines. For a complete discussion, see Senge (1990a).

8One of the few field projects carried out, the "Claims Learning Laboratory" at Hanover Insurance, is described in Peter Senge, The Fifth Discipline, p.326-32. and in Peter Senge, "Catalyzing Systems Thinking In Organizations." in Advances in Organization Development. Ed. F. Masarik. Ables Publishing, 1990.
manufactures greater volumes of the product and is based on the theory of
the "experience curve."9 "Learning by failure" takes place as managers
launch successive generations and variations of products into the market and
gain a better understanding of the development process and market responses
by identifying "failure patterns" and "weak links in the organization." This
third concept of learning comes closest to the flavor of organizational
learning that this project hopes to enhance. However, Maidique and Zirger
focus on learning effects across projects, while we emphasize the importance
of learning within project teams, as well.

Meyers and Wilemon (1989), in contrast, direct their attention toward
"intra-team learning" and the mechanisms by which it can be reinforced,
documented, and transferred. Drawing on the work of Argyris and Schön10,
they make the key distinction between learning "aimed at adjustment or
adaptation" and learning that involves "discontinuous organizational change
of attitudes and norms as well as actions." Both of the learning modes are
needed by organizations, and mechanisms must be put in place to support
both.11 This concept of learning fits closely with the flavor of learning
emphasized in the Learning Center's pilot research efforts.

Imai, Nonaka, and Takeuchi (1985) argue that learning is central to
Japanese firms' product development success. They depict product
development as an interplay between "learning" and "unlearning." Learning
occurs within and between "self-organizing product teams" in "a highly

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9 See Henderson (1972) for a discussion of experience effects.
10 Described in Section Three of this thesis. For a deeper explanation see Chris Argyris and
Donald Schön, Organizational Learning: A Theory of Action Perspective. Reading, MA:
11 Typically, organizations have a more developed capacity for the first sort of learning (what
Argyris and Schön have called "single-loop learning." Capacity for the second mode, "double-
loop learning," is more difficult to foster because of the implicit threat to standard ways of
thinking and operating.
adaptive and interactive manner." The authors characterize the five companies studied in their research as possessing "an almost fanatical devotion to learning." "Unlearning," on the other hand, is akin to "double-loop learning" in that it involves a continuous process of reflection on and reevaluation of prevailing structures and views.\textsuperscript{12} This prevents the development process from "becoming too rigid," and provides a mechanism for continuous improvement.

Based on these varied perspectives on the product development process, it is clear that an important "intersection" exists between the topics of organizational learning and product development. Learning can be an important "byproduct" of the product development effort, enhancing understanding of both the firm's markets and its internal processes. Judging by the importance placed on product development and organizational learning by those viewing them in isolation, this intersection should provide an extremely powerful leverage point for focused effort to improve organizational performance.

1.5 Project Objectives

The goal of this project is emphatically not to teach Company Z structured methodologies for better product development. The sponsors of the Learning Center are already highly knowledgeable concerning the "how to's" and "best practices" of product development. Instead, the goal is to examine the reasons behind why recurring problems exist in firms that "know what to do." Evidence shows that many firms are in this situation. Gupta and Wilemon's survey data indicate that while 88% of managers face

\textsuperscript{12}Imai, Nonaka, and Takeuchi characterize this as a process of "creative destruction," borrowing the phrase from the economist Schumpeter.
increasing pressure to accelerate development cycle, 87% report that, despite increased attention to product development, the problems of the past persist in their firms. (1990) As Meyers and Wilemon (1989) point out, this persistence of error is an indicator that learning is not taking place. Our focus is thus placed on helping managers to "learn to learn," and thus to identify, understand, and remove the obstacles to learning and change. As a product development manager from one of the Center’s sponsoring companies said, "There is a lot of stuff out there that will tell you what to do, but not much to tell you how to do it." Improving learning capacity and the learning rate will be a key to shrinking product development cycles and to improving the quality of the process (and, hence, the product and component designs it produces). Such an enhanced product development capability should translate into an acceleration of firm performance improvement and a heightened capacity to respond to competitor actions, changes in customer needs, and technological advances.
Section 2: Review of Previous Approaches Taken to the Study of Product Development

2.1 Overview

Product development has been analyzed from many perspectives, using many different research methods. This section will provide a brief, cross-sectional review of the body of research on the product development process. These studies have been separated into several categories. "Best Practices/How To's" offer advice on how "world class" firms have organized and managed their product development efforts. These are typically normative in style and prescriptive in tone. "Empirical" studies are based on well-defined research methodologies and involve the study of a sample of firms or managers. These have been further segmented into three areas based on the functional perspective and focus of the author: Operations Management, Organizational Behavior, and Marketing. Finally, "Process Oriented" approaches use methodologies involving intervention in the product development process to attempt to study and improve it. Two types of process oriented studies are distinguished, Organizational Development methodologies and Total Quality Management approaches. Studies of each of these types are discussed in order to contrast them with the approach chosen by the Center for Organizational Learning.¹

2.2: Best Practices / How To's

There have been a number of recent books aimed at managerial audiences that offer guidance on how to organize and manage product development efforts. Examples of these are Rosenthal (1992), Smith and Reinertsen (1991), and Rosenau (1989). In addition, management consultants

¹Described in Section 3
Stalk and Hout (1990) and Roussel, Saad, and Erickson (1991) while not focusing exclusively on the product development process, devote significant time to new product issues. Almost all of these authors appear to draw heavily on concepts discussed earlier by Imai, Nonaka, and Takeuchi (see Imai, Nonaka, and Takeuchi 1985, and Takeuchi and Nonaka 1986) in their widely cited descriptions of Japanese product development efforts.

There appears to be a broad consensus among these authors regarding the shape of "world class" product development systems. These characteristics are summarized here (in no special order):

- **Balance between four performance objectives:**
  - Development Speed
  - Product Cost
  - Product Performance
  - Development Program Expense

- **Use of "concurrent" or "simultaneous" engineering - placing as many tasks in parallel as possible**

- **Empowered, cross-functional teams (reporting to a product or program manager with a high level of experience and respect in the organization)**

- **Colocation of project teams for enhanced communication and informal interaction**

- **Design for manufacturability to minimize product complexity and smooth transfer into production**

- **Use of project management tools and software to schedule activities and highlight dependency relationships**

- **Elimination of approvals and "signoff" steps (replaced by decentralized authority and informal involvement and information sharing with senior management)**

- **Early involvement of top managers, before the design specifications are set and the opportunity to influence design goals and costs drops**

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2Adopted from Smith and Reinertsen, but also found similarly in several other works.
• Emphasis on the customer interface - via market research techniques or structured approaches such as Quality Function Deployment (see below)

• Pursuit of incremental improvements to respond more quickly to the market, maximize learning through iteration, and minimize the risk of individual projects

• Use of "post mortems" to analyze projects' performance vs. objectives and to make lessons learned explicit

In addition to these common themes, several authors attempt to show how the redesign of product development methods relates to other management thrusts such as "time-based competition" (Stalk and Hout, 1990), "world class manufacturing" (Smith and Reinertsen, 1991), and "total quality management" (Rosenthal, 1992).

