LEARNING TO MANAGE INNOVATION: SIMPLE AND COMPLEX SOLUTIONS TO THE PROBLEM OF IMPROVING INNOVATION PERFORMANCE

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ABSTRACT

The paper analyzes methods general managers used to improve innovation performance in four divisions of a diversified European firm. The managers tried simple interventions, like budget increases, before progressing to more complex interventions, like changes in the project management system and organizational reforms. Periods of 'learning' preceded more complex interventions. Managers used inductive methods to identify components of the problem and to devise solutions to problem components. *Their ability to improve the system's performance increased as their understanding of the system increased.* Implications for innovation management and for the theory of organizational decision making are discussed.

What happens when a large, diversified firm goes through a major strategic change, going, for example, from a low cost strategy to a differentiation strategy? In a set of cases to be presented here, managers viewed improving innovation performance as a key to the change. But how can a firm *improve* its innovation performance? We know a lot about what *drives* innovation performance, but far less about the processes a large firm must go through to *improve* innovation performance. What methods are available to general managers who want to improve innovation performance? Which methods do they use and what drives the sequence they use them in? These questions will be addressed in this paper.

Behind these questions lie deeper ones which link the innovation problem with deeper issues in organization studies. Faced with the need to change a firm's direction, how can a top management team do it? When no one in the firm, including top management, knows what structures, systems and processes are needed to implement the new strategy, how do they do it? How can managers make and implement decisions in a situation where they don't even know what the alternatives are and don't know where to look for them?

The behavioral theory of the firm (March & Simon, 1959; Cyert & March, 1963) can explain rigidity. It holds that firms are limited by their own learned routines and by the proclivity of firm members to form coalitions with interests that diverge from those of the firm as a whole. So how do managers change innovation routines in the first place? An how do they change routines in a context where coalitions within the firm have divergent interests, some of which may be hostile to the new strategy?

The organizational change literature, from Argyris (1985) onwards proposes a variety of techniques for managing organizational change. But how can they be used in this context, to change innovation performance? And how do managers who have never heard of the tools discover them and begin to use them?

Finally, how do we model the kinds of choices managers make over time when they engage in a complex, long term effort like improving innovation performance? Basic textbook models of decision making are not sufficient. But with a few modifications they would be.

I do not propose to answer all of these deeper questions. I simply propose to shed light on them. Through most of this paper I will focus on the questions in the first paragraph. The

general question is, 'How can general managers improve a large diversified firm's innovation performance?' The subsidiary questions are: 'What methods are available to improve innovation performance?' 'What sequence do managers use them in?' and 'Why do they choose this sequence?'

I will draw evidence from detailed case studies of what general managers in four divisions of a large, diversified European firm did as they tried to improve innovation performance over a period of four to six years. The firm is pseudonymed Manufacturing Group Europe, or MGE. The material was collected through fifty interviews with forty-six MGE managers and innovation project participants. The interviews were conducted over a period of eight months.

The study is focused on the behavior of 'general' managers. A general manager is here defined as a manager at the business unit leadership level or above. Functional managers above the business unit (e.g., a sector R&D head) are included.

There has been much previous work on innovation management. But most of it has focused on the determinants of project success (see Brown & Eisenhardt, 1995, for a summary), on project team structures (e.g., Clark & Fujimoto, 1991; Wheelwright & Clark, 1992), on selection among projects (e.g., Schmidt & Freeland, 1992; Wheelwright & Clark, 1992). Other works have focused on specific drivers of innovation performance, such as communication (Allen, 1977), or on components of the process, such as resource allocation (Bower, 1970). Others have studied general managers as project champions (Fischer, et al, 1986; Burgelman, 1983). But the general managers role in integrating (much less changing) the entire system has received little attention. It is on this aspect of the innovation question that I will focus my attention.

BACKGROUND OF THE STUDY

This paper is a partial report of results from a project which was designed to develop grounded theory on the subject of the general manager's role in innovation management. The

grounded theory methodology was first presented in Glaser & Strauss (1967). Its techniques have been further developed by Yin (1984), Eisenhardt (1989), Strauss & Corbin (1990), and Miles & Huberman (1994). Key issues in application of this methodology are the sample of data used, the framework used for data collection, and the methods used in analysis. In this section, I will discuss each of these subjects in turn.

The Data

The data reported in this paper comes from a database of 273 events which occurred in four MGE divisions during the lives of four innovation projects. Each of these events involved an interaction between one or more general managers and the firm's innovation program.

MGE was selected as a site after initial screening had identified forty companies which had comparable characteristics of size ($5+ billion in annual sales), structure (M-form) and diversification (operating in several distinct but related businesses). MGE was selected from among the forty companies for two reasons.

First, MGE management was willing to allow substantial access to the firm and its personnel. Over a period of seven months, I was able to interview 46 people involved in four innovation projects in four divisions (a total of 50 interviews). Several managers, additionally, gave significant amounts of their time to comment in detail on the case histories I constructed from the information gained in the interviews.

Second, four years before my research began, MGE management had begun deliberate and sustained efforts to improve the firm's innovation performance. Several succeeding waves of effort had resulted in substantial (they said) changes in the firm's innovation system. In each of the four divisions, I was able to gather detailed information on what the firm's general managers had done to improve innovation performance. For each division, I wrote a case study which described the history of the focal project and any efforts managers had made to improve the division's innovation system during the history of the project. Because of the longitudinal nature of the data collected (the case studies covered six to twelve years), I was also able to determine, with the help of the managers involved, the impact of their efforts to improve innovation performance.

Each of the four MGE divisions was supervised by a different group of general managers, though there was some overlap at the highest levels. Each of the four general management groups took a different approach to the problem of improving innovation performance, thus giving some variation to the data.

The number of interviews per project ranged from ten to seventeen. The people interviewed varied in level from one member of the corporate executive committee (the member most concerned with innovation management) to members of each innovation project. Four interviews (those with the most senior managers) covered more than one project.

In all, the MGE case histories contain information on 273 events which involved interaction between general managers and the firm's innovation program. But 84 of these events occurred before managers began trying to improve innovation performance. These 84 events are not reported here. The 189 reported events include efforts to improve innovation performance and other interactions between general managers and the innovation projects.

Framework for Data Collection

As this was a theory development project, the initial questions used to structure interviews were open-ended, focusing on project history, the innovation process, and change efforts. Such open-ended questions would allow interviewees to bring up issues not foreseen in previous literature. Nonetheless, I surveyed previous literature to find variables which had been identified as impacting innovation performance. I made a list of such variables to assure that data was collected on them within each site (i.e., within each MGE division or other organization). The list was used to create follow-up questions used as prompts during the interviews.

Space limitations prevent the discussion of more than a fraction of the works surveyed. Here I will simply list the general categories of variables found, together with a few representative works dealing with the category.

Structural factors identified as impacting innovation performance include the following: the firm's internal communications system (Allen, 1977; Maidique & Hayes, 1984; Van de Ven, 1986; Angle 1989; Dougherty, 1992; and others); the firm's communications links with

its environment (Von Hippel 1986, 1987); the structure of the firm's resource allocation system (Bower, 1970; Burgelman, 1983); and the overall hierarchical structure (Bower, 1970; Burgelman, 1983). Non-structural factors identified as potentially impacting innovation performance included the following: firm culture & incentives generally (Burgelman, 1983; Imai, 1986), monetary incentives & other specific aspects of the personnel system (Roberts & Fusfeld, 1981; Angle, 1989), overall firm strategy (Porter, 1980), and firm strategy & controls in relation to structure (Haspeslagh, 1985, 1986; Goold & Campbell, 1987). A list was made of these factors and follow-up questions were constructed on the basis of this list.

