A Model of General Managers' Methods of Improving Innovation Performance

by

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ABSTRACT

Numerous studies of innovation identify *determinants of innovation performance*. This paper develops a model which identifies *managerial actions which improve innovation performance*. The model is derived empirically, from data on managers' activities in ten firms. The two types of model complement each other by bringing different aspects of innovation management into focus. The paper discusses the benefits of increased investment in models focusing on managerial action.

Numerous studies of innovation focus on the *determinants of innovation performance* (see Brown & Eisenhardt, 1995, for examples). No one questions the usefulness of such studies. Nor will I. Yet by focusing on determinants of performance, one brings certain factors into sharp relief while ignoring others. If we focus a study of innovation in a different way, we will find things which we miss when we focus on performance determinants.

In this paper I will focus on *managerial actions designed to improve firm-wide innovation performance*. The two focuses are not the same. In a typical study of performance determinants, the research question is, 'What determines the success/failure of individual innovation projects?' In this study, which focuses on managerial actions, the research question is, 'How do general managers act to improve firm-wide innovation performance?' The independent and dependent variables in the two models are different. I will discuss the differences at some length later.

The managerial action focus brings some things into sharp relief which the performance determinants focus ignores. I will give one example. If an organization is not innovating effectively, its general managers have a wide variety of tools which they can use to improve innovation performance. They can use some tools to increase the generation of ideas. They can use others to improve the project funding system. They can use still others to improve the management of development projects. Some tools will have an impact across all three phases of the innovation process (idea generation, funding and development). Others have more precise impacts on a single phase. In short, managers have a choice of which phase or aspect of the process to work on and of which tools to use in each phase. The range of tools available, their effects across the process, and managers' methods of choosing among them do not necessarily come to light if one focuses only on the determinants of performance.

The managerial action focus, thus, brings to light some things which the performance determinants focus ignores. The opposite is also true. A managerial action model will ignore structural determinants of performance (e.g., industry or technological variables) which managers cannot control. These will be featured in a performance determinants model. Thus, neither model can replace the other. They are complementary. Both are necessary for a full picture. One (performance determinants) helps us discover the determinants of a state. The

other (managerial action) helps us determine how the change the state. The two are logically linked and complementary.

Other scientific fields study both determinants of a state and methods of changing a state. Physics researchers study not only states of matter (temperature, motion, position, etc.) but also how to change them. Medical researchers study not only what causes diseases (i.e., what determines a patient's state), but also how to cure them (i.e., how to change a patient's state). There is no reason why management researchers should not study both determinants of a state (performance determinants) and methods of changing that state (managerial action).

Numerous studies have been done of the determinants of innovation performance. Brown & Eisenhardt (1995) summarized them in the form of a model. No comparable model has been produced of managerial action to improve innovation performance. I will propose such a model in this paper. I build my managerial action model, not from a summary of previous work, but from an empirical study of how managers in ten firms and one government administration acted to improve innovation performance.

In the next section, I outline the methods I used to collect data and build the model. Then I present the model. Finally, I discuss the differences between the managerial action model and more traditional performance determinants models.

BACKGROUND OF THE STUDY

This paper involves the development of grounded theory on the general manager's role in innovation management. 'General manager' is here defined as business unit managers and those above them in the hierarchy. 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 data analysis. I will discuss each of these issues in turn.

The Data

Two different sets of data were collected and analyzed. The primary database includes information on 273 events which occurred during the history of four innovation projects at a diversified European manufacturer pseudonymed MGE (Manufacturing Group Europe). Each of these events involved an interaction between one or more general managers and the firm's innovation program. Ninety of these events, those involving changes in the firm's project management or overall business management system, were used in the analysis reported below. This data was collected through fifty interviews with MGE managers.

The second database consists of over 1200 descriptive statements on innovation systems used at ten other organizations (9 business firms and 1 government bureaucracy) and on general management activity in relation to these systems. Over 1000 of these descriptive statements dealt with descriptions of key aspects of these firms' project management and business management systems, or descriptions of efforts to change these systems. These statements were used in the analysis reported below. This data was collected in fifty-four interviews with managers from these firms.

MGE was selected as a primary 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 these forty companies for two reasons. First, MGE management was willing to allow substantial access for a period of seven months. During that time, I was allowed to interview 46 managers involved in four innovation projects (a total of 50 interviews) in four different MGE divisions. Several managers, additionally, gave significant amounts of their time to comment in detail on the four case histories (one for each project/division) I constructed from the information gathered 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. During the fifty interviews, I was able to gather detailed information on what the firm's general managers had done to improve innovation performance. Because of the longitudinal nature of

the data collected (the four case histories covered six to twelve years), I was also able to determine, with the help of the managers involved, the impact of their efforts.

The four MGE divisions were supervised by different groups 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. This gave some variation to the MGE data.

The number of interviews per division 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 activities in several divisions.

The MGE divisions I visited competed in a relatively narrow range of chemical-related industries. Their innovation reputations were 'average.' To broaden the range of interventions in the sample, I gathered data from companies in other industries, and from companies with better (and worse) innovation reputations. The additional sites included nine business organizations and one government agency. Managers at these sites used some methods to improve innovation performance which were not used at MGE.

The ten business organizations (including MGE) where interviews were conducted varied in terms of their innovation performance. I measured performance by ratings in polls of industry managers and by the results of industry prize competitions. By this measure, MGE was an average innovator. Three of the companies were clearly superior to MGE on this dimension. The companies also varied by industry, with manufacturers of industrial and consumer products (both durables and non-durables) being heavily represented. MGE mainly manufactured industrial products, though it also had a pharmaceuticals branch. Three were headquartered in the United States, with the rest being headquartered in two European countries. The government bureaucracy was European. Interviews were conducted in four countries with managers of ten nationalities. Table 1 gives a brief description of each site.

[Insert table 1 about here.]

Framework for Data Collection

As this was a theory development project, the initial questions used to structure interviews were open-ended. These questions allowed 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 list the general categories of variables found, together with a few representative works dealing with each 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 to organize data collection in this area.

Methods of Data Analysis

Data collection and analysis proceeded somewhat differently at MGE than at the other sites. The difference was due to the fact that data collection at MGE focused on the histories of four innovation projects and the divisions within which the projects were housed. There were no focal projects at the other sites.