To support efforts to reduce the development cycle, House and Price (1991) offer a set of metrics for tracking product development projects. These measures, used at Hewlett-Packard, include "break-even time" (BET), the span until the project is cash positive, and "time-to-market," the time from the start of commercial development until the product is released to manufacturing.

Krubasik (1988) cautions managers to "customize" the product development approach chosen based on factors related to product and the competitive environment. Specifically, he states that two key variables, the opportunity cost of not reaching the market within a certain time window and the "development risk" (i.e. technological complexity and "newness") of the project, should determine the way in which resources are allocated and projects are structured and managed. This is in contrast to most of the authors cited above who advocate "one best way" to achieve development success.
While offering helpful models and insights and perhaps providing a vision of an idealized product development system, these studies have inherent limitations. Best practices examples and anecdotes about "how the Japanese do it" typically focus heavily on the "what" of product development and give little attention to detailed analysis of how new methods can be introduced into the complex realities of functioning organizations. Similarly, benchmarking can be a valuable tool, but it only describes an achievable level of performance, not a viable method of reaching that level or a sustainable rate of improvement and learning. Discussing best practices perspectives on management innovations, Senge has stated, "...such descriptions can do more harm than good, leading to piecemeal copying and playing catch-up. I do not believe great organizations have ever been built by trying to emulate another, any more than individual greatness is achieved by trying to copy another great person." (Senge 1990a, p.11) Thus a need exists for a deeper understanding of the realities of product development in real organizational contexts. Such an understanding is the goal of many of the "empirical" studies examined in the next section.

2.3: Empirical Studies

Operations Management: Product development can be viewed as a process by which value is added to and "work" is done on information of various types. Rosenthal (1992) highlights this aspect of the development process, stating that it constitutes a "series of decisions that combine to transform an initial [conceptual] product into a physical reality." (p. 7) Because of the focus on the mapping of flows and the examination of processing stages, I have labeled this an "operations management" view. Several studies of product development have adopted this "information perspective." By far the most
extensive and detailed is the research on product development performance in the automotive industry conducted by Clark and Fujimoto (1991) whose work also forms the basis for the section on design in Womack, Jones, and Roos' (1990) broader study of the auto industry. The authors studied projects in 20 firms over a six year period, basing their work on a view of product development as a "process by which an organization transforms data on market opportunities and technical possibilities into information assets for commercial production." (Clark and Fujimoto, 1991, p.20) They findings are summarized by four "themes":

- Superior performance is reflected in measures of leadtime, engineering productivity ("the hidden source of variety and responsiveness") and "product integrity" (which they define as a coherent design whose total "consumption experience" matches customer expectations.)

- Integration is crucial to development success. This requires "overlapping in time, space, concept, skill, language, methods, attitudes, and philosophy" within and between the team and the rest of the organization. It also necessitates caution against "overspecialization" and is promoted by the use of simple, flatter organizations.

- Customer expectations must be funnelled into the process. This entails use of "heavyweight product managers" that "champion" the product concept and have an "intuitive sense of . . . future customers' needs." It also requires broad access to customers and market data by those at all levels on the team.

- "Manufacturing for design" can help improve the design process. The existence of analogs in design processes for manufacturing measures such as inventory, throughput, and rework means that firms that excel at just-in-time production and total quality management also can apply these to development effort. (Clark and Fujimoto, 1991, pp. 338-345)

Other authors who have examined product development from an "operations management" perspective include Larson and Gobeli (1988) who

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3 They credit Thomas Allen and Donald Marquis along with David Nadler and Michael Tushman with pioneering the use of the information processing paradigm.
analyzed the impact of organizational structure on product development success. They found that a "project-biased matrix" (where the other dimension is functional) yielded the best results for the firms in their sample. Thomas Allen's pioneering studies of communication patterns in R&D groups (see Allen 1977 and 1980) also are relevant to the analysis of product development teams. Among other results, Allen shows that the level of communication drops dramatically if team members do not work in close proximity. This provides strong support for the concept of colocated teams, given that a high degree of communication leads to improved team performance.

Organizational Behavior: Taking a view distinctly different from the one described above, product development can be studied as an organizational process that involves the resolution of conflict between representatives of various functional cultures or constituencies. The focus here is on how effective teamwork can be fostered in a process that cuts across the various "turfs" that delineate the political / power structure of an organization.

One of the earliest attempts to examine product development from an organizational behavior perspective is based on the research of Lawrence and Lorsch (1965). They examined the "processes of specialization and coordination" that were required to generate and market innovations. Their conclusions showed that while specialists are needed to increase the efficiency of development tasks, coordinating mechanisms (of which there can be many forms) are crucial to integrate the views and work of specialists.

Writing more recently, Dougherty (1987) has studied the interaction of functional units as they attempt to "comprehend 'the market'" for a new product. She emphasizes that "functional units think about the market in
different ways. They seek disparate information about it, and interpret the information differently." (p.1) She coined the term "thought worlds" to describe the distinctive views of different organizational constituencies. She finds that "organizations' institutionalized routines for product development reinforce the distinctions of the thought worlds, keep them separate, and prohibit creative learning." (p. 1)

Other studies have also emphasized the disparate views of those whose actions must be coordinated in order to bring products to market. For example, McDonough and Leifer (1986) analyze the role of multiple cultures within firms engaged in product development projects. They find that, although a degree of "creative tension" is valuable among those responsible for innovation, strong project leadership is needed to reconcile the cultural clashes that result. Rubenstein et al. (1976) examined a sample of product development efforts in attempt to understand "factors influencing innovation success at the project level." They conclude that one of the two areas in which "organizational re-design" efforts should focus is in improving "communication in terms of frequency, openness, timing, quality, context, and content between many pairs of company functions involved in the RD/I [product development] process." (p. 20) This emphasis on communication is clearly a response to the need to develop shared understanding between multiple cultures or "thought worlds" in order to move product innovations forward.
Section 3: The Learning Center Approach

3.1: The Role and Goals of the Center for Organizational Learning

An internal memo states that the "basic charter" of the Center for Organizational Learning is "to draw closer the communities of management research and management practice so as to make learning about complex, dynamic managerial issues a way of life in organizations."1 This neatly summarizes the Center's fundamental mission. However, the Center, which was formally established in early 1991, has a number of particular defining aspects which I will highlight in this section. Explanation of these aspects should provide the background needed to understand the Learning Center's distinctive research methodology. The two primary methodologies applied to the product development management project discussed here, "systems thinking" and "action science," together with some of the tools and techniques associated with them, are explored in detail in Sections 3.3 and 3.4, respectively.