In addition, given the complexity of the innovation process, I thought it useful to have a framework for collecting data on how the process was accomplished at each firm or MGE division. Thus, I used a modified version of Angle & Van de Ven's (1989) model of the phases in the life of an innovation project organize data collection in this area.

The Method

Each interview began with three open-ended questions. These questions related to: (1) the history of the project and the interviewee's role in relation to it, (2) the interviewee's job and their unit's role in relation to the innovation process, and (3) what had been done and what still needed to be done to improve the innovation process at their company.

The questions were left open-ended to allow respondents to bring up aspects of project history and company structure which they viewed as significant to innovation management but which were not foreseen by the investigator. Follow-up questions were used, to the extent necessary, to assure that information was obtained on all aspects of firm management which were previously identified as having an impact on innovation performance. No one manager was expected to be able to answer all questions. Rather, respondents were selected so that, as a group, they would be able to give a full and detailed history of each project, along with information on the factors previously identified as impacting innovation performance.

Detailed handwritten notes were taken at each interview. These notes were transcribed into typewritten form, normally within forty-eight hours of completion of the interview.

The information contained in the interview notes was then assembled into four detailed project histories. Information on general management activity related in any way to the project was included in the histories. Each history was verified through criticism from at least two MGE managers familiar with the project (including the project head) and from one co-investigator. Follow-up interviews were conducted to fill in details missed in the first round of interviews. Inconsistencies and errors of fact were corrected until all readers were satisfied that the history constituted a complete and accurate account of events significant to the project's history.

After this process of verification was completed, each project history was analyzed into a series of events. Each project history contained over one hundred and fifty events. Material on a few additional events involving general managers was added from the interview notes. All events involving general managers were then identified and analyzed separately. These events were classified into over forty types via a Q-sort. The types were then aggregated, via a second Q-sort into five overall categories (later consolidated to four) and sixteen sub-categories. Only the four overall categories will be used in the analysis presented here, though I will give examples from each of the sixteen subcategories as illustrations.

Once the basic classification work had been done, I examined the chronological pattern of interventions used by MGE's general managers. The chronological sequence of interventions used within the four project histories were compared and a common pattern found in all of them (strongly in three, more weakly in the fourth).

There were several possible explanations for the pattern observed. In order to determine which explanation was most plausible, I reviewed the interview data for evidence consistent with each explanation. While not conclusive, the interview data pointed strongly toward the idea that 'learning on the part of managers' was the principal reason for the changes in the types of interventions used.

WHAT HAPPENED?

Types of General Management Activity Found at MGE

Table 1 lists the four categories and sixteen subcategories of management interventions in the innovation system found at MGE. Examples are given to illustrate the types of interventions found in each subcategory.

The four overall categories are defined as follows:

1. Single Project Interventions. Activities related to the creation, funding, management, or supervision of a single project. These interventions were narrow in scope and low in complexity. They normally had no impact beyond a single project. (138 interventions)

2. Project Management System Interventions. Making changes in the project management system. These interventions were moderate in scope and moderate in complexity. They impacted all or most projects with a division. (56 interventions)

3. General Business System Interventions. Making changes in the business management system, changes which had impacts beyond the project management system. Changes in general incentive systems, in the overall organizational structure, or in inter-unit communication patterns are examples. These interventions were broad in scope and high in complexity. (70 interventions)

4. Stimulation of Reflection. Encouraging reflection by others (either inside or outside the company) on the functioning of the company's innovation system. Typically such reflection preceded and stimulated other interventions designed to change the project management system or the business management system (interventions falling in categories 2 and 3, above). The act of stimulating reflection did not directly impact any projects or systems, however. Thus these interventions cannot be classified on the dimensions of scope and complexity in the same way as the other interventions. (9 interventions)

[insert table 1 about here]

I will not discuss the sixteen subcategories here. The examples given in the table should illustrate the content of each subcategory sufficiently for the purposes of this paper. The reader does not need to understand or remember each example or each subcategory at this stage. I present the table now only familiarize the reader with the range and types of interventions available to the general manager.

Use of the Interventions over Time

In this section, I will briefly describe the histories of the four projects studied. These brief histories will give the reader a general idea of what prompted different types of interventions and what sequence the interventions occurred in. The histories will be followed with more analytic discussions.

The divisions which housed the projects are labeled Industrial Chemicals, Pharmaceuticals, Lawn & Garden, and Advanced Materials. The projects are labeled the Chemical Residues, MedEx, LC49, and Safety Materials projects. All are pseudonyms, as are the names of individuals given below. In 1994, MGE management believed that each of these four projects represented a significant new opportunity for the company.

I will give disproportionate attention to the Industrial Chemicals division and its Chemical Residues project. Industrial Chemicals was, in many ways, the most 'typical' division of the four, being close to the historical core of MGE. Its story is also the most typical. After describing events in Industrial Chemicals, I will discuss how managers' behavior varied in the other divisions.

I use the events database to document how managers intervened to improve innovation performance beginning in 1990 (1988 in Pharma). On table 2, the history of each division's efforts to improve innovation performance is divided into three periods. Generally, the periods are equal in length (exception: Lawn & Garden). I show the number of interventions of each type (single project, project management system, etc.) occurring during each period. Interventions occurring before 1990 (before 1988 in Pharma) are not included, since they occurred prior to the beginning of the innovation performance improvement effort.

Industrial Chemicals Division, Chemical Residues Project, 1986-1990. The Chemical Residues project began when George Marsh, an MGE chemist, found a new use for an existing MGE product. It was clear that developing the new use would take a considerable investment in new competences. So Marsh began to look for support to fund the research.

At that time, business unit managers were the only people at MGE empowered to fund innovation projects. Unfortunately, Marsh's project did not fit neatly within any business unit. It took Marsh two years to find any funding at all. Then he found funds but the funds were withdrawn after a year. After searching for a few more months, he found funds from another business unit, but shortly that funding source dried up as well. Ironically, just before the last withdrawal of funds, a test by a potential customer had convincingly demonstrated the feasibility of the idea in a commercial setting.

Division and corporate management had little interest in new product innovation at this time. They were not even aware that the project existed.

1990-1991. By early 1990, the corporate executive committee began thinking that MGE needed to change strategy. Long a low cost producer, the company was having increasing trouble competing against Asian and other competitors with lower wages and cheaper raw material costs. By mid-1990, the executive committee decided to adopt a differentiation strategy. This meant a considerably greater emphasis on new product innovation.

As a result of this decision, Paul Thomas, a senior member of the executive committee, began looking for innovation projects to support. He viewed this as a quick method to increase the company's innovation performance. While business unit managers were responsible for funding innovation, he did not think the company could wait until all the business unit managers had been reoriented to give more support to new product development. He would fund a few projects himself, or get the divisions (the level between business units and corporate) to do so.

By accident, Thomas heard about the Chemical Residues project just a few weeks after it had lost funding the second time. He did not hear about it through normal MGE channels. He read about it in the business section of his local newspaper. He decided to give the project

corporate and divisional support. Quickly, the project's budget increased to a level several times larger than its previous maximum. The project also had the support of corporate management. Before Marsh had been forced to beg for support from business unit managers three or more levels below Thomas.