Each interview began with three open-ended questions. At MGE, 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 division/company.

The questions were left open-ended to allow respondents to bring up aspects of management activity 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/division, along with information on the factors previously identified as impacting innovation performance.

Interviews at the other sites followed the same procedures as the MGE interviews. The first open-ended question (on project history), however, focused on the history of a 'typical' project, rather than on a specific project.

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 MGE interview notes was assembled into four detailed project histories. Information on general management activity related in any way to innovation management in the division 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 at least 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 history was analyzed into a series of events. Each 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 and sixteen sub-categories. The classifications were modified as the analysis proceeded, as inconsistencies and useful additional distinctions were found. The final classification includes forty-nine types, sixteen sub-categories, and five categories. The forty-nine types corresponded to forty-nine methods by which general managers could impact innovation performance.

While I did not write detailed case histories at the other companies, the notes from interviews at these companies were analyzed in a similar fashion. Each interview was broken into a series of descriptive statements about the company's management practices and innovation structures. Over 1200 descriptive statements were identified in all. These statements were also classified via a Q-sort method. The sort revealed a number of management practices which had not been used at MGE. It also revealed a number of dimensions of structural variation which had not yet been manipulated at MGE. In all, thirty-one potential methods by which managers could impact innovation performance were identified, in addition to the forty-nine already identified in the MGE data.

The eighty types of interventions were grouped into five overall categories. While a detailed discussion of the eighty types would be far beyond the scope of this paper, I will briefly describe each of the five categories.

The first category included thirty-eight types of intervention impacting the overall business system. These included changes in corporate strategy & goals, changes in organization and communication structure, changes in personnel policy, and attempts to change corporate culture. The second category included nineteen types of interventions impacting the innovation project system. These included methods of generating ideas, changes

in project funding systems, changes in project structure and in project management methods. These two categories were analyzed to produce the model presented in this paper. Examples of each type of intervention in these two categories are given in table 4, which appears later in this paper.

The third category included four types of interventions involved in setting up a project. The fourth category included twelve types of interventions impacting the ongoing management of a project. These included routine supervision, participation, consulting (or mentoring), and direct project management. Since these two categories involved actions which impacted only one project, and not the whole innovation system, these categories were not part of the analysis presented in this paper.

Finally, the fifth category included six types of intervention, each related to the stimulation of reflection about the whole innovation management system. Since interventions in this category had no direct impact on the innovation system, they, too, were excluded from the analysis presented in this paper.

Building the Model

The interview notes included information on what managers were trying to accomplish when they intervened in the innovation system. In addition, in the case of many historical events, managers were able to describe the actual impacts of their interventions. These descriptions of what managers were trying to accomplish (or had accomplished) were compared in a search for common themes.

One dependent variable was common to all interventions. Given the focus of the study, it is not surprising that this variable was 'changes in overall corporate innovation performance.' In other words, the ultimate goal of managers' interventions was to improve overall corporate innovation performance. But in addition, several sets of intervening variables were identified. These will be reported in the next section. I used an iterative, trial and error process to construct a series model to represent the links between interventions, intervening variables and the dependent variable. Each model in the series was compared to the data to find

discrepancies (i.e., interventions which weren't adequately represented). An overview of the last version of the model is presented in this paper.

It is not possible to present the model in all its detail in one paper. Here I will discuss in detail the dependent variable and two sets of intervening variables (see figure 2). In addition, I will give examples of how individual interventions impact the intervening variables. A more complete discussion of how the interventions link with intervening is available from the author.

OVERVIEW OF THE MODEL

The Dependent Variable

The dependent variable is 'changes in firm-wide innovation performance,' or, simply, 'improved innovation performance.' Several companies measure this variable. USMfg and USChem systematically quantify innovation outputs in terms of revenues and profits gained from new products or product improvements, or in terms of costs reduced due to process improvements. These numbers are not necessarily made public. They are used in internal accounting and are sometimes used to determine the effects of long-term changes in policy.

Innovation performance can be quantified in terms of increased revenues, decreased costs, and increased profits, all deriving from innovation efforts. If performance is measured, then changes in performance can be measured as well. All companies interviewed shared the goal of improving innovation performance.

It would be possible to build a model which linked management interventions directly with changes in innovation performance. This would not be a very helpful model, however. Too many types of intervention can cause changes in firm-wide innovation performance. Some of them (e.g., efforts to improve idea generation) have five and ten year lags before they have a measurable impact on corporate innovation performance. A serious effort to sort them all out would be an econometric nightmare.

Managers who tried to measure the impact of their interventions faced a similar problem. At some firms, managers made many different interventions to improve innovation

performance. Trying to measure the impact of each on overall performance was impossible. Managers at sample firms dealt with this problem in two ways. First, they broke the concept of 'overall innovation performance' into four components. I label these components 'intermediate goals' and discuss them in the next paragraphs. Second, they broke the innovation process into subprocesses and measured the impact of their actions on each subprocess. I discuss their way of looking at sub-process goals shortly in the section on 'innovation process performance characteristics.'

Intermediate Goals Related to Components of Innovation Performance
(Downstream Intervening Variables)

When managers talked about overall innovation performance, they talked about four distinct aspects of performance. Organizations set goals with respect to two or more of these aspects of performance. These intermediate goals related to:

1. The extent to which the company produced innovations which matched existing (i.e., manifest) customer needs,
2. The extent to which the company produced innovations which matched unexpressed (i.e., latent) customer needs,
3. The overall speed of the innovation process, and
4. The overall cost of the innovation process (less often cited).

(See figure 2, which lists the four intermediate goals and summarizes the whole model.)

[Insert figure 2 about here.]

Managers were concerned both with the creativity and with the efficiency of the innovation processes. The first two goals related to the creative side of innovation. In effect, managers operated with a market model which featured two kinds of opportunities. One kind involved things that customers knew they wanted. Customers could talk about these opportunities clearly. Such opportunities could readily be identified. In many cases, their value could be quantified. In traditional marketing terms, these were market-led innovations.

The other kind of opportunity was more difficult to identify and quantify, for it related to latent, or unexpressed customer needs. These could be called technology-led innovations. But in many cases (e.g., Post-It Notes), the technology involved was simple. These opportunities involved speculative development of a product in advance of expressed customer demand.