Learning to Learn: Professor Fred Kofman uses a framework which shows that, on the surface, the interaction of firms and their competitive environments leads to a slew of performance measures and metrics (often expressed in "the language of management accounting")2 A company can draw insight from these data points only to the extent that it has the capability to learn. Furthermore, the firm can only learn effectively to the extent that it has learned how to do it (i.e. to the extent that it has internalized learning as a core value and put in place mechanisms, formal and informal,

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1 From a memo dated 8/6/91 to the Corporate Affiliates of the Center for Organizational Learning from Peter Senge (Director of the Center) and Bill Isaacs.
2 This discussion draws on an in-class presentation by Prof. Kofman in subject 15.521 (Management Accounting and Control) at the MIT Sloan School of Management.
that promote it). The center's efforts are thus focused on helping organizations to "learn to learn." If, as Stata (1989) holds, organizational learning occurs only as a function of time, it is vital for firms to improve the effectiveness, and, hence, accelerate the rate, of learning processes. This requires a deeper understanding of the manner in which learning mechanisms operate and the ways in which their actions can be reinforced within the realities of living, breathing organizations. However, if the process of learning to learn could be facilitated, the potential for leveraging focused improvement efforts would be immense.

*The Process Model:* Professor Ed Schein (Chairman of the Center's Board of Governors) has explicated a model for intervention in organizations known as "process consultation." (Schein 1988)³ Schein's model relies on several basic principles. First, organizations often "do not know what is wrong and need special help in diagnosing what their problems actually are." Second, organizations that can "diagnose and manage their own strengths and weaknesses" are more effective. This leads to emphasis on transferring diagnosis and intervention skills to managers. Finally, "unless a client/manager learns to see the problem for himself and thinks through the remedy, he will not be willing or able to implement the solution, and, more important, will not learn how to fix such problems should they recur." (Schein, Vol. I, pp. 10-11) Thus, not only skills, but "ownership" of the process must be transferred. The Learning Center attempts to base its interventions on the principles embedded in this model.

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³Note that this concept was described briefly in the preceding section under the topic of "organization development."
**Participant-Observer Approach:** The Center's pilot projects (of which I describe one) utilize a research approach labelled "participant-observer." This is characterized by active participation in meetings and the methodical recording of the process on the part of the researchers.

**Dissemination of "Tools":** Another objective of the Center is the development and dissemination of tools for systems thinking and organizational learning. Daniel Kim, a researcher with the Learning Center, has noted that this function is analogous to the role of JUSE. (the Japanese Union of Scientists and Engineers) which has been actively involved in refining and promoting the use of the tools of total quality management in Japan. Such tools include "causal loop diagrams," "system archetypes," and "management flight simulators." (Kim 1990, p.15)\(^4\)

**Academic / Business Partnership:** Underlying the Center's goals is a strong commitment to and confidence in the power of active partnerships between business and academia, between management researchers and management practitioners. The concept of managers as researchers and "theory-builders" is crucial to the development of learning organizations. As Kim (1990) states, "The dichotomy between manager and researcher must end because the pace of change is such that one can no longer separate the two functions - managers must wear both hats simultaneously." (p. 20) Thus, the Center's activities should help to further the development of what Schön (1983) has termed "reflective practitioners." Such managers would be able to balance the traditional managerial activities that emphasize advocacy with theory-

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\(^4\)These tools are described in Section 3.3.
building roles that place a premium on skills for inquiry and productive reflection. A network of partnerships could also lead to the facilitation of creatively-structured collaborative efforts among partners (as opposed to merely two-way programs between the Center and its individual affiliates). Several of the affiliated firms are already investigating modes of potential collaboration on learning initiatives.

The key challenge, however, in the structure of a successful partnership of this sort is to effectively serve the goals of each partner where they diverge as well as where they converge. In this instance, this means that in the words of Center board member Chris Argyris, we need to define "projects that meet the standards of both a CEO and a rigorous researcher."5 As a result, project definition receives great emphasis, and significant mutual effort must go into the choice of issues to examine and avenues of investigation to pursue.

These distinctive aspects of the Learning Center's approach tend to be mutually reinforcing. For example, the concept of academic-business research partnerships that foster the development of reflective practitioners, fits well with Schein's principles of process consultation that emphasize the transfer of skills and ownership to managers. The concept is also congruent with the notion that the Center should develop and propagate tools and techniques for inquiry, problem articulation, and diagnosis.

The Learning Center works with its sponsoring firms6 to apply this perspective by defining an agenda for collaborative research. As one part of

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5 From an internal Center memo sent 7/4/91 to "liaison officers" in the Corporate Affiliates from the Learning Center Staff regarding the process of defining projects.
6 Currently the Center has 14 sponsors.
this agenda, at least one pilot project is to be executed at each sponsor. In Section Four, this thesis describes the structure of one of these early pilots. Because of the body of existing work done on the dynamics of service quality, product development, and product lifecycle management, these broad topics were suggested as potential areas of investigation for pilot efforts. The next section will explain the reasoning behind the application of this research perspective to the product development process (the area of investigation chosen for the pilot project at Company Z).

3.2: Rationale for the Application of This Research Approach To Product Development

Having reviewed a number of analytical approaches to the study of product development processes in Section 2 above, it is apparent that each has certain shortcomings. In this section, I will show how the approach chosen in the Learning Center's pilot projects addresses many of these issues.

"Best practices" descriptions are primarily aimed at changing the prevailing "espoused theories" of product development in organizations. However, Argyris' work has shown that there can be broad differences between the theories espoused by individuals in organizations and the "theories-in-use" evident from the observation of actions and behaviors. (Argyris, 1990) Change in espoused theory is necessary but not sufficient for change in organizational and/or individual mindsets and patterns of behavior.

Empirical studies have uncovered pivotal issues in project control, information flows, communication patterns, team interactions, and cross-

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7Another tenet of the Center's research approach is that the learning research should be "grounded" in some specific organizational process that is central to the sponsoring firm's competitive strategy.
functional conflict resolution. Yet, they often recommend group process or communication skill improvements and the creation of better modes of interaction without discussing viable strategies for intervention and change.

Process oriented studies offer insight into problem articulation and solution as well as intervention methods, but often may lack a recognition of the systemic interrelationships which, coupled with ingrained ways of thinking and filtering information, lie at the root of many persistent organizational problems.

Much work has been done to develop and implement such theoretically sound concepts as QFD, concurrent engineering, and cross-functional development teams. Yet, with all of the effort, time, and money expended, what has kept them from being implemented more broadly or effectively? What has confined the successes of many improved product development approaches to isolated experimental teams or "skunk works" groups? The hypothesis driving the Learning Center's product development efforts is that there is a . . .

- Lack of understanding of the gap between theory-in-use and espoused theory and how to close it.
- Lack of understanding of the informal organizational dynamics and defenses that can short-circuit attempts to intervene through modification of the formal system of procedures within a firm.
- Lack of understanding of the unintended consequences of well-intentioned actions that arise due to the underlying systemic structure of organizational processes.