Business unit managers were reluctant to invest more in speculative innovation projects, despite corporate's new interest in innovation. BU managers had long been evaluated on the basis of short term profits. The pressure for short term profits had not been reduced. Managers were, as a result, still reluctant to risk their reputations and careers on speculative projects.

Division management, less under pressure to produce short-term profits, was less conservative. They quickly saw that corporate was serious about increasing the firm's innovation performance. They went along with corporate and gave more support to projects such as Chemical Residues. But, after some reflection, they did not see this as enough.

Reflecting on the history of the Chemical Residues project, Industrial Chemicals management saw that much time had been lost because of the project's failure to find funding. Giving the project more money now was fine, but it didn't solve the basic problem. Corporate management couldn't be everywhere looking for projects. If a new project like Chemical Residues came along, it might slip through the cracks and fail to find funding, just as Chemical Residues had.

With this thought in mind, Ken Smith and other division managers decided to fix the funding system. They set up a division-level board which would be responsible for all projects or potential projects in the division. The board could fund projects (like Chemical Residues) which fell outside of business unit boundaries.

1992-1993. After redesigning the funding system, division management began to look at other problems in project management. George Marsh, it turned out, had never been very effective as a project manager. In nearly six years, he had never performed an effective market study, nor had he documented the technical side of the project effectively. Division management decided to put Marsh in charge of technical development on the project while hiring a new project manager.

Division management did not stop there. They realized that Marsh's problem was a symptom of a broader one. The division did not have an effective, systematic project management system. To fix this, division management conducted numerous interventions in the project management system. Project structures were strengthened and formalized, the availability of funds for innovation was broadened, and more effective project management methods were implemented. One of the driving forces behind these changes was Mark Green, who had recently moved to Industrial Chemicals from the Pharmaceutical division, where more formal project management systems had been in place for some time. Division managers also began changing more general business systems. The incentive system, for instance, was changed to give more rewards for innovation-related activity.

1993-1994. As the project management system began taking more effective shape, division managers began paying attention to other problems and opportunities. They decided that the division could be producing more new product ideas. Contact between customers and the division's technical people was limited. Opportunities to adapt MGE products to specific customer needs were being missed. At the same time, contact between technical people across business units was also limited. Potential ideas based on synergies between the firm's many technologies were being missed. Once they saw these lost opportunities, division management decided to fix them.

With the help of a consultant, division management planned and implemented a major reorganization. Sales committees were set up for each customer group. The membership of each committee included technical people from each business unit serving the customer group. Communications links between customers and MGE technical people were thus shortened dramatically, while the amount of communication was increased. Direct communication links between technical people from different business units were established for the first time.

Industrial Chemicals, Summary. Table 2a presents a summary of general managers' interventions in Industrial Chemicals from 1990, when the effort to improve innovation performance began. The data was collected from general managers themselves and from the Chemical Residues project team. The table breaks the period into three roughly equal parts of one and one-half years each. The events occurring during these periods are classified

according to whether they affected only one project (single project interventions), all projects (project management system interventions), or both business units and projects (business system interventions). Reflection interventions, which did not involve immediate changes in any system, are included as well.

On the table, I note the scope and complexity of each type of intervention. Interventions affecting only one project are considered narrow in scope and low in complexity. Interventions affecting the project management system are considered moderate in scope and complexity. Interventions impacting the whole business system are considered broad in scope and high in complexity. Reflection interventions, as they did not involve any direct changes in the innovation system, are not classified in terms of scope and complexity.

The table reveals a pattern. In 1990-1991, single project interventions were numerous and more complex interventions were few. This reflects the fact that general managers (like Paul Thomas) were going around looking for projects to give funds to. Few changes were made in project and business management systems during this period.

In 1992-1993, single project interventions declined while project management system interventions increased considerably. Business system interventions increased as well. This reflects the fact that general managers were paying less attention to individual projects and putting more effort into reforming structures and systems, particularly the project management system.

In 1993-1994, both single project and project management system interventions decline, compared to the earlier period, while business system interventions increase. This reflects the fact that general managers had largely fixed the project management system by the end of 1993 and then turned their attention to the broader management problem of reforming relationships between operating units, customers and project teams.

[Insert table 2 about here.]

Pharmaceuticals Division, MedEx Project, 1982-1988. In 1982, one of MGE's half-dozen pharmaceutical labs began screening a certain class of organic molecules for a unique

disease-fighting property. The project was speculative. The lab manager in charge estimated the probability of finding an effective, non-toxic molecule as low. The project was controversial within Pharma. Other lab managers had their own pet projects and were jealous of the resources given to MedEx. With demand for resources high, the project's budget was threatened several times in its early years.

In 1984, the small MedEx team found a promising molecule. Confirmatory testing began. But once again, the project's budget was threatened as other lab managers pushed their own projects and competed for resources.

1988-1990. By 1988, the team had made much progress. While the project had been slowed at certain points by a lack of resources, general effectiveness had been confirmed, early toxicity tests were promising, and an industrial process for producing the molecule was almost ready. In short, the project was nearly ready to enter full development. But at that point, division management decided that the division's innovation system needed serious reform. Too many projects had suffered serious delays. Competition over resources was taking too much time and energy. The decision to enter full development was delayed as division management began discussing how to reform the system.

In the event, Pharma management decided to bring in a consultant. The consultant recommended that the division radically cut the number of its projects. He also recommended that the division invest much more in the remaining projects. The consultant recommended which projects be kept. To the surprise of many lab managers, MedEx was on the list of project's to be kept.

Reforms did not stop there. Pharma management decided that, besides cutting the number of projects, the division needed a more effective project management system. They decided to hire a number of managers from a rival firm, one whose project management systems were reputed to be superior. The new managers instituted many changes in Pharma's project management systems. In particular, they strengthened project managers and formalized many aspects of project management.

1991-1992. Reforms in project management continued. Before 1991, different lab functions had taken responsibility for projects in sequence. Starting in 1991 they were forced

to work in parallel in order to finish projects more quickly. New project tracking and other project management tools had to be developed to facilitate parallel work. In addition, further cuts were made in the number of projects. Hurdles for selecting projects for development were raised and made more clear.

1993-1994. In this period, management conducted a major organizational reform which broke up the entire R&D area into product groups. Each product group functioned, in effect, as a multi-project team, capable of taking on several projects at once. This speeded up projects even further, as cross-functional relationships did not have to be rebuilt with each new project.

The product groups became the primary organizational unit of the R&D area, superseding the functional areas, which formerly had controlled the system. This segmentation of the R&D area allowed greater specialization along product lines.

Pharmaceuticals, Summary. Table 2b presents data on general management activity in the division from 1988 to 1994. The data was collected from general managers themselves and from members of the MedEx team. On the table, the 1988-1994 period is broken into three roughly equal parts.

Again, single project interventions peak during the first period. Project system interventions peak during the second period. And business system interventions peak during the third period. The differences between periods are not as stark as they were in Industrial Chemicals, since project and business system reforms began earlier in Pharmaceuticals. But, nonetheless, there is a clear pattern of movement from the simpler single project interventions to the moderately complex project management system interventions, and finally to the highly complex business management system interventions over time. Pharma management was able to move more quickly to the more complex interventions for two reasons. They were willing to use consultants from the beginning (Industrial Chemicals used them only in the last phase). The consultants helped them detect problems and design solutions. In addition they were willing to hire outsiders into top-level division management. The outsiders helped design and implement solutions.