With respect to efficiency, managers saw two different aspects of efficiency which needed managing: speed and cost. Of these, speed received the most attention. Managers believed that opportunities were time sensitive (see Stalk & Hout, 1990). The earlier they were able to enter the market, the more profit they would earn.

The concern with speed was based on three things. First, patents and patent protected profits expire. In industries such as pharmaceuticals and chemicals, where new molecules can be effectively protected by patents, one extra year of patent life equaled one extra year of profit. Second, in areas with less effective patent protection, the entry of potential competitors was seen as reducing profit available to a late starter. Third, in still other areas, annual profits were not forecast to decline over time. But entry one year earlier was seen as bringing one extra year of profits.

Cost was mentioned as a concern less often than speed, but was nonetheless viewed as important, particularly by those who dealt with large projects. Concern with cost came out in cost reduction programs, particularly in companies which handled large number of similar projects (e.g., pharmaceutical companies). But even companies with more diverse project portfolios made cost reduction efforts (e.g., USChem).

I will give several examples of methods managers used to achieve their intermediate goals. In 1994, managers reorganized MGE's Industrial Chemical division. Formerly, each business unit within the division had established its own independent contacts with customers. As a result, many customers were visited by separate sales people from different MGE divisions. In addition, only sales people had direct contact with customers. Technical people had to rely on sales people to pass on information on customer needs.

In the 1994 organizational reform, division management established new industry sales teams which included representatives from all relevant business units. For the first time,

representatives from all business units serving each client were expected to talk to each other and to look for potential synergies between their product offerings. It was anticipated that this access to the full breadth of MGE technology would make these new teams more effective at generating ideas for solutions to manifest and latent customer needs (goals 1 & 2).

In addition, the new teams included technical representatives from each business unit. For the first time, technical people from each BU were in direct contact with customers. It was anticipated that this would speed communication between customers and the technical side of MGE (in fact this was the case). It was anticipated that quicker communication at this early stage would reduce the time needed for the entire innovation process (goal 3).

These reforms weren't the whole story. Management also put considerable emphasis on retraining operating unit and project managers so that they would react more quickly and effectively to the needs they found, thereby decreasing overall cycle time and increasing the effectiveness of MGE's response to customers.

USMfg used surveys of customers, and of their customers' customers, to help in the early identification of manifest and latent customer needs. The establishment of satellite labs within business units helped speed the innovation process once needs were identified.

EurAuto was concerned with the cost of its new vehicle development process (goal 4). Cost reduction was viewed as an important and valuable side effect of cycle time reduction.

The organizations studied did not necessarily give equal weight to all four downstream goals. Managers interviewed at USMfg put considerable emphasis on detecting and reacting to customer needs, both latent and manifest. Speed and cost were concerns as well, but, in most interviews, they received less emphasis. By contrast, at MGE Pharma, speed of development was the chief preoccupation, and the reason for most of the interventions which occurred. Meeting manifest customer needs was also a concern, as was cost reduction. But matching latent needs received much less emphasis, as it was believed that most needs in the medical area were already manifest.

Innovation Process Performance Characteristics (Upstream Intervening Variables)

While managers would at times say that they were working on 'increasing the overall speed of the development process,' or on 'achieving a more effective match with customer needs,' in fact their interventions were usually more focused than that. Most interventions were designed to impact, not the whole innovation process, but one phase of the process.

When they worked on speed, for instance, managers did not try to speed up idea generation, funding decisions, and development all at once. Rather, they would conduct separate interventions, some of which were designed to speed up funding decisions, others to speed up development, still others to speed up idea generation (i.e., to make sure that the company recognized opportunities without delay).

By looking at the components of the innovation process, I was able to identify eight specific components of innovation performance which managers tried to manage. These were:

1. Generation of useful innovation ideas related to expressed customer needs,
2. Generation of more speculative innovation ideas, based on possible latent needs, ideas which might result in the development of new products or businesses,
3. Speed with which ideas are generated (i.e., minimizing the delay between the time an opportunity comes up and the company recognizes it),
4. Ability of the project selection/funding system to select projects which will bring something to the company (appropriateness of project funding decisions),
5. Speed with which the project funding system makes decisions,
6. Appropriateness of decisions made by development team during development,
7. Speed of development, and
8. Cost of development.

The first three performance components relate to the idea generation phase. Of these, #'s 1 and 2 relate to creativity or effectiveness in meeting customer needs, while #3 is an efficiency concern (speed). The next two performance components relate to funding decisions. Of these, #4 relates to creativity/effectiveness (creative ideas must be approved and funded if they are ever to reach fruition) and also to efficiency (avoiding waste on pointless projects, a cost concern). #5 is an efficiency concern (speed). The last three performance components relate to development. Of these, #6 relates to creativity (the development team may frequently

have to choose between creative but risky solutions and more conservative solutions), while #'s 7 and 8 are efficiency concerns (speed & cost). Thus, as indicated by the model, managers were concerned with both creativity and efficiency throughout the innovation process. (See figure 3.)

[Insert figure 3 about here.]

These eight performance components are far more easily measurable, particularly in the short term, than innovation performance overall. Managers measured the impact of their actions on these components of performance rather than trying to measure their impact on overall performance. I will give examples of how companies measured each of the components.

1. MGE Pharma counted ideas which reached a certain hurdle in terms of feasibility and interest. USChem not only counted such ideas, it estimated their potential value to the company.

2. Some of the ideas generated at USChem were speculative in nature. Like ideas related to expressed customer needs, these ideas were screened for feasibility, counted, and their value to the company estimated.

3. In a variety of specific instances, USMfg looked at the amount of time it took to communicate information from customers back to technical units. This communication was viewed as part of the idea generation cycle and USMfg took steps to shorten it.

4. No company was able to quantify the accuracy of project selection decisions in a single number. But managers frequently talked about mistakes made in selecting projects. Prominent mistakes (e.g., the failure to give stable funding to an important project during its first four years) sometimes resulted in reforms to funding systems. One measure of effectiveness was the incidence of mistakes, such as reversed funding decisions or missed opportunities.