But, by bringing together the tools of systems thinking and action inquiry to surface assumptions, make defensive routines discussable, make systemic interrelationships explicit, and focus team efforts on cutting through the
layers of abstraction that obscure problem articulation and inhibit effective
generation of solution alternatives, we can strengthen learning mechanisms
and build the capacity for change in organizations. Effective application of
these tools (to be described below) can address the broad shortcomings that
effect the analytical perspectives previously applied to product development.

In addition, these tools can be applied to modify "the system," not to
develop "work arounds," parallel systems, or "shadow systems," the path
taken by many attempts to improve product development processes. Instead,
this approach offers a potential method of grappling with what Lorenz
terms:

... one of today's most thorny management conundrums: what
companies need to do in organizational terms to continue to run this
never-ending race [toward more rapid development cycles]. They must
learn to gird themselves up, not just for the first high-speed lap, with
its near-halving of development time on one or two 'hero projects,'
but also how to accelerate rapidly around the second and third laps, and
beyond - not just on selected high-profile projects, but as standard
practice on almost every new product throughout the organization.
(Lorenz 1991, p.14)

This statement captures very well the capability for continuous improvement
and continuous learning that must be "wired in" to the existing product
development process. As Dougherty (1987) says, "If the new is separated from
the old, how can the old be transformed?" The answer is clear, change must
start from a systemic understanding of the existing process and the
organizational defenses that buttress it. In the next two sections, I will briefly
explain the ideas behind systems thinking and action inquiry, describe some
of the "tools" of each discipline, and show how each applies to the study of
product development.
3.3 The Systems Thinking Perspective

In his book, The Fifth Discipline, Senge describes systems thinking as "the art of seeing the forest and the trees." (Senge 1990a, p.127) This statement reflects the fact that systems thinking is a way to grapple with the increasing complexity of the modern world by focusing on "interrelationships rather than things," a way of seeing the non-linear causal linkages that form the roots of patterns of behavior. The "art" lies in "seeing through complexity to the underlying structures generating change" and "organizing complexity into a coherent story that illuminates the causes of problems and how they can be remedied in enduring ways." (p. 128)

Senge envisions systems thinking as one of the five disciplines of the learning organization, the "five component technologies" that "converge" into a mutually-reinforcing "ensemble" to foster the generative learning that allows organizations to "create their own futures." Systems thinking is, however, the "discipline that integrates the disciplines, fusing them into a coherent body of theory and practice" and "[keeping] them from being separate gimmicks or the latest organization change fads." (p. 12) The other four disciplines (personal mastery, shared vision, mental models and team learning) reinforce the insights provided by systems thinking and provide mechanisms that support the internalization of new patterns of behavior and ways of thinking across the organization.\(^8\) The disciplines of mental models and team learning will be discussed in greater detail in the next section.

Systems thinking has its roots in the work of Forrester (1958), who founded and continues to develop and broaden the field of system dynamics. System dynamics is, at heart, a way of looking at any system as a collection of

\(^8\)See Senge (1990a) for an in-depth explanation of the roles and interplay of the five disciplines.
interconnected feedback structures and time delays. Because such structures behave in non-linear ways, they tend to produce behavior that is counterintuitive to most people, trained as we are to model the world in terms of linear approximations of "reality." Even though the systemic structure drives behavior, the presence of multiple time delays in the system makes it difficult for those that are part of the system to detect the true causal linkages, and leads to the shifting of attributions (or blame) to external processes and other organizational actors. Senge (1990a) has summarized the effects that feedback processes, time delays, and unintended consequences have in organizations in his collection of the eleven "Laws of the Fifth Discipline":

- Today's problems come from yesterday's solutions.
- The harder you push, the harder the system pushes back.
- Behavior grows better before it grows worse.
- The easy way out usually leads back in.
- The cure can be worse than the disease.
- Faster is slower.
- Cause and effect are not closely related in time and space.
- Small changes can produce big results - but the areas of highest leverage are often the least obvious.
- You can have your cake and eat it too - but not at once.
- Dividing an elephant in half does not produce two small elephants.
- There is no blame. (Senge 1990a, Ch.4)

Systems thinking researchers have developed a number of tools over the years to aid and facilitate processes of inquiry and change in organizations.9 Three of these will be described here: causal loop diagrams, system archetypes, and management flight simulators.

_Causal Loop Diagrams:_ The need to "organize complexity" to tell a "coherent story" about the linkages of causality that exist in a system has necessitated the

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9For a more complete discussion of systems thinking tools see Kim (1990).
development of diagrammatic means to capture shared understanding of system structure. Because linear cause-effect logic is embedded in English vocabulary and grammar, it is very hard to describe even moderately complex feedback processes in words. (Senge 1990, p. ) Therefore, a picture showing the flow of causality is required, "the causal loop diagram." Causal loop diagrams provide a learning team, working to explicate its shared model of a process, with a method of representing, sharing, and revising its common views. The creation of a causal loop diagram is typically an iterative process involving drawing, redrawing, and validating the loop, as new variables and new understandings of relationships are surfaced.

System Archetypes: These are "common dynamic structures that seem to recur in many different situations." (Kim 1990, p. 16) They are intermediate structures. As such, they are composed of basic elements such as reinforcing (positive feedback) and balancing (negative feedback) loops and time delays, but in order to represent the reality of an organization’s dynamics, they must usually be customized. The study of archetypes often allows people to begin to notice them operating in many aspects of their lives. It helps to heighten their sensitivity to systemic relationships, while at the same time providing a short-hand method of referring to specific modes of behavior.10

Management Flight Simulators: These utilize computer-based models of dynamic systems in order to provide a risk-free setting in which managers can experiment with policy and strategy choices. By "playing" multiple trials at the simulator, managers can build experience with recognizing and

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10For a more complete discussion of system archetypes, see Senge (1990a), Appendix Two, pp. 378-390.
handling the unintended consequences of their actions. Opportunities for reflection on the insights gained are required, however, in order to prevent "game playing" from becoming an end in itself. In addition, the managers should be involved as closely as possible with development of the understanding of the systemic structure of the process being modeled. This should make the model more valid and, hence, more credible (i.e. less of a "black box") to the managers who must use it. This process would involve the creation of a causal loop diagram, the accuracy of which would be "honed" by multiple iterations of review and validation, and by the presentation of the diagram for comment to multiple groups in the organization.

The application of the tools and techniques of systems thinking to the product development process can yield important insights. Many authors have described the systemic nature of development efforts. Gomory (1989) makes the distinction between the "ladder of science" and the "product development cycle," noting that cyclic product development is underemphasized in the United States, while the more linear scientific method is stressed perhaps too heavily. Maidique and Zirger (1985) write about the "New Product Learning Cycle," and envision multiple learning cycles which operate simultaneously during development efforts. These systemic characteristics of product development tend to make it difficult to analyze using traditional methods of "systems analysis."