Lawn & Garden Division, LC49 Project, 1986-1990. This project began when a L&G division chemist began searching for a molecule which would offer a breakthrough in fertilizer technology. Some elements in the division viewed the molecule as 'too radical' and innovation. As a result, the chemist had considerable trouble finding funds to pursue the project. Even after he found a promising molecule, finding funds to support the project was difficult.

1990-1993. In 1990, corporate and division management began taking an interest in innovation and identified LC49 as a promising project. Division management began funding the project generously. But they went much further. They actually began running the LC49 project themselves, overruling numerous decisions made by the project team.

Division management took over the project because they thought they could run it better than anyone else. They were wrong. The project entered the market too soon, was badly positioned when it did enter, and failed to meet sales expectations by a wide margin. Division management immediately recognized their mistake and stopped trying to run the project.

1993, 2nd half. The division's head, Bill Grage, was disturbed by LC49's failure to meet expectations. Other problems with innovation management had occurred as well. Grage briefly consulted with an academic known for his expertise on entrepreneurial corporations. He decided to propose some general changes in the division's management systems. He made the proposals and then asked all managers in the division to contribute their own ideas. A six month period of reflection followed.

1994. After the period of reflection, division management implemented substantial reforms in the division's business management and project management systems. The reforms had the full cooperation and endorsement of most managers in the division. The reforms included a decentralization of power from division headquarters to operating units, an increase in the power of project managers, and greatly increased links with customers and distributor groups throughout the innovation process.

Lawn & Garden, Summary. Table 2c presents a summary of general management interventions in the division from 1990, when management first took an interest in innovation,

through 1994. The data was collected from general managers themselves and from members of the LC49 project team. This time, the 1990-94 period is not broken into equal parts. Rather, it is broken at the beginning of the period of reflection initiated by Bill Grage in 1993. The second break is at the end of the period of reflection.

As table 2c shows, prior to the period of reflection, general managers largely focused on interventions impacting single projects. After the period of reflection, they made substantial changes both in the project management system and in the business management system. The sequence, as in the previous two projects, went from simple, narrow interventions to broader, more complex interventions. But this time, reform of project management and business management began at the same time.

Advanced Materials Division, Safety Materials Project, 1988-1990. The Safety Materials idea was developed by the management team of the Advanced Plastics business unit. Frank Kelly, head of Advanced Plastics, supported the project from the beginning. In this respect, Safety Materials' history differed from that of the other three projects. It always had local management support. Prior to 1990, in fact, Kelly protected the project from a division management team which wanted him to cut funding for all innovation projects.

1990-1991. In mid-1990, corporate management began taking an interest in innovation. Given the changed corporate climate, Kelly revealed the project. To his surprise, corporate tried to influence a number of the project team's policies, particularly on the issue of sales forecasts and pricing. But unlike the LC49 team, the Safety Materials team was able to maintain its independence. They could do this in part because they were located more than 5000 kilometers away from corporate headquarters, and in part because Kelly continued protecting the project.

1992-1993. Conflicts over the project's policies continued, though in a milder form. The US team tried to enter the market but was unsuccessful in getting paying customers. Corporate asked Kelly to replace the part-time project leader. Kelly resisted for a year, but then agreed that the project needed a full-time manager.

1993-1994. The new project manager was hired and reoriented the project's marketing package. A full-service package was developed around the original product. Customers were

interested and the team registered its first sales, but resistance among the bulk of customers continued. Kelly continued to be involved with the project during this phase, mainly helping with high level sales and regulatory contacts.

During this period, Advanced Materials management conducted a major organizational reform. The reform was identical to what happened at the same time in the Industrial Chemicals division. But the reform had little impact on Safety Materials or the Advanced Plastics business unit. Advanced Plastics, profitable and far from headquarters, continued to be independent and in charge of its own innovation systems.

Advanced Materials, Summary. Fewer project management system and business management system interventions were observed at Advanced Materials than in the other divisions. It is likely that this was partly due to an unforeseen problem in using the Safety Materials project team as a data source. The bulk of the team was located in a business unit which was isolated from the rest of the division. The reforms which occurred in the division had little or no impact on the project team. As a result, interviews with the project team did not reveal much about how division-wide innovation systems changed during the period.

Division management provided considerable information on efforts to reform the division's innovation system in 1994. It is possible, however, that some reforms occurred earlier which my interviewees, some of whom had recently come from other divisions, were unaware of.

By contrast, single project interventions were quite numerous. Both the business unit's general manager, Frank Kelly, and a corporate executive, Paul Thomas, were quite interested in the project from 1990 on. Kelly acted as a consultant to the project team and frequently became involved in the project to smooth its path with important insiders and outsiders. In short, he supported the project team. Thomas, by contrast, disputed the project teams policies on pricing and other issues and periodically tried to influence operational decisions.

In both Lawn & Garden and Advanced Materials, senior managers tried to influence project team decisions. In the Lawn & Garden (LC49) case, they succeeded in taking over the project. Thanks partly to its isolation and partly due to the protection offered by Frank Kelly,

the Safety Materials team was able to successfully resist senior manager's efforts to influence operational decisions.

Table 2d presents data on interventions beginning in 1990, when the executive committee began taking an interest in innovation. Once again, the period from 1990 to 1994, is divided into three roughly equal periods.

In Advanced Materials, as in the other divisions, interventions involving single projects declined over time. More complex interventions, impacting the project management system and the business system, increased over time. But fewer project management and business system interventions were observed because the changes which did occur in the division had little effect on the isolated BU which housed Safety Materials.

The Overall Pattern: Movement from Simple to Complex Interventions

The overall pattern observed in all four cases (weakly in Advanced Materials) was a movement from simple to complex interventions. General managers began their reform efforts by concentrating on individual projects, generally giving them more financial support. But simple increases in budget did not solve all problems. Better systems for funding and management projects were still needed. As a result, managers went on to reform project funding systems and project management systems. These changes were more complex than the first ones, since they affected, not just one project, but all projects and all prospective projects. Managers in Pharma brought in consultants and hired outsiders to help them design these changes. Managers elsewhere designed them on their own.

Changes in project management systems helped, but did not solve all problems. In particular, managers were concerned that idea generation was insufficient and that integration of projects into business units was lacking. In addition, Pharma managers believed that further specialization on the basis of product type was possible. As a result, major organizational reforms were undertaken in all divisions. As recounted in the cases, organization structures, communications systems and incentive systems underwent major changes in each division.

These organizational changes were markedly more complex than the changes which had taken place before. They affected not only innovation projects, but also operating units, the

links between operating units, and the links between operating units and projects. All divisions made use of outside consultants to help design these changes, though in Lawn & Garden the use of consultants was limited to a few conversations with a leading academic guru.

In the next section, I will look at several possible explanations of this movement from simple to complex solutions.

INTERPRETING WHAT HAPPENED: EXPLAINING THE SEQUENCE OF SIMPLE TO COMPLEX INTERVENTIONS

What Drives Managers' Choice among Interventions?

Managers did not choose interventions randomly. Their explanations of why specific methods of intervention were chosen, where available, indicated that a consistent set of issues lay behind choice. The two key issues were knowledge and power.

To illustrate the importance of knowledge and power, I will go back to the Lawn & Garden story and discuss the knowledge and power issues evident during each part.