Senior managers interviewed were particularly concerned that their funding systems not exclude good, creative ideas. Cases of missed opportunities at Industrial Chemicals, USMfg, and others, were long remembered

USChem tracks the impact of funding decisions on the company's competence base. Project investments are coded with respect to which of the company's competences will be affected. If the funds being invested in one competence are considered insufficient, additional funds will be allocated to be sure that that competence is maintained at a high level.

Thus, two methods existed of tracking the quality of funding decisions: tracking mistakes, and tracking impacts on specific outcomes, such as the development of the company's competences.

5. Speed of funding decisions can be measured by measuring the time interval from submission of the initial proposal to when a decision is communicated to the prospective development team. No company in my sample tracked this universally, but several tracked it in specific cases. USMfg, for instance, noted that allocation of resources was slow for ideas coming in from overseas business units. To fix this, the firm decentralized both responsibility for funding decisions and the lab resources themselves to the business units.

6. Like the appropriateness of funding decisions, the appropriateness of project management decisions is hard to sum up in a single number. Nonetheless, managers judged whether projects were well run or not. Increasingly over time, organizations such as MGE's Pharma and Industrial Chemical divisions developed standards and training programs for project management.

Project management is not just a cost issue, though the cost impacts of project decisions are obvious. Creative ideas can fail needlessly if the projects designed to develop them are not well run. At the same time, creative solutions to problems may emerge during the course of a project. Managers at innovative companies such as USMfg expected project managers to facilitate the emergence of such solutions, rather than sticking to rigid plans.

Measuring the effectiveness of project decision making is difficult. The efficiency dimensions (cost and time) are clear, but the effectiveness dimension is not. When senior managers judged the effectiveness dimension, they looked at issues such as the following.

Were opportunities were seized or missed? Did the project manager effectively track changes in his/her market and important technologies? Did the project manager identify and focus on the real critical issues? Were timely, appropriate actions taken in situations of crisis or change? Did the project manager show enough personal initiative? Supervisors could judge performance on these criteria only when they had considerable knowledge of a project's history. Supervisors with this level of knowledge did not hesitate to make judgments about the effectiveness of project management.

7. By 1994, speed of development was measured routinely in pharmaceuticals and motor vehicles. Within these industries, projects could be expected to follow roughly the same schedules. MGE Pharma and EurAuto both measured elapsed time between major project milestones. Both companies set strict time goals for project completion.

Measuring time measurement was more difficult in companies with a variety of non-similar projects. Here, it was not possible to set universal standards for project completion times. Nonetheless, MGE's Industrial Chemicals and Advanced Materials divisions asked project managers to set goals for completion time. The divisions monitored their success at complying with their own estimates.

8. In most companies, cost of development was a secondary concern, with speed having a higher priority. Nonetheless, all companies measured cost. Most companies had systems where people's time was contracted and billed to project budgets. Typically they undertook efforts to reduce project cost.

Companies measured cost reduction opportunities in two ways. Motor vehicle and pharmaceutical companies could compare costs across projects, since they typically had series of similar projects. In companies with more diverse portfolios, comparisons were more difficult, since projects varied widely in size.

Management at USChem dealt with size variation by comparing large groups of projects. In the early 1990s, management compared the cost of projects brought to completion with those terminated before completion. They were surprised to learn that there was little difference in total cost incurred between these two groups. They took this as evidence that people were investing in projects beyond the appropriate termination point. To encourage

early termination, when appropriate, they tried to remove any stigma from termination. Far from being punished for having a 'failed' project, team members were congratulated by senior managers for terminating a project appropriately. The phrase 'failed projects' was banished from the company's vocabulary and replaced with the phrase 'terminated projects.'

Links between Upstream and Downstream Intervening Variables

Figure 2. which outlines the whole model, shows links between the Performance Components (upstream intervening variables) and the Intermediate Goals (downstream intervening variables). I describe these links here.

Goal 1: Better Match with Existing Customer Needs. Broadly, there were three ways to assure a better match between a company's innovation activity and existing customer needs. These were: (1) generation of more ideas in relation to existing customer needs, (2) selection of projects on the basis of their match with existing customer needs, and (3) making decisions during development which take account of existing customer needs. Thus, in figure 2, arrows are drawn from three of the Performance Components boxes (Idea Generation: Manifest Needs, Appropriateness of Project Funding Decisions, and Appropriateness of Development Decisions) to the first Goal box (Match Existing Customer Needs).

Goal 2: Improved Anticipation of Future Customer Needs. The methods of achieving this goal parallel those for reaching the first goal. Companies can assure that they better anticipate future customer needs by: (1) generating more ideas in relation to anticipated future customer needs, (2) selecting projects on the basis of their likely match with future customer needs, and (3) making decisions during development which take account of potential future customer needs. Thus, in figure 2, arrows are drawn from three of the Performance Components boxes (Idea Generation: Latent Needs, Appropriateness of Project Funding Decisions, and Appropriateness of Development Decisions) to the second Goal box (Anticipate Future Customer Needs).

Goal 3: Increasing Speed Versus Competitors. Broadly, companies had three methods of speeding the overall innovation process: (1) generating ideas of all kinds more quickly, (2) making project funding decisions more quickly, and (3) speeding up development once projects

are funded. Thus, in figure 2, arrows are drawn from three of the Performance Components boxes (Quicker Idea Generation, Speedier Project Funding Decisions, and Speed of Development) to the third Goal box (Speed Versus Competitors).

Goal 4: Reducing Cost. Managers cited two ways of reducing overall cost. The first related to funding decisions. With better funding decisions, investment in projects unlikely to bring anything to the company could be reduced, thus saving the company money overall. The second method related to the cost of funded projects. To the extent the productivity of repeated activities (chemical screening, etc.) could be improved, money could be saved overall. Thus, two arrows are drawn to the Reducing Cost goal box.

Having discussed the dependent variable and the intervening variables, I will now turn to a brief discussion of the independent variable, management interventions.

The Independent Variable: Interventions by Managers

In figure 2, the independent variable, 'managers' interventions,' is left unspecified. Five categories of management interventions were discussed in the methodology section. Two categories are relevant to this model: interventions impacting the project management system, and interventions impacting overall business management systems. Examples of these interventions are given in table 4. I cannot, given space limitations, discuss each type of intervention and its impact on innovation performance. Nor does the reader need to understand each type. Rather, I will limit myself to giving one or two examples of methods managers used to impact each of the process performance characteristics.