The toughest and most complex problems in firms are those that cut across organizational boundaries. These tend to crop up in horizontal, cross-organizational processes like product development. Their interconnectedness is particularly insidious in that their causes and effects are
separated not only by time (and perhaps by space), but often, by functional walls of management authority and responsibility. Millson, Raj, and Wilemon (1992) clearly view the product development process in terms of its systemic complexity:

    New product development is complex, and the standard paradigm for dealing with complexity is to break down the overall task into individual parts for specialists to master. . . . separate parts become more and more isolated with the result that the original reason for complexity, namely the interrelatedness of tasks, is forgotten. What should have been an iterative process with feedback is linearized and sequentialized resulting in disjointed efforts. (p.56)

Kim (1990) provides a graphical depiction of the sources of complexity in product development, contrasting it with other processes that might be targets for improvement projects or change efforts. (see Figure 1)
Clearly, the process cries out for the application of the systems thinking viewpoint. Systems thinking is well-adapted to the analysis of "dynamic complexity" as observed in development programs. Yet, in order to build a consensus among a group that may bring together as many mental models of the development process as it does functions, systems thinking must be supported by the disciplines of mental models and team learning. These have their roots in the Action Science perspective that I will describe in the next section.
3.4 The Action Science Perspective

The concept of "action science" is derived from the work of Chris Argyris of Harvard and a number of his colleagues.\textsuperscript{11} It is "a body of theory and method for reflection and inquiry on the reasoning that underlies our actions." (Senge, 1990a, p.182) It provides tools and approaches for developing a deeper understanding of interpersonal behavior in organizations and for examining how common behavior patterns can create barriers to learning and change. These barriers come in the form of a "system of organizational defenses" (Argyris, 1990) that serve to protect members from situations or inquiry that might result in embarrassment and threat. These defenses (or "defensive routines" as Argyris labels them) serve to inhibit effective surfacing of and reflection on people's "mental models"\textsuperscript{12} of how the world works. Senge, in describing the discipline of mental models, notes that these models are crucial to understanding behavior in organizations because "they affect what we see. Two people with different mental models can observe the same event and describe it differently, because they looked at different details." (Senge 1990a, p. 175) This affects organizations in several ways. First, the shared mental models of a group can affect what data it takes in to make a decision or, for example, what performance measurements it tracks. Second, if the mental models of people in a group differ \textit{and} they are submerged by defensive routines, it will be very difficult for them to engage in reasoning together productively. This inhibits attempts to use systems thinking skills to design high leverage interventions because, since group members bring their

\textsuperscript{11}For a complete description of the theory of action science, see Argyris, Putnam, and Smith (1985) and Argyris (1990).

\textsuperscript{12}Mental models here can be seen as roughly equivalent to the idea of "theory-in-use" (also derived from the work of Argyris) mentioned above.
own worldviews based on their vantage point in the system, the group will lack consensus on what the shape of the system and how it behaves. An understanding of mental models and how to bring them into the open is thus crucial to the effective practice of systems thinking in an organizational setting.

Such an understanding is also a prerequisite for practice of the discipline of "team learning." Team learning requires a characteristic Senge has labeled "alignment," a condition in which the team's "shared vision becomes an extension of [team member's] personal visions." (p. 235) In order to reach this state it is necessary to suspend the assumptions inherent in mental models and to make defensive routines discussable. Argyris holds that organizational defenses maintain their power only when they remain "covered up" and "undiscussable." Teams that can recognize these routines in their interactions can then drive them out, an establish the conditions required for a free interchange of information and an unconstrained flow of ideas.

Thus, in order to integrate the insights of a team into a systemic depiction of patterns of behavior, it is necessary to understand the ways in which mental models and organizational defenses influence actions. Furthermore, if the power of teamwork is to be unleashed and channelled, similar understandings are also required. To aid in the processes of inquiry and reflection necessary to untangle defences and surface assumptions, action science researchers provide a number of tools, three of which will be explained here: the "ladder of inference," "Left hand/Right hand cases," and the "OADI loop."
The Ladder of Inference: Bill Isaacs of the Learning Center characterizes the "ladder" as a "model of the way the mind works." By this he means that people naturally draw inferences about their observations of the world. An observation is no sooner made than the mind has layered it with meanings. These meanings are derived from "cultures," from "conclusions," and from "beliefs." (The ladder is depicted in Figure 2 below.) "Leaps of abstraction" can occur in an instant.

An example will show how this can occur. Jose enters a meeting 20 minutes after the scheduled starting time. Hiroshi observes this and interprets this as a sign of disrespect for the host manager. (Cultural meaning) He infers that Jose is not committed to their joint venture project. (Conclusion) This reinforces his belief that Jose is just trying to get access to his firm's process technology. (Belief) This chain of thought happens so fast that Hiroshi does not even recognize it as a chain. The project is in jeopardy because Jose's Brazilian cultural meaning structure does not recognize the slight. In addition, the issue is likely to be submerged, perhaps only evidenced by a shift in Hiroshi's negotiating stance.

Figure 2: The Ladder of Inference
Adopted from Isaacs (1992)

This stylized example illustrates the need for dialogue and discussion to be driven back down the ladder in order to focus on the directly observable data (in this case Jose's foot on the threshold and the time on the clock). Once the layers of inference have been cleared away, mutual meanings can be imposed on the data and alternate hypotheses generated. However, it takes conscious effort and practice in order to avoid "leaps of abstraction" and their consequences.

*Left Hand / Right Hand Cases:* This is another technique based on the work of Argyris (see Argyris 1990) which is useful in helping people to understand how much of what they say and do is based on generalizations and assumptions that remain unvoiced. It requires thinking of a situation that involved an important topic, but with which you felt frustrated at the outcome or at the feeling that no mutual understanding was being created. You then write out a conversation you had (or even imagined) in the situation just as though you were writing a play, but only on the right side of the page. Next, you write down the things that you were thinking and feeling (but did not say) during the conversation in the left-hand column of the page. This "always succeeds in bringing hidden assumptions to the surface and showing how they influence behavior." (Senge 1990a, p.198) Once these assumptions are in the open, it becomes much easier to see ways in which the interchange might be improved. Note that this does not mean to *always* speak the "left-hand column," but it does encourage one to actively reflect on attributions and assumptions that influence action and perhaps to validate them by deciding to "bounce them off" others. This, technique offers another
method of fostering openness in interpersonal exchanges and of building spirit of inquiry within a group.\textsuperscript{13}

\textit{The OADI Loop}: The OADI (Observe-Assess-Design-Intervene) loop (See Figure 3 below) is adapted from the original work of the philosopher/educator, John Dewey. It was later adopted by W. Edwards Deming. Deming used it as the basis for his "Plan-Do-Check-Act" cycle which forms the basic model of problem solving that underlies the Total Quality Management approach.