When they first discovered the LC49 project (part one), Lawn & Garden management thought they knew enough about the project to run it themselves. They viewed their knowledge of the market as being superior to that of the project team. In their minds, there was considerable justification for this belief, since they had 'grown up' in the Lawn & Garden business and had far more years of experience in this business than the members of the project team. Power was not a major issue during this period, since division management had sufficient hierarchical power to simply impose their will by fiat. While managers lower down might have resisted, they proved to be unable, or unwilling, to resist division management's efforts to run the project. No real confrontation or power struggle took place.

Top management's perception of their own knowledge changed with the initial entry of the LC49 product into the market. Division management's optimistic view of the product's prospects proved to be completely unfounded. As a result, division management's original view, that their knowledge of the marketplace was superior to that of the project team, was

completely undermined. Very quickly, division management surrendered actual, as well as formal, control of the project to the project team. Power, again, did not come up as an issue, as division management clearly had the power to cede control to people lower down in the hierarchy.

A new knowledge issue developed when Bill Grage, the division manager, began looking at the larger picture. As he contemplated several disappointments, including the LC49 entry, he decided that the division's problems went beyond the LC49 project. Its innovation system and its management systems as a whole needed a substantial reform. As the idea of such a reform put him on ground he wasn't completely sure of, he consulted with a leading academic for a few days. At that point, he viewed the academic's knowledge of corporate management systems to be superior to his. But, after a few days of learning, Grage felt he had learned what he could from the consultant, and the relationship ended.

In the next phase of the story, knowledge and power issues were both in the forefront. Fortified with the understanding he had gained from the consultant, the division head felt confident enough to make specific proposals on how the division's management systems should be reformed. But two things prevented him from simply imposing his solution by fiat.

The first issue was a knowledge issue. He did not think that he knew all the details of the division's business system well enough to specify in detail all of the changes to be made. Thus he asked large numbers of his subordinate managers to help in specifying the details of the changes to be accomplished.

The second issue was a power issue. The credibility of division management had been seriously undermined by the LC49 project's problems. Grage did not think he had the power to impose drastic changes without the willing cooperation of his subordinates. Thus, he saw a need to coopt his subordinates into supporting the changes. He was able to do this by appealing to their interests in two ways.

First, the changes he envisioned worked largely in the interest of junior managers. They involved increases in the power of junior managers and corresponding decreases in the power of division-level managers. This was widely viewed as appropriate and was supported by

junior managers. Second, he gave junior managers the opportunity to design details of the changes. This gave them ownership of the changes and smoothed their introduction.

Knowledge was also an issue in Industrial Chemicals, though power was not. But the knowledge issues worked differently. When division management discovered the Chemical Residues project, it had no illusions that it could run the project. Part of the project's technology and all of its marketing issues were unfamiliar to them. As a result, they did not try to run the project. But management did think that the project needed a larger and more stable resource base. This they provided.

Shortly after they discovered Chemical Residues (CR), division management began to reform the project management system. In reflecting on the history of projects like CR, it was obvious that the funding system was inadequate. George Marsh, for instance, had spent two years trying to fund Chemical Residues before he found any funds at all. He then spent another two years trying to maintain stable funding as one funding source after another dried up. Division managers thought that they knew enough about funding methods to design and build a better funding system. So they went ahead and did it.

While they understood the funding problem, it took longer for division management to realize that the Marsh was (and had always been) an inadequate project manager. A competent scientist and the originator of the CR idea, he was out of his element when dealing with broader management issues. Despite the fact that his work was unorganized, his documentation nearly non-existent, and his surveys of the market and technological options incomplete or lacking, he was allowed to continue as project manager for several years. This suggests that division and corporate management did not have a clear idea of what good project management consisted of. By late 1992 they had a better understanding of what was needed. They then replaced Marsh as project manager. In addition, to prevent further problems, they introduced project management training programs. They also made the project supervision system more rigorous.

With several more years of experience and reflection, Industrial Chemicals management realized that changes in the project management system were not enough. They needed ways to generate more ideas and to better integrate projects with ongoing businesses. They decided

that changes in the organization of the whole business system were necessary. To broaden their experience base, they invited consultants to help them design a new system. Then they implemented the new system from the top.

While Industrial Chemicals managers used others (consultants) as sources of ideas, they did not ask anyone to help when they implemented their decisions. They had the power and inclination to impose reforms themselves.

This was not the case at Pharmaceuticals. By the end of 1988, division management was tired of watching different R&D units squabbling over resources. But it did not have the means, by itself, to achieve consensus on priorities. So it brought in consultants to help. With the help of prestigious outsiders and the volumes of analysis they produced, Pharma management was able to set and enforce priorities.

Shortly after the consultants' study, Pharmaceuticals management decided it needed a more effective project management system. Numerous outsiders were hired into the firm from a rival with more effective project management systems. In addition to knowledge, these outsiders provided a critical mass of new people (in effect, a powerful and respected new interest group) dedicated to speeding change.

After the first rounds of change, Pharma managers began to be habituated to change. When additional outsiders were brought in, their ideas for change were accepted readily.

If we analyze the power issue, we find that behind it lies the issue of common goals. Before the changes in Pharmaceuticals began, different groups in R&D were squabbling for resources. In effect, each had the goal of maintaining or (preferably) increasing its own resources. This was a competitive goal. An increase in one labs resources meant a decrease in the others' resources.

But, over several years, people's attitudes were refocused from protecting their resources to improving overall performance, a common goal. Pointless battles over resources decreased as people became more focused on the health of the whole system. The increase in the power of the center helped this process along, but was not a fully independent factor. For the refocusing of people's energies around a common goal increased the center's power just as the focus on fighting one's neighbors had decreased it.

These examples have focused on decisions at the division level. But BU managers behaved similarly. Frank Kelly, head of Advanced Plastics, provides an example.

Some corporate managers thought that the Safety Materials project team was underpricing its product. Kelly disagreed. He believed that the project team was right (i.e., that they had the best knowledge on the subject). Kelly and the team were independent enough (i.e., powerful enough) to resist corporate pressure on the issue.

Later, Kelly resisted corporate pressure on other issues. Corporate wanted him to replace Walsh as project manager. He resisted successfully for a year. Eventually he gave in, but not just for power reasons. While corporate pressure played a role, the fact that Walsh no longer had enough time to manage the project was more important.

To summarize, the key drivers behind choices among interventions were perceptions of relative knowledge and power. When general managers perceived their knowledge to be better than those of others, and felt they had enough power to impose what they wanted effectively, they acted on their own and took control. When they perceived other's knowledge to be superior to their own, they asked them for their ideas and used their ideas. When they believed that they could not (or should not) simply impose their will on others (their subordinates), they brought in outsiders to give them greater leverage, and/or they attempted to coopt their subordinates by consulting them for their ideas, and/or by bringing them into the decision process earlier.

Alternative Explanations for the 'Simple to Complex' Sequence

Several alternative explanations for the 'simple to complex' sequence can be derived from this section's discussion. One is a 'knowledge-related' explanation. The second is a 'power-related' explanation. I discuss these and compare them to a simple decision theory framework.

The 'Knowledge' Explanation. It is possible that MGE's managers chose simple solutions first for knowledge-related reasons. To apply a solution (i.e., to perform an intervention), they would first have to have some knowledge about the potential solution. That is, they would have to be aware of the fact that intervening in a particular way was likely to

have a positive impact on the firm's innovation performance. This may seem obvious, but acquiring the requisite knowledge, in the case of the more complex interventions, is far from obvious. Several examples will illustrate.