[Insert table 4 about here.]

Interventions Impacting Idea Generation. In the area of idea generation, managers implemented several broad types of interventions. One related to assembling competences potentially relevant to customers' needs. Another involved setting up communications paths between people holding different competences. Various methods were used to set up paths, including cross-functional work groups, facilitating *ad hoc* links, and rotating people. The

theory behind all of these methods was that new innovation ideas were likely to come from new links between existing competences. The denser the network of links, and the easier it was to form new links, the more links would be formed (Performance Component 1 & 2) and the faster they would be formed (PC3).

Interventions Impacting Funding Decisions. Managers in several sample firms restructured their project funding systems. One typical intervention was to decentralize funding decisions so that people closer to the relevant technologies and markets could make the decisions. The theory behind this was that better information would be brought to bear on the decision, resulting in more appropriate decisions (PC4). In addition, communications links between the potential project team and the decision maker would be shorter, resulting in faster decisions (PC5).

Interventions Impacting Development. Several companies implemented training programs for their project managers. One intent of these programs was to train project managers to take a variety of technical and market factors into account when making decisions (PC6). In addition, several companies, particularly those in pharmaceuticals and autos, began measuring and controlling the amount of time needed to complete projects. Project workplans were often redesigned to overlap pieces of work, thus shortening the time to completion (PC7). USChem (among others) also compared costs across projects. USChem devised means of identifying problems in projects early, thus reducing overall cost (PC8).

These few examples do not give a complete picture of the interventions used to improve innovation performance. Nor can any one paper give a complete picture. Working papers which describe the interventions in more detail are available from the author.

COMPARISON WITH MODELS OF PERFORMANCE DETERMINANTS

There are several important differences between the model presented here (the managerial action, or MA model) and the performance determinants models (PD models) discussed by Brown & Eisenhardt (see figure 5). I will summarize the differences by

comparing, first, the dependent variables, then the independent variables, and finally the intervening variables.

[Insert figure 5 about here.]

Dependent Variables

Brown & Eisenhardt identify three streams of product development research. Two of these streams (rational plan & communications web) have the success of individual projects as their dependent variable (true PD models). The third (disciplined problem solving) has intervening variables from the other models (e.g., speed and productivity of the process) as dependent variables.

By contrast, the MA model has changes in corporate-wide innovation program performance, not individual project performance, as its focus. The differences are two. The MA model focuses on a corporate-wide variable, not an individual project variable. And it also focuses on changes in performance, not absolute levels of performance (success or failure).

The differences are important. The corporate-wide performance perspective focuses attention on issues which can be overlooked if the focus is on individual projects. These include: (1) methods of facilitating the generation of ideas prior to the formation of projects (as opposed to methods of evaluating ideas, once they are generated), (2) methods of developing a long-term competence base useful for multiple projects, (3) methods of identifying likely-to-fail projects early, and (4) methods of dealing with project personnel after the project ends (particularly important in the case of failed projects). These issues have not been a focus of the project management literature, as witnessed by their omission from Brown & Eisenhardt's discussion.

The MA model focuses on changes in performance rather than on absolute levels of performance. The independent variables involve interventions designed to improve performance. To see the impact of these interventions, it is necessary to measure changes in performance, not just absolute levels of performance.

Independent Variables

In the MA model, the independent variables are interventions, or actions by management. In PD models (e.g., Brown & Eisenhardt), the independent variables are measurable conditions (rather than managerial actions) of the corporation, or measurable conditions of the environment. In the MA model, environmental variables receive no emphasis, since they are rarely manipulable by management. (A decision to enter or leave a market, i.e., to enter or leave an environment, would count as an intervention in corporate or business unit strategy.)

There is a correspondence of a sort between many of the intervention types in the MA model and the independent variables in the Brown/Eisenhardt summaries. The MA model includes interventions impacting internal and external communication, team composition, team organization, and the other independent variables in the Brown/Eisenhardt summaries. This correspondence is to be expected and is completely appropriate, since most of the independent variables in the Brown/Eisenhardt summaries are subject to direct management manipulation (in MA model terms, they can be impacted by direct management interventions).

But not all the intervention types in the MA model have equivalents in Brown & Eisenhardt's summary model. In some areas (e.g., communication), the MA model identifies numerous ways to impact the state variables which are present in Brown/Eisenhardt (compare table 4 with figure 5). In other areas (e.g., competence building) the MA model includes issues which are important to the corporation as a whole, but less relevant to the success of individual projects.

Intervening Variables

Brown & Eisenhardt identify two sets of intervening variables. The first are process performance characteristics: lead time (speed) and productivity. The second are product concept effectiveness measures: fit with market needs, and fit with firm competences. There is an inexact correspondence between these intervening variables and the intermediate goals in the MA model.

Brown/Eisenhardt's variable 'lead time (speed)' corresponds to the MA model's goal 3: 'increasing speed versus competitors.' Brown/Eisenhardt's variable 'productivity' corresponds to MA goal 4: 'reducing overall cost.' Their variable 'fit with market needs' corresponds to MA goals 1 and 2: 'better match with existing customer needs,' and 'better anticipation of future customer needs.'

Their last intervening variable, 'fit with firm competences,' does not correspond to anything in the MA model, since the latter focuses on overall program success, not project success. While fit with firm competences is recognized as an important factor in project success (as reflected in Brown & Eisenhardt's model), managers I interviewed believed that it was necessary to do some projects which went beyond the firm's existing competences. They recognized that such projects were riskier. Nonetheless, if the firm wished to diversify into new areas or expand its competence base, it was necessary to do such competence-stretching projects now and then. Though such projects were more likely to fail, investment in a limited number of them was viewed as having a positive effect on the firm's innovation performance.

Other Differences

As noted at the beginning of the paper, the two types of model are designed to answer quite different questions. PD models identify factors leading to project success/failure. A proper weighting of factors is an important outcome of such a model-building effort. Such weightings could help both managers and academics predict which projects (or potential projects) within a group are likely to succeed. It could also help managers determine what variables to manipulate in order to encourage project success.