\textbf{Figure 3: The OADI Loop}

![Diagram of the OADI Loop]

The OADI cycle can be seen as a model for effective intervention in complex organizational settings.\textsuperscript{14} Historically, managers have focused their activities on the Design-Intervene portion of the loop, while academics concentrated

\textsuperscript{13}For an example of a Left hand/Right hand case see Senge (1990a, pp. 195-6)

\textsuperscript{14}This discussion and the OADI diagram are adopted from Fred Kofman.
their efforts on observation and assessment without a direct link to the actions that might be derived from their insights. The model of managers-as-researchers described by Kim (1990), implies that managers must take responsibility for Observation and Assessment, as well, in order to take those actions which offer the greatest degree of leverage and which avoid unintended negative consequences. In our work with Company Z, we focused heavily on building skills for observation and assessment, because those are the skills less practiced by managers. Managers' "bias toward action" often leads them to jump from observation to intervention, short-circuiting the loop. By building capabilities for reflection and inquiry, it is possible to rein in this instinct, and encourage managers to balance inquiry (their new role) with advocacy (their traditional role).15 By recognizing the influence of mental models on what it is that we observe, and by bringing to light the ways in which that "leaps of abstraction" and hidden assumptions can shape our assessments, it is possible to use the OADI cycle to reason from directly observable data --> to assessments about the nature systemic structures --> to identification of powerful improvement actions --> to further observations of the effects of intervention. The end result is the creation of an organizational capability to make positive changes in systemic structures and thus to "create the [organization's] future." This is the ability that characterizes "learning organizations."

The techniques of action science can be helpful in improving the functioning of groups through building a spirit of inquiry and by paving the way for productive reasoning. It is now necessary to tie these tools back to the

product development process, and discuss what it is about the development cycle that makes these tools particularly valuable in analyzing and improving it.

There are two key reasons that product development process is likely to be the nexus for a web of just the sort of problems action inquiry is designed to handle. First, innovations in products or processes require changes in ways of thinking and operating that create resistance in the organization. In his article "The Fear of Innovation," Donald Schön (1981) explores the effects of innovation on organizations, finding that it almost invariably creates a variety of threats to various actors in the innovation process. Argyris (1990) has shown that "threat" leads to the engagement of organizational defenses to fend it off. As discussed above, such defenses tend to "gum up the works" of productive reasoning. However, tools and modified "theories of action" which serve to inhibit the propagation of defensive routines, can limit the negative impact on the organization of the changes that accompany innovation.

The second reason action science tools are needed is that, because it demands the integrated action and abilities of multiple (typically functionally specialized) actors, product development requires "team learning" in order to be effective. Yet, cross-functional teams possess many inherent obstacles to team learning. In examining the "challenges in developing team solutions for enhanced product development," Rosenthal (1992, p. 103) finds "two types of barriers . . . how people think and what they do." He writes that:

Effective cross-functional collaboration requires that the various NPI [new product introduction] team members communicate well with each other and can develop shared views of problems that need to be resolved. Such cognitive capability is liable to be lacking in most U.S. companies.
However, it is exactly this sort of capability that the disciplines of mental models and team learning seek to foster. Randolph and Posner (1988) also highlight the importance of improved interpersonal skills, "... to be a successful project manager, you must learn to put yourself in the other person's shoes. You must constantly be open to learning about people, yourself included." Ancona and Caldwell (1992) show that teams need training in "group processes" and "facilitation" to help understand and diffuse the tension created by the difficulty of integrating different functional perspectives. Finally, Dougherty's term "thought world" describing the systems of meanings that different team members bring to the meeting table translates well into "mental models." (Dougherty 1987) The methods of action science can allow managers to surface and integrate incongruous meaning systems, building instead the shared mental models required for alignment and, hence, for effective team reasoning and action.
Section 4: The Project at Company Z

4.1: Company Motivation

Company Z had achieved an impressive turnaround several years ago, and had reclaimed much of its core market from foreign competition. Achieving this turnaround had required extraordinary commitment from the organization, and the firm reflected a deserved measure of pride in its accomplishment. However, senior management recognized the need to keep pushing the company down the continuous improvement path. Having been exposed to systems thinking and organizational learning through sponsorship of the Center for Organizational Learning, the company's top management recognized the need to improve the firm's learning capabilities in order to achieve their improvement goals and remain competitive in their markets. They also recognized the need for shared vision and goals if they were to maintain the momentum that they had established. This then led to their interest in working with the Center to execute a pilot project in the organization.

Schein (1988), drawing on the work of organization development theorist, Kurt Lewin, describes this readiness to change as being in an "unfrozen" state. There are several conditions for such a state:

1) The present state is somehow disconfirmed
2) Some anxiety or guilt is aroused because goals will not be met or standards will not be achieved. (p. 3)

These conditions do seem to have been in place in this firm at the start of this change process.

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1This section is based on the author's attendance at a number of meetings related to the design and execution of this project and on documents generated as a result of the project. The description has been disguised, but the basic substance of the case is unaffected.
4.2: The Planning Process

The concept of the project received support directly from the CEO who had personal experience with systems thinking, having attended programs for corporate leaders that were involved with the Center. Support from top management was a critical factor in getting the project off the ground. However, the project team later became subject to conflicting pressures, as the CEO pressed for the group move ahead rapidly, and others, concerned that the project might provide further distraction in an organization already attempting multiple simultaneous change efforts,\(^2\) wished to limit the scope of the team's activities. As I will discuss later, it is very important to devote ample time to understanding senior management expectations for an initiative such as this, and then managing those expectations actively. In addition to the CEO, a small cadre of managers had been exposed to systems thinking through "competency courses" conducted by the center for its sponsoring firms. These courses served to build interest and excitement among this group of managers. This enthusiasm to put some of these ideas into practice also proved to be vital in assuring that the people who needed to be on the team were included. Thus, the previous experiences of senior management and a cadre of middle managers with systems thinking concepts formed a foundation, upon which the project planning process could be built.

The planning process involved a series of exchanges over a span of around seven months, before the first meeting of the Learning Team in April, 1992. The CEO designated the Vice-President of Customer Satisfaction

\(^2\)Company managers could (and did) list 30-40 separate significant change efforts under way. The multiplicity of programs led to increased cynicism in the organization about the potential benefits of change efforts (or AFPs, "Another F____ Program," as they were labelled in the company.)
who had extensive experience leading quality improvement programs to
head the effort. An Executive Vice-President was also chosen to act as the
"project sponsor." As discussed in Section 3.1, the Center's pilot projects
must be grounded in the study of some critical organizational process. Thus,
the first priority was to identify the process in which the project would focus.
Working with Center researchers, managers from Company Z explored areas
in which systemic behavior patterns were leading to performance problems
for the firm. One area examined was product development. Company
managers developed a "causal loop diagram" showing the interrelationships
leading to "late, expensive, and wrong" (LEW) products. The recognition of
the way in which the structure of the system led to dysfunctional behavior
and LEW projects led to a preliminary decision to focus the pilot project on
the product development process.