The cause and effect relationships involved in increasing the resources devoted to innovation are fairly obvious. Two propositions summarize this relationship. (1) All other things being equal, devoting increased resources to innovation is likely to lead to increased innovation performance. And (2), reducing resources, by contrast is likely to lead to reduced innovation performance. It is likely that anyone with general management experience would agree with these propositions.

By contrast, the cause and effect relationships involved in conducting a far-reaching organizational reform are far from obvious. In part this is because there are many potential levers to pull. Adding resources involves only one lever, increasing a budget. But an organizational reform may involve changes in reporting relationships, communication patterns, work team structures, and work process flows, incentives, and evaluation methods, to name only a few. Unless a general manager has devoted extensive thought or study to the subject, it is not likely that he will be aware of all of these levers. Thus, prior to executing an organizational reform, it is necessary to learn how to do it, that is, to learn what the levers are which can be pulled and what the effects of pulling them are likely to be.

In addition, in an organizational reform, it is impossible to ignore the impact of the reform on the firm's non-innovation activities. Simple changes in a project's budget may have no impact whatsoever on a division's ongoing operations. But an organizational reform, involving the division's operating units, cannot help but have an impact on ongoing operations. Figuring out all the contingencies and secondary impacts of an organizational reform can take many person-months, if not person-years. Prior knowledge of likely cause and effect relationships will be necessary. Difficult trade-off's may have to be made between innovation performance and ongoing operations. As a result, the process of designing, much less implementing, an organizational reform is a much more demanding intellectual task than that posed by a simple increase in a project's budget.

With this difference in mind, it is possible that MGE managers chose simple solutions (like increasing project budgets) first because they understood them better. The cause and effect relationships were simple and obvious enough that they were immediately understood, even by general managers with no prior interest in innovation. By contrast, executing a complex organizational reform presented two problems. Having grown up within one nearly uniform system, MGE managers were not familiar with the many ways a business system (or a project system) could be organized. Nor had they had the opportunity (or the reason) to learn about the cause-and-effect relationships linking different organizational configurations with innovation performance. Before implementing organizational reforms, they had to learn both about the alternatives available and about the likely effects (and side effects) of any changes they made.

Evidence for the Knowledge Explanation. The present research was not designed to 'test' the knowledge explanation. Nonetheless, the it did provide some evidence in favor of this explanation. The evidence came in the form of examples.

In 1989, Industrial Chemical's management team was happy with their project funding process. Business unit managers were in control of funding and there were few, or no, calls to change this system. But, by 1992 division management had substantially changed the funding system. Why?

Once Chemical Residues was declared a high priority project, attention was drawn to the fact that the division had ignored or underfunded the project for four years. While some fingerpointing and defensive avoidance of blame occurred, there was also much constructive investigation. Ken Smith, a senior division manager, said that he and his colleagues looked in detail at what happened to Chemical Residues. By building their knowledge about the project's history and studying the division's own innovation management systems, they were able to identify the causes of the division's failure to fund the project.

In their view, the key issue was the fact that business unit managers had a monopoly for funding innovation projects. Business unit managers did not have incentives to fund projects which had only long term payoffs. Quite the opposite. They were rewarded for steady, predictable short-term profits. It was not surprising that a long-term project like Chemical

Residues had failed to find funding. To make things worse, Chemical Residues had not had an obvious fit with any particular business unit. In the old system, it had no natural home.

Smith and his colleagues devised several solutions. First, they transferred control of projects to a division-level committee. While business units would continue to fund and supervise most projects, they would have to report on project activity to the division's R&D committee. The R&D committee, in turn, could provide direct funding for projects. It could also arrange that certain projects be supervised directly by division management. In addition, the R&D committee set up a special fund to provide money for projects which fell between the cracks of existing business unit domains.

In short, Smith and his colleagues identified a problem, the fact that projects like Chemical Residues had difficulty in obtaining funding. They then identified a set of cause-and-effect relationships which explained the existence of the problem. These cause-and-effect relationships involved a number of variables, including budgets and cash flows, incentives and human behavior, reporting relationships, and territories of responsibility for decision making. These cause-and-effect relationships were not immediately obvious. Smith and his colleagues uncovered them only after numerous hours of discussion and reflection. But once they uncovered them, they moved quickly and decisively to reform the system and prevent similar problems. Achieving a better understanding of the problem was a necessary condition of finding a solution.

Smith and his colleagues found ways to improving the division's funding system by reflecting on the division's own experience. They felt no need to consult with outsiders before reforming the funding system. This was not the case when they undertook broader organizational reforms. In fact, each of the organizational reforms which occurred at MGE was preceded by consultation with outsiders.

Organizational structures, company-wide communications systems, and incentive systems impact operating units project teams and R&D areas. Changing one of these broader systems will have an impact on operating systems as well as on the innovation system. The effects of a change cannot be localized as easily as can a change in project funding. No MGE

manager felt totally confident about undertaking a reform of these broader systems without first consulting with one or more expert outsiders.

Pharma management, the first to begin broad-scale reforms, brought in a consultant immediately to help design the reforms. The consultant helped, not just with broader business system reforms, but also with the reform of Pharma's project management system. Pharma also hired numerous outsiders into senior management roles as a way of bringing in outside expertise.

Industrial Chemicals and Advanced Material division management used consultants as well. Lawn & Garden management used outsiders less than the others. But even here, Bill Grage, the division head, consulted with a leading academic expert for several days. And, unlike the others, Bill Grage made extensive use of his junior managers as sources of ideas on how to design the reforms.

In summary, wherever data is available, it indicates that reforms in project management systems and in business management systems were proceeded by periods of learning by senior management. During these periods of learning, senior managers either reflected on their own experience or consulted with outsiders to develop an understanding of the cause-and-effect relationships involved in making the desired reforms.

The 'Power' Explanation. There is evidence (presented above) that MGE managers chose interventions on the basis of their knowledge of what would help them improve innovation performance. Nonetheless, I will ask the reader to ignore that evidence for a moment and consider the other explanation.

Perhaps MGE managers simply did what they had the power to do. Early in the reform effort they increased budgets because they knew they could do it. They waited until later to undertake serious organizational reforms because they could not have imposed such a reform against the near unanimous wishes of their subordinates. Only when subordinates began to understand the innovation problem, and began to understand that increasing innovation was in their interest, did senior management have the power to impose organizational reforms.

One difficulty with this explanation is that it is difficult to disentangle it from the knowledge argument. Two kinds of knowledge appear in the argument in the last paragraph.

First, it is assumed that subordinates' 'understanding the innovation problem,' and of the fact that 'increasing innovation was in their interest' had an impact on the power balance. In other words, as subordinates learned, the power balance changed. At the same time, one might assume that general management 'learned' more about the innovation problem themselves, and, thus, 'learned' how to show their subordinates that reform was in their interest, either through persuasion or through changes in incentives. Disentangling the power argument from the knowledge argument is, thus, difficult.

A further issue which limits the stand-alone value of the power argument is the fact that MGE managers expressed few doubts about their power vis-à-vis junior managers. Managers in Industrial Chemicals and Advanced Materials simply imposed organizational reforms without asking junior managers. In Pharma and Lawn & Garden there was concern with power, but it was muted.