The MA model, as currently presented, does not attempt to weight the relative impact of different types of interventions. Rather, it attempts to identify the full range of methods which managers can use to improve innovation performance. While frequency of use may be a proxy for impact (measures with higher impact may be used more frequently), no other effort is made in this paper to distinguish between high- and low-impact interventions.

In effect, the decision rule for inclusion in the MA model is whether an intervention works at all. If the sign of impact is positive, it is included, regardless of the size of the

coefficient (no coefficients are estimated here). This reflects a perspective that views the innovation process as a complex one which can be impacted (or adjusted) at many points. All aspects of the process must be working optimally for the process as a whole to be working optimally. As a result, the MA model gives a finer-grained look at the workings of the innovation process, and of the methods available to managers for adjusting it, than does a PD model.

CONCLUSION AND NEXT STEPS

The model presented in this paper links managerial action with measures of change in innovation performance. The model is an overview. There is room for considerable additional work. This would involve filling in details of how managerial actions affect firm subsystems and innovation process components which, in turn, have an impact on overall innovation performance.

In this paper I have given examples of interventions used to improve three phases of the innovation process: idea generation, funding systems, and development. But the examples given were not complete. Much more can be said about the specific methods general managers use to improve idea generation capacity. Methods of structuring and improving a funding system also deserve a closer look. Methods of transforming development processes have already received considerable attention (e.g., Clark & Fujimoto, 1991). But much work in this area has focused on the auto industry. There is still room for studies of methods used to improve innovation performance in more diversified firms.

Another stream of work could focus on the transformation of key subsystems. Many interventions reported in the database focused on companies' communications systems, organization structure (particularly project structure) and human resource systems. In table 4, I listed examples of the types of interventions used in each of these areas. Further disciplined, detailed work is needed to identify, classify and analyze the methods used to transform each of these key subsystems.

At a more micro level, the model disaggregates 'innovation performance' into eight components. Each component was measured (at least informally) by one or more companies in the sample. One of these performance components (speed of development) has been studied in detail (see, for example, Eisenhardt & Tabrizi, 1995). It would be useful to have equally detailed analyses of performance and methods of transformation in each of the other seven areas.

This work would be greatly facilitated if we were able to develop better measures of performance in each area. At least one company in the sample measured performance (sometimes informally) on each dimension. But few companies attempted to measure the volume of ideas generated, the appropriateness of funding decisions, or the appropriateness of decisions during development. Those which did try to measure these constructs used measures which were crude at best. The absence of measures inhibits our ability to progress further in this area. Developing better methods of measuring these aspects of performance is another task for the future.

REFERENCES

Allen, T.J. 1977. Managing the flow of technology: Technology transfer and the dissemination of technological information within the R&D organization. Halliday.

Angle, H.J. 1989. Psychology and organizational innovation. In Van de Ven, A., Angle, H., and Poole, M.S., eds., Research on the management of innovation: 135-170. New York: Harper & Row.

Angle, H.J., & Van de Ven, A.H. 1989. Suggestions for managing the innovation journey. In Van de Ven, A., Angle, H., and Poole, M.S., eds., Research on the management of innovation: 135-170. New York: Harper & Row.

Bower, J. 1970. Managing the resource allocation process. Homewood, IL: Irwin.

Brown, S., & Eisenhardt, K.M. 1995. Product development: Past research, present findings, and future directions. Academy of Management Review, 20: 343-378.

Burgelman, R.A. 1983. A process model of internal corporate venturing in the diversified major firm. Administrative Science Quarterly, 28: 223-244.

Dougherty, D. 1992. Interpretive barriers to successful product innovation in large firms. Organization Science, 3: 179-202.

Eisenhardt, K.M. 1989. Building theories from case study research. Academy of Management Review, 14: 532-550.

Eisenhardt, K.M., & Tabrizi, B.N. 1995. Accelerating adaptive processes: Product innovation in the global computer industry. Administrative Science Quarterly, 40: 84-110.

Glaser, B.G., & Strauss, A.L. 1967. The discovery of grounded theory: Strategies for qualitative research. Chicago: Aldine.

Goold, M., & Campbell, A. 1987. Strategies and styles: The role of the centre in managing diversified corporations. London: Basil Blackwell.

Haspeslagh, P. 1985. Toward a concept of corporate strategy for the diversified firm. Stanford Business School Research Paper Number 816.

Haspeslagh, P. 1986. Conceptualizing the strategic process in diversified firms: The role and nature of the corporate influence process. INSEAD working paper number 86/09.

Imai, M. 1986. Kaizen: The key to Japan's competitive success. New York: McGraw-Hill.

Maidique, M., & Hayes, R.H. 1984. The art of high technology management. Sloan Management Review, Winter: 17-31.

Miles, M.B., & Huberman, A.M. 1994. Qualitative data analysis: An expanded source book, 2nd edition. Thousand Oaks, CA: Sage.

Porter, M.E. 1980. Competitive strategy: Techniques for analyzing industries and competitors. New York: The Free Press.

Roberts, E.B., & Fusfeld, A.R. 1981. Staffing the innovative, technology-based organization. Sloan Management Review, Spring: 19-34.

Stalk, G., & Hout, T.M. 1990. Competing against time: How time-based competition is reshaping global markets. New York: Free Press.

Strauss, A.L., & Corbin, J. 1990. Basics of qualitative research: Grounded theory procedures and techniques. Newbury Park, CA: Sage.

Van de Ven, A. 1986. Central problems in the management of innovation. Management Science, 32: 590-607.

Von Hippel, E. 1986. Lead users: A source of novel product concepts. Management Science, 32: 791-805.

Von Hippel, E. 1987. Cooperation between rivals: Informal know-how trading. Research Policy, 16: 291-302.

Yin, R.K. 1984. Case study research: Design and methods. Beverly Hills, CA: Sage.

TABLE 1

Sites

MGE. Diversified in a variety of industrial & consumer products. Interviews were conducted in the Industrial Chemicals, Pharmaceuticals, Lawn & Garden, and Advanced Materials divisions. Efforts to improve innovation performance since the late 1980s. An average innovator. 50 interviews.

USChem. Diversified in a variety of chemical specialties. An excellent innovator, though not as highly rated as USMfg or ConPro. Efforts to improve innovation performance since the mid-1980s. 16 interviews.