At this point (Jan., 1992), a "Project Definition Clinic" was conducted
involving several executives from Company Z and the Learning Center staff.
The purpose of this session was to:

- Explore each other's realities and willingness to learn
- Surface central themes
- Explore the level of commitment
- Develop a shared vision of the process

The last objective was particularly critical because, while engaged in a
common enterprise, the Center and the company had divergent basic goals
for the process. Soon after this meeting the Center expressed the goals for the
pilot projects in general as:

- Develop generative experiments in organizational learning
- Empower managers and academics to work collaboratively
- Expand systemic knowledge

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3From an internal Learning Center presentation (dated 2/92), p. 7.
Produce usable knowledge also considered valid by the academic community.

On the other hand the company expressed the "project objectives" in a presentation to the Management Committee as:

- Begin to understand the company's Product Development process from a total system perspective - recognizing the complexity of the environment in which it exists.
- A single P.D. project and the project team will serve as a "microcosm" to understand the system issues.
- Develop a laboratory to expand the use of systems thinking to other problems.

The importance of each group developing a shared vision of the project and a clear understanding of the goal of the other party is highlighted by the divergence of these statements. The output of the Project Definition Clinic was confirmation of the focus of the project on the topic of product development, a rough schedule for the process, and a proposal to the management of Company Z stating the specific goals and staffing for the project. This proposal was reviewed and revised with the help of the project leader from the company. This leader (the Vice-President mentioned above) then presented the proposal to the firm's Management Committee for approval. The next section outlines the proposed schedule of project activities. In addition, it will describe the selection of the Learning Team and the methods used by both the team and the Center researchers to collect data.

4.3: Outline of the Proposed Process

The basic framework within which the pilot projects are planned is shown below (Figure 5).

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4 Ibid., p.2
5 Internal Company Z presentation.
Adopted from an internal Learning Center presentation (1992)

The "contracting" portion of this framework encompassed both the preliminary, exploratory contacts with the company, the creation of the initial causal loop diagram, interviews with several executives to explore potential themes, the Project Definition Clinic, and the Project Kickoff session (described in Section 4.5). The function of the contracting segment is to both plan the project and to build mutual understanding and an atmosphere of trust between the researchers and the managers. As mentioned above, these contracting activities ranged over a period of 7 months.

In mapping out activities for the "diagnosis and articulation phase," the model of an ongoing project (kicked off in January) at another Learning Center sponsor greatly facilitated the process. Below is the "preliminary plan" presented to management after the Definition Clinic.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Deliverables</th>
<th>Time</th>
</tr>
</thead>
</table>
| I.    | - Descriptive system maps  
       |   - Shared picture of fundamental issues  
       |   - Learning laboratories  
       |   - Identification of key leverage points for action | 6 months |
| II.   | - Tests to produce change  
       |   - Evaluation of tests  
       |   - Plan for ongoing learning activities | 6 months |
While it was refined at the Kickoff Session, this schedule was intentionally left relatively vague, based on the belief that a project of the sort should be adaptively defined as the project moves forward. Broadly, the first phase is to be an "extended collaborative diagnosis" aimed at gaining a better understanding of current realities while building the reflection and inquiry skills of the Learning Team. This is to last approximately 6 months. Next, interventions will be planned and executed over a period of 6-12 months. During and after that period, plans further learning activities and for broadening the organization's exposure to learning tools and techniques will be developed.

The other key activity in this contracting period was the selection of the Learning Team members. This was carried out by the company with the guidance that the people chosen should be key players in the product development process. Changes in their actions and behavior patterns would thus have the potential to change broader patterns of behavior around the process. The team chosen identified by function is shown here:

- VP of Customer Satisfaction
- Manager of customer service
- Manager in charge of overseeing development projects
- Manager in charge of manufacturing engineering at one of the company's plants
- Manager of Purchasing and Quality at another plant
- The chief design engineers in charge of the two major component subsystems of the product
- Executive VP overseeing the engineering function

Most of the group members had worked together previously, and thus were acquainted. They represented a good cross-section of the functions which had a hand in product development (with the exception of marketing). Their tenure with the firm ranged from one year to over twenty. All but two had
previously attended systems thinking seminars conducted by the Center. It was expected that this group would remain together for the duration of the project.

The group and the researchers would collect data in a number of ways. The group was expected to draw on their personal experiences and to conduct interviews with other members of the organization having a role in product development. To assist in this, an interviewing skills training session was planned. Company data and documents might also be drawn upon to test hypotheses or to validate (or disconfirm) assumptions. The researchers collected data in several ways. First, all key meetings were taped and some were transcribed. This was done with the assurance that no one would have access to the tapes or transcripts without the approval of those in the room at the time of the taping. In addition, in each meeting so far one researcher has played the role of "scribe" taking notes that focus on the process and its effectiveness. Finally, meeting summary memos were prepared for each session, both to record the events for later review and to offer members who may have missed a meeting the chance to catch up with the process.

4.4: Initial Results

A series of interviews was conducted with those who were to be on the Learning Team prior to the Kickoff Session. From these preliminary interviews and discussions, a set of themes emerged which were presented to the team during the Kickoff Session. The themes were broad areas of concern that reflected the opinions at least two of the team members. These themes are shown below:

- Lack of Coordination (within projects, among all projects)
- Crisis Management
Manufacturing Culture vs. Product Engineering Culture

Limited Learning

The themes were explored and the team, having been exposed to the "ladder of inference" (See Section 3), attempted to generate directly observable data points to support them. They were asked to review the themes between the initial meeting and the second session, and to generate further data to support them. In the second meeting, a KJ session was conducted to analyze the roots of the theme "Crisis management." (The question asked was: "What promotes crisis management at Company Z?")

The result was the statement that "We are forcing change without understanding the system, the magnitude of the change, or the implications of the change on the system." This exercise proved very valuable in both teaching a new problem analysis technique and in helping the team see the value of building reasoning up from directly observable data about the organization.

4.5: Early Meetings

At the time of this writing, two meetings of the Company Z Learning Team have occurred. The Kickoff meeting was a 1.5 day session that focused on three objectives:

1) To build a foundation for working together by introducing the team members and acquainting them with each other's roles in the product development process,
2) To engage in skill development activities for reflection, inquiry, and systems thinking,

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6 The directly observable data is not included because of the difficulty of disguising it.
7 KJ is one of the "Seven Management Tools" of TQM. It is a structured method for working as a group to determine the root causes or drivers of a weakness in an organization. For an in-depth discussion of the approach see (?)
3) To identify a development project or set of projects to focus on and to lay out near-term activities.