In Pharma in the 1980's, management was not able (or perhaps not willing) to unilaterally impose centralized control of the R&D system. The different labs operated like independent fiefs, each with its own budget and priorities. But when management decided to change this, they were able to. They brought in an objective outsider, a consultant, who was not embedded in the system. The consultant owed no one any political favors and could not be accused of favoritism in his recommendations. With the help of the consultant, management was able to impose new centralized systems and priorities on the formerly independent labs. Because of the consultants reputation for objectivity, it was difficult for junior managers to continue using political means to obtain resources.

Part of the transition and the power shift involved knowledge issues, however. The consultant's report was accepted because the consultant was able to convince everyone that his view of the pharmaceutical market, and his recommendations on how to develop products for it, were accurate. He was able to convince management and many lab managers that the centralized system he was proposing was superior to the previous status quo.

In Lawn & Garden in 1993, Bill Grage was similarly concerned with the power of his many subordinates. If they opposed the organizational reforms he wanted, he would not be able to impose them, he reasoned. But he was easily able to coopt his junior managers by

bringing them into the design stage of the reforms. His method of cooption involved sharing knowledge and building a consensus around a common view of the division's problems and the reforms needed. Junior managers listened to Grage's perspectives and he listened to theirs. Once a shared consensus was reached (and it was), the power issues were no longer problematic and Grage was able to institute the reforms he wanted. In short, Grage's concerns about his subordinates' power influenced they way in which he introduced the reforms. But he was still able to introduce reforms much as he wanted.

Had MGE's leadership structure been less stable or less unified, power might have been a larger factor in choosing interventions. Had several top management groups, each with different ideas about how to lead the company, been competing for control, then the relative power of these groups would have been a key issue. But this was not the case. MGE management was relatively stable and unified. Division management quickly agreed with corporate that it was necessary to improve innovation performance. As a result, there was little conflict between divisions and corporate. Faced with a unified top management, business unit managers put up little open resistance. But they were reluctant to risk their own careers on innovation until it was clear that risk-taking would not be penalized.

In summary, while the power explanation adds additional insight to the knowledge explanation, it does not stand on its own. Both appear to be needed to fully explain the behavior of MGE general managers.

Comparison with a Simple Decision Theory Approach. The most simple textbook model of managerial decision making specifies that decision makers, faced with a problem, identify possible solutions and choose the one which maximizes the value of the firm's income stream. But here we have to explain two things which don't fit the simple model. The first is that top management suddenly decided to emphasize innovation, thus forcing managers at all levels of the firm to reset their priorities. The second is that it took a long time (four to six years, and still counting) for complete solutions to the problem to emerge and be implemented.

A look at the historical record shows why top management 'suddenly' decided to emphasize innovation. MGE had long practiced a low-cost strategy which required little effort at product innovation. Fundamental changes in a number of MGE's markets were beginning to

make this simple low-cost strategy untenable, however. To continue to produce worthwhile profits, the executive committee decided that MGE would have to put more emphasis on product innovation.

This change in strategy can readily be explained in the context of the behavioral theory of the firm (March & Simon, 1959; Cyert & March, 1963). Profits had declined or disappeared in a number of MGE businesses. The executive committee feared, with reason, that this could happen in other businesses. They feared that the corporation would no longer produce a satisfactory level of profits. This triggered a rethinking of the corporation's strategy as the executive committee searched for ways to redress the profit decline. In effect, the old 'satisficing' solution was no longer working, so they had to find a new way to 'satisfice,' a new way to reach a satisfactory level of profits.

Subordinates at the division level bought into the new strategy quickly, but they found no way to satisfice. The new goal was open ended: to increase innovation performance as much as possible. Here the issue is: why it took so long for solutions to emerge. I have suggested in the case write-ups and earlier in this chapter that MGE's managers were learning as they went along.

In the Industrial Chemicals division, they reflected on what had happened to the division's own projects. Looking at the history of Chemical Residues (the first project top management picked to support in the division), they saw that the project had been seriously delayed because of difficulties in finding funding. This pointed to a problem in the funding system. They quickly devised a solution which would prevent recurrence of this problem. Closer observation of this project over the next two years revealed that project management was also deficient. This, in turn, was fixed. Finally, more general observation of the division's performance, particularly in comparison to more innovative competitors, led to an organizational reform. Managers designed the latter, not by themselves, but with the aid of consultants. Except at the end, managers in Industrial Chemicals relied on their own experience and skills to find ways to improve innovation performance. Managers at Pharma, by contrast, accelerated the process by drawing on outside expertise (consultants) sooner.

In effect, the problem of improving innovation performance was not fully defined at the beginning of the process. The general problem was defined, but it had many components which were not defined. As managers identified the components, they were able to devise (partial) solutions. But identifying components of the problem and devising solutions both took time. The time needed for this mental work led to long lags between initial problem definition and the implementation of solutions.

The time lags involved in identifying problem components and in devising solutions are not part of the simple textbook model of problem solving. Identification of problem components followed an inductive pattern like that described by Holland, et al (1986). Managers accumulated large amounts of information over a period of time, and gradually identified patterns within the information. (Holland use the label 'rules' for what is more commonly referred to as 'patterns.' The word 'rule' does, indeed, better capture the fact that the patterns identified reflect logical links evident within the data). The process took time. Devising solutions also had inductive elements and took time. This inductive process, involving long periods of observation and detection of patterns, explains the long delays between recognition of the overall problem, identification of components of the problem, and discovery of solutions.

The power issue can be added to the simple decision theory model as follows. Before 1988 in Pharma, lab managers had different goals. Each wanted more resources for themselves and (implicitly at least) less for the others. By 1994, each (at least publicly) had the same goals. All wanted money to be invested in the most promising areas. Conflict was transferred to a new arena: meeting strictly specified project funding criteria.

Division management achieved common goals by doing two things: (1) it brought in outsiders (consultants and new hires) uninvolved in the previous political conflicts, to set up new, neutral criteria, and (2) it reasserted its centralized power by changing incentives, persuading people, and shifting people until everyone who mattered shared the new common goals.

In the simple model of decision making, decision makers maximize the value of the firm's income stream. This matches, roughly, the situation in Pharma in 1994. All were

expected to choose projects to support based on their potential value to the firm. To model the situation in 1988, at least one of two features must be added to the model.

The more traditional approach is to assume that lab managers were making decisions on the basis of their self interest, that they identified their self-interest with the size of their own budgets, and that this led to the conflict. They started acting differently when incentives changed and they saw that they would lose (as individuals) if they continued to push the interests of their labs.

The less traditional approach is to assume that individuals perceived the interests of the firm differently. Lab A's manager genuinely believed that Lab A's projects would lead to greater income for the company than Lab B's projects. And he had evidence to prove it. But of course Lab B's manager believed that Lab B's projects would lead to greater income for the company than Lab A's projects. And she, of course, had evidence to prove it, evidence just as convincing as Lab A manager's evidence. From this perspective, the behavior change occurred when a credible, neutral outsider came in and convinced both parties to follow a common, standard procedure for evaluating projects.

Both approaches (individual interests and differing perceptions of what is good for the company) have face validity. In any real situation, it may be impossible to distinguish one from the other. I include both in the discussion since together they demonstrate that both changes in incentives and changes in perceptions may have an impact on whether people share common goals.

The Lawn & Garden story has similar features. Division management lost credibility because of the disappointing performance of the LC49 project. As a result, there was potential for conflict over the way the division was being managed. The potential conflict was defused when division management brought junior managers into the discussion of how the division should be managed. During six months of discussion, all sides could air their perceptions of how the division's management processes worked and how they could be reformed. In Holland et al's (1986) terms, this period was an intensive sharing of the inductive rules (logical links) they had formed. Through comparison and discussion of their rules, junior and senior management arrived at a common understanding of how the division's management structure

could and should work. Once the common understanding was in place, the possibility of conflict diminished greatly and implementation was easy.