EurAuto. A motor vehicle assembler. An average innovation reputation. Management very active in trying to improve innovation performance since the mid-1980s. 10 interviews.

ConPro. A diversified manufacturer mainly focused mainly on consumer products. An excellent innovator. 10 interviews.

USMfg. A diversified manufacturer focused on industrial and consumer products specialties. An excellent innovator. 8 interviews.

EChem. Another diversified manufacturer with interests in chemicals and pharmaceuticals. An average innovator. 3 interviews.

MachineCo. An industrial machinery manufacturer. A leader in its niche, with several recent innovative breakthroughs. 3 interviews.

ConElec. A consumer electronics manufacturer. An average innovator. 1 interview.

OptiCo. A manufacturer of optical equipment. A leader in its niche. 1 interview.

FinCo. A diversified financial services company. One of several leaders in its industry. 1 interview.

Admin. A public bureaucracy focusing on defense-related issues. No clear indication of its reputation for innovation. 1 interview.

FIGURE 2
Model of Managers' Impact on Innovation Performance

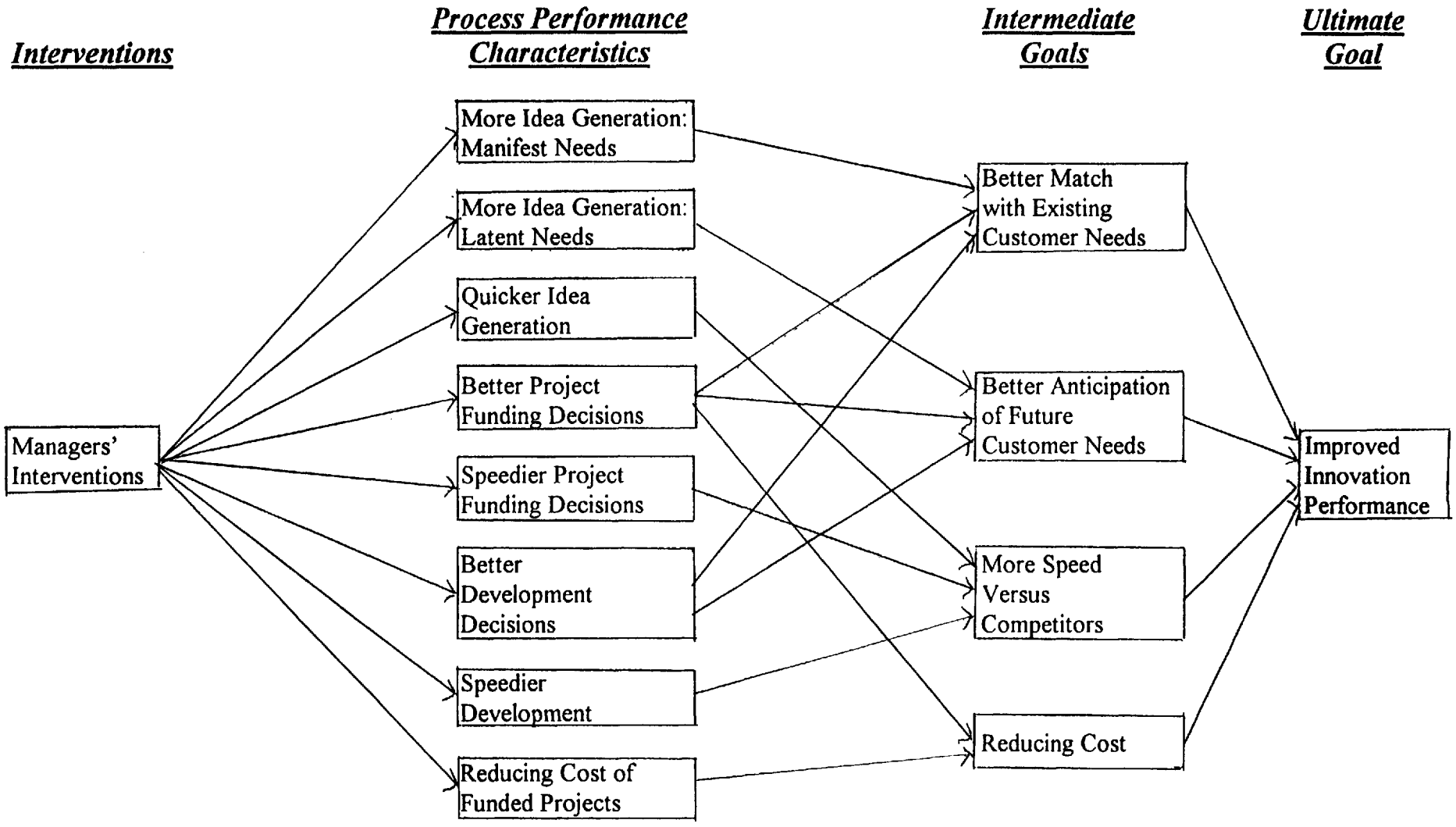


FIGURE 3
Innovation Process Performance Characteristics by Goal and Phase

Goal	Idea Generation	Funding Decisions	Development
Effectiveness or Creativity (meeting customer needs)	PC1: Number, value of ideas: manifest needs PC2: Number, value of ideas: latent needs	PC4: Appropriateness of funding decisions	PC6: Appropriateness of decisions during development
Efficiency: Speed	PC3: Speed of idea generation	PC5: Speed of funding decisions	PC7: Speed of development
Efficiency: Cost		PC4: Appropriateness of funding decisions	PC8: Cost of development

Phase

TABLE 4

Intervention Categories with Examples

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.)

*Idea Management
- *Implementing methods, such as creativity seminars and the like, with are designed to directly stimulate the generation of new ideas.
- *Identification of classes/types of ideas which commonly recur in the firm's industry; dedication of resources to the detection/exploitation of these ideas (e.g., regular advances in a particular component technology).
- *Identification of areas of the firm and environment which are likely sources of ideas; dedication of additional resources to these areas.
- *Identification of the sources and nature of consumer pull; dedication of resources to respond to that pull.

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.
- *Changes in the timing of funding decisions (i.e., how often they are made, when they are made).