The first goal also encompassed setting out team-defined ground rules for interaction and decision making. The ground rules are shown here:

- Be focused/time-conscious
- Speak your "left-hand column" thoughts
- Don't go to closure too fast. (examine "certainties" first)
- Practice careful listening
- Suspend assumptions about how the world works
- Listen for the "sense" in the apparent "nonsense" of someone's perspective. (What is their worldview?)
- Take "process timeouts" whenever needed to discuss the way in which the group was interacting or thinking

To this list was added the idea that a "parking lot" or "bin" of issues brought up but not yet resolved should be created. The process of working together to define these "rules" seemed to help the team to take ownership of the process.

The second objective involved brief training sessions on the OADI cycle, the Ladder of Inference, and Left Hand/Right Hand Cases. These were conducted by a researcher from the Center, and were reinforced by discussion and practice exercises.

The final objective resulted in the decision to focus our investigation on three development efforts (instead of one) because of the need to look at projects in different stages of their lifecycles. Plans were also made to develop further direct observables around the themes for analysis in the next meeting and to conduct the interviewing skills workshop discussed above in the third meeting. Perhaps the most important aspect of the session, however, was the participation of the project leader from another pilot project ongoing at a firm in a related industry\(^8\) during the last 1/2 day of the meeting. This provided

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\(^8\)See Giancola (1992) for a complete description of this project.
the Company Z team the chance to hear "war stories" and encouraging words from someone further along in a very similar process. This seemed to boost the morale and level of excitement of the team. Perhaps more importantly, a preliminary agreement was reached on a scheme for the two firms to work collaboratively in their learning efforts. Several modes of cooperation were explored, and it was decided that data would be shared between the groups, "second opinions" would be offered about hypotheses, and that a team member from the other firm would attend all team meetings. Both groups agreed that the potential benefits from collaboration could be very great.

The second meeting involved a review of the directly observable data collected by the team and the KJ session described above.

4.6: Next Steps

The next activity for the team will be the interviewing of members of the three project teams chosen for analysis. This data would be used to create action maps, a method for laying out and exploring potential causal sequences. Work with the action maps and additional data will then by used to create and refine system maps. These would be in the form of causal loop diagrams. After the system map has been validated, it could be used to create a management flight simulator of the sort described in Section 3.2. This then could lead to the creation of a learning lab, a session which would allow managers to use the simulator as a risk-free "practice field" (see Senge 1990c). It would allow them to test alternate strategies and policies on a model validated in their own organization and thus embodying its idiosyncratic dynamics. It would also allow opportunities for reflection on the reasons for the success or failure of policies. Stages beyond the creation of a learning lab remain to be defined in detail.
A final and ongoing activity is the creation of a personal "learnings journal" in which the team member is to record instances in which he/she makes use of one of the learning tools or techniques presented in the course of the project. This journal serves both as a record of the internalization of techniques for systems thinking and inquiry and as a reinforcement tool which helps the team member recognize the everyday benefits of new modes of thinking.

4.7: Reflection on the Process

In this section, I will offer initial impressions on the effectiveness of the process at building team commitment to the learning process, at surfacing key issues, and at building inquiry skills. I will also examine some of the key hurdles the process must overcome.

**Building Team Commitment:** Overall, I believe that the process of building commitment and a shared understanding of the process among the team members has gone quite well. This is due in large part to the significant groundwork laid in advance of the pilot project process. This foundation includes systems thinking training for the CEO and other top managers, similar training for a cadre of middle managers, and a great deal of attention to the "contracting" phase of the project. One problem that could arise, however, is the fact that it is not possible to insulate the team from the time pressures and demands of the system they are studying. In a project with as long a timeframe as this one has in an organization where managers are burdened with responsibilities to multiple change efforts (and the usual recurring crises), it is very possible that the current high level of morale in the team will erode.
Surfacing Key Issues: I believe that all of the team members would agree that the process has succeeded in bringing out into the open issues that might have been ignored or unrecognized in the blizzard of daily events. So far, it appears that openness has been maintained in the team's discussions. It will be interesting to observe if defenses become engaged as the team pushes further toward the root causes of dysfunctional behavior.

Building Inquiry Skills: While these abilities need to be reinforced with experience and practice, it is clear that the team has gained greater ability to use frameworks such as the Ladder of Inference to recognize abstractions and the filtering effects of mental models. For example, the data collected to support the themes for the second meeting was clearly better (in the sense of being more free from inference and abstraction) than that gathered in the exercise used during the Kickoff Session. This is small but encouraging evidence that new cognitive skills are being developed.

Hurdles: Several key hurdles must still be overcome by those developing this research process. First, a clear understanding of top management's expectations is crucial to the effective operation of the team. Uncertainty along these lines disempowers the group by making it uncertain as to the standards by which it will be judged. The effect of this sort of uncertainty was significant even in a project that enjoys very good (and public) top management support. Even after management's expectations have been initially comprehended, they must be continually managed as they may change as the project takes shape and activities begin.
Second, a fundamental difficulty arising from a team of line managers attempting to work from within to diagnose and change a complex system so that the group members remain subject to the demand and pressures of the system. At Company Z this was seen as both pressure for rapid "results" and as concern that the managers on the Learning Team and others who might need to assist the team's efforts would be overburdened by programmatic change. Each of these stresses could be traced to systemic mismatches uncovered by the team in the course of the project. This dynamic reinforces the need to make clear to management the demands and timeframe of an intervention such as the one attempted here.

Finally, better methods need to be developed for transferring ownership of process issues to the team. Despite subtle (and not so subtle) attempts to get the team members to "define their own course" the researchers have not as yet been able to move fully and effectively out of the "expert" mode and into a mode of "facilitation" in which they more subtly guide the team to "discover the logic" of learning tools on their own. A start in this direction may be to emphasize. This second mode of operation should remain the goal, although the socialization processes which lead us to seek answers and expertise from interveners have made it very difficult to put into practice.

4.8: Future Challenges

There are two primary future challenges facing projects aimed at building learning skills through collaborative efforts between managers and researchers. The first is to move beyond a "project" or program and instead toward an organization-wide process for shifting patterns of thinking and interaction. This will require a level on organizational ownership of the
process and comfort with the tools far beyond what we currently see. But
given sufficient time and support it should be possible to achieve such a goal.

The second is how to build a cross-organizational network of "reflective systems thinking practitioners." Such a network may be required
to spread the use of these techniques beyond a relatively small group of
visionary firms. Having witnessed the power of bringing a manager who is
relatively experienced in using learning tools into a group that was just
going started, it is clear that collaborative efforts hold great potential to
spread and reinforce the practice of the learning disciplines. Perhaps
companies can come together to share their successes in much the same way
as companies which are pursuing quality improvement have shared their
experiences.

Overall, I believe that this pilot project will be successful in achieving
both a better understanding of the underlying causes of breakdowns in the
product development process at Company Z and in building the learning
capabilities of the firm. In addition, the Learning Center's researchers should
be able to learn much about ways of structuring collaborative efforts between
managers and practitioners.
BIBLIOGRAPHY