NEXT STEPS

I have shown how MGE's management started with simple solutions to the problem of improving innovation performance, but then progressed to much more complex solutions over a four year period. I have explained this sequence, and the delays involved in it, as being a result of the fact that managers learned over time as they focused attention on the problem of improving innovation performance.

Managers unfamiliar with the management methods used by more innovative companies (i.e., virtually all MGE managers in 1988) had to learn new ways to manage. This involved two things. First, managers identified ways in which components of the innovation process (the funding system, project management methods, etc.) were not working optimally. Second, they found ways to improve performance of these components of the process.

Power also played a role. Some interventions (e.g., organizational reforms) could not be implemented without the cooperation of a large number of people. Sometimes such interventions were delayed until managers built a consensus on the need for the interventions. Other interventions (changes in incentives, hiring & firing, discussion with subordinates) were designed to speed the achievement of a consensus. Cognitive issues (agreement on what drove innovation performance, agreement on the relative value of innovation investment and short-term profits) played a role in achieving consensus.

The implications of the learning explanation are the following. It suggests that learning by managers can be a key factor in a successful performance improvement effort. Managers can't, or at least don't, create new systems unless they understand (or think they understand) what they are creating. The more accurate and detailed their understanding of how innovation works, the more likely they will create systems with high innovation performance. And the more they can accelerate their learning, the faster they can improve innovation performance.

For some, these propositions will be obvious. But they challenge us to do the following: (1) systematically specify what we know about the drivers of innovation performance, (2) measure how well managers in a variety of firms understand what drives innovation performance, (3) measure the correspondence between what managers think is the ideal system and their firms' own structures and systems, (4) measure the correlation between the firm's structures and systems and firm-wide innovation performance, (5) measure the correlations between managers' understanding of innovation performance and firm-wide innovation performance, and (6) identify what determines speed and effectiveness of learning. This is a substantial research agenda by itself. But the discussion points to other issues as well.

We can also in what areas (besides innovation) managers' learning will have a significant impact on performance. In the cases presented here, managers' learning was important because they were trying to do something they had never done before. They were trying to encourage substantially more new product development. By analogy, learning would be important in other situations where a firm was trying to do something which required new management methods which the firm had never used before. A shift from differentiation to low-cost strategy (the opposite of the case presented here) is one example. A shift from an emphasis on financial controls to an emphasis on strategic controls would be another example (Haspeslagh, 1986). Entry into a new market or adoption of a new technology, to the extent they demanded a different management style, are other examples. Researching the learning process and the impact of learning in these situations is another entry on the research agenda.

The limitations of this work are clear. I have shown that managers in four divisions of one firm followed the same pattern of movement from simple to complex interventions in the innovation system over time. It is not possible to be sure that other managers at other firms would follow the same pattern. Similarly, I developed a knowledge-related explanation of the sequence of interventions. But it is not possible certain that the same explanation would hold elsewhere. Detailed observation of other cases could lead to the discovery of other interesting patterns, or to other new insights.

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Table 1

Category 1: SINGLE PROJECT INTERVENTIONS: Interventions involving the creation, funding, management or supervision of a single project.

Project Creation
- Setting up a formal project team.
- Allocating funds to the project, or increasing the funds allocated.
- Determining who the project team will report to.
- Designating a project leader and project members.

Routine Supervision
- Receiving routine communications from the team.
- Reviewing and evaluating the team's activities.
- Applying pressure to the team to perform better.
- Helping the team identify critical issues.
- Deciding to remove or replace the project manager.
- Managing goal conflicts between project team and other units.
- Giving public recognition to the team.
- Protecting the team from pressure or interference from others.

Participation
- Developing an idea which becomes a project.
- Contributing technical ideas to the project team.
- Negotiating with important insiders or outsiders to encourage their cooperation.

Consulting, Mentoring
- Acting as a consultant to the project leader or project team.

Direct Management
- Running the team, making operational decisions for the team.
- Blocking communications which would be essential or useful to the team.

Category 2: PROJECT MANAGEMENT SYSTEM INTERVENTIONS: Changing the way projects (or ideas for projects) are managed. (Note: interventions in this category apply to all projects, but not to operating units.)

Laboratory Management
- Changing lab structure or management methods.
- Changing lab communication patterns (internal&external).
- Changing lab personnel or hiring patterns.

Project Funding System
- Changing where funding decisions are made within the organization.
- Changing the types of information used in funding decisions.

Project Structure
- Change the level of cross-functional cooperation within a project team.
- Changing the standard project reporting structure (i.e., who projects report to).
- Changing links between project teams and outsiders.

Project Management Methods
- Changing methods of managing development projects.

(continued on next page)

Table 1, page 2

Category 3: GENERAL BUSINESS SYSTEM INTERVENTIONS: Changing the way the firm as a whole is managed (i.e., interventions which impact both projects and operating units).

Corporate Strategy
- Changing corporate strategy.
- Making and executing merger & acquisition decisions.
- Changing the competence portfolio held by the firm.

Goal Structure
- Changing overall pattern of subunit goals.
- Setting overall corporate or divisional goals (e.g., financial targets).
- Setting goals on the number/type of ideas generated.
- Setting goals on the length/cost/quality of development.
- Setting goals on the timing/cost or other features of market entry.

Organization Structure
- Changing hierarchical relationships between subunits.
- Changing who is responsible for specific decisions.

Communications System
- Changing communications paths within the firm.
- Changing communications paths with the outside.

Personnel System
- Changing the sources or profiles of personnel hired.
- Changing monetary incentives in relation to innovation.
- Changing career incentives in relation to innovation.
- Changing status incentives in relation to innovation.

Culture
- Attempts to change unwritten rules of behavior.
- Attempts to change behavior towards customers.
- Attempts to change behavior in relation to innovation.

Category 4: STIMULATING REFLECTION: Asking insiders or outsiders to reflect on the way the firm manages innovation.

Reflection on Firm Organization or Behavior
- Asking outsiders to study and recommend changes in the firm's own innovation processes.
- Asking insiders to study and recommend changes in the firm's own innovation processes.
- Encouraging firm managers to look at their own role in contributing to the firm's problems; suppressing finger-pointing.

(end of Table 1)

Table 2

Number of Interventions over Time
by Division

	Single Project	Project Mgmt System	Business Mgmt System	Reflection
a. Industrial Chemicals				
1990-1991	9	2	1	0
1992-1993	5	7	4	0
1993-1994	3	3	7	2
b. Pharmaceuticals				
1988-1990	8	4	5	1
1991-1992	1	11	6	0
1993-1994	0	6	7	2
c. Lawn & Garden				
1990-1993	20	0	4	0
1993, 2nd half	1	0	0	4
1994	4	6	11	0
d. Advanced Materials				
1990-1991	20	0	0	0
1992-1993	13	1	1	0
1993-1994	7	2	5	0
Scope	Narrow	Moderate	Broad	NA
Complexity	Low	Moderate	High	NA

Note: five events (1 single project, 1 project management system 3 business management system) in 1994 impacted both Advanced Materials and Industrial Chemicals. They were part of a reform effort which involved both divisions. These events appear under both projects.