Project Structure
- *Changing the internal structure of project teams.
- 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.
- *Changing the role of project team supervisors.

Project Management Methods
- Project Management Methods, Development. Changing methods of managing development.
- *Implementation Methods. Changing standard implementation methods.

(continued)

TABLE 4, page 2

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.
- *Changing business unit strategy.
- *Changes in who is responsible for determining corporate or BU strategy.
- Making and executing merger & acquisition decisions.
- Changing the competence portfolio held by the firm.
- *Developing methods to manage competence development.

Goal Structure
- Changing overall pattern of subunit goals.
- Setting overall corporate or divisional goals (e.g., financial targets).
- *Identification of customers' goals; dedication of resources to helping customers meet their goals.
- *Developing methods to measure progress towards goals.
- 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.

*Decision System
- *Changes in the methods by which decisions are made (e.g., consensus vs. autocratic methods of making decisions).
- *Changes in the system by which decisions can be protested or appealed to superiors.
- *Changes in level & timing of the monitoring of decisions by superiors.
- *Changing top managers' role in the decision system.

Communications System
- Changing communications paths within the firm.
- Changing communications paths with the outside.
- *Developing a common language and vocabulary.
- *Developing methods to communicate complex technical information.
- *Developing methods to facilitate searches for technical or market information within the firm.
- *Developing communication plan for encouraging innovation within firm.

*Information Management
- *Changing format in which information is communicated.
- *Changing the types of information a unit receives.
- *Changing the types or amount of information gathered from customers.

(continued)

TABLE 4, page 3

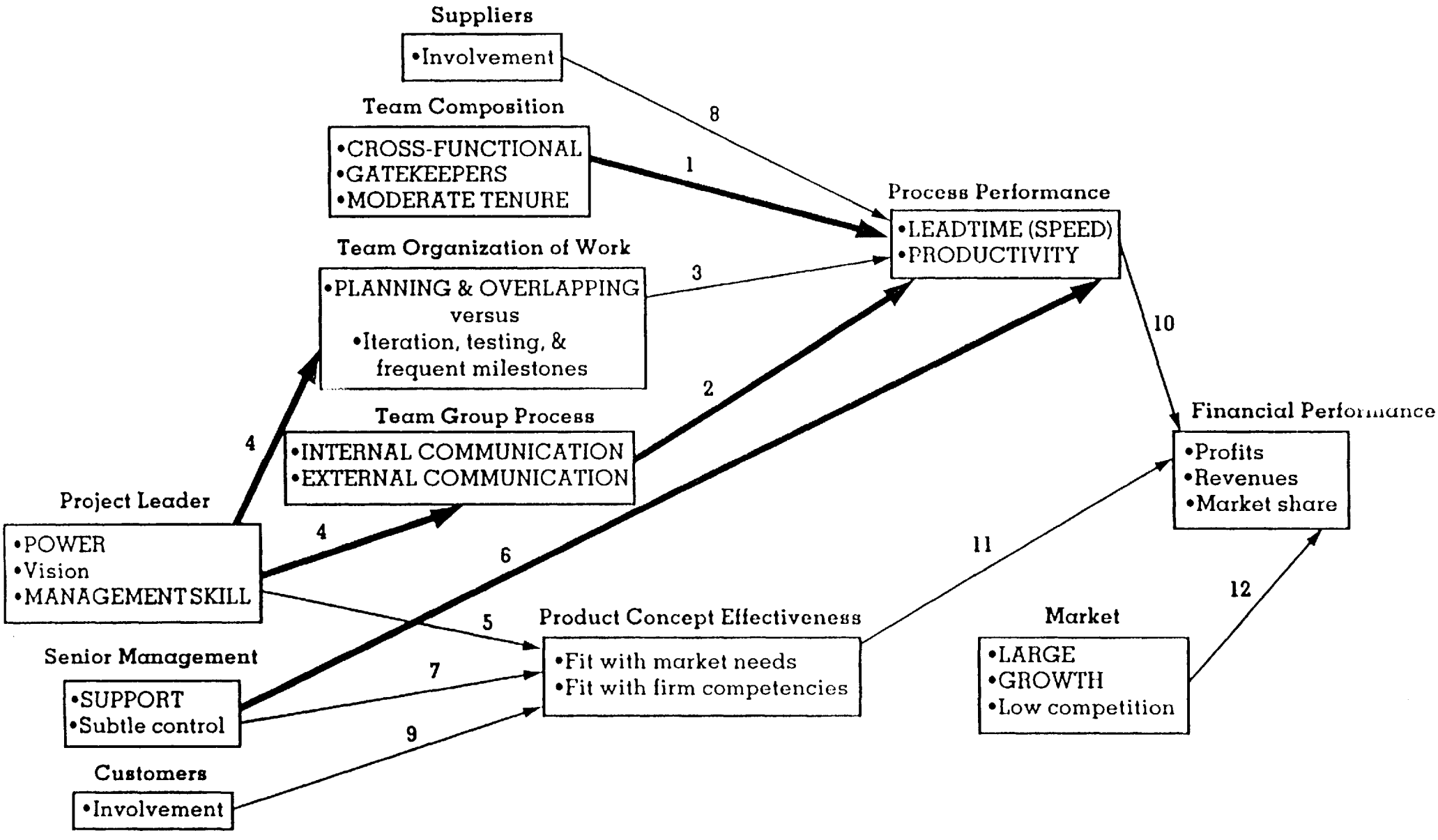
General Business System Interventions, continued

- Personnel System
  - Changing the sources or profiles of personnel hired.
  - *Changing career development patterns.
  - *Establishing policies to decrease turnover.
  - *Changing systems of individual goal setting and management.
  - Changing monetary incentives in relation to innovation.
  - Changing career incentives in relation to innovation.
  - Changing status incentives in relation to innovation.
  - *Changing personnel evaluation methods.
- Culture
  - Attempts to change unwritten rules of behavior.
  - Attempts to change behavior towards customers.
  - Attempts to change behavior in relation to innovation.

'*' = Examples not found at MGE but found elsewhere.

FIGURE 5 : Brown-Eisenhardt Summary Model

Factors Affecting the Success of Product-Development Projects[a]



[a] Capital letters and thickened lines indicate robust findings.