The Valley of Death as Context for Role Theory in Product Innovation

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The purpose of this paper is to define and explain the front end of product innovation as a discrete segment of development between research and product development. The Valley of Death is used as a metaphor to describe the relative lack of resources and expertise in this area of development. The metaphor suggests that there are relative more resources on one side of the valley in the form of research expertise and on the other side by commercialization expertise and resources. Within this valley a set of interlocking roles are examined that move projects from one side to the other. The empirical methodology used in this study gathered data from 272 Product Development & Management Association (PDMA) members with extensive experience in the front end of product development using a Web-based survey instrument. Extensive pretests with experienced practitioners were conducted to develop the instrument. Results indicate that significant development takes place before projects enter into a firm's formal product development process. The data also support the roles of champion, sponsor, and gatekeeper as major actors that work together to develop and promote projects for introduction into the formal process. Champions make the organization aware of opportunities by conceptualizing the idea and preparing business cases. Sponsors support the development of promising ideas by providing resources to demonstrate the project's viability. Gatekeepers set criteria and make acceptance decisions. The data also reveal a dynamic interdependence between role players. It is concluded that the Valley of Death is a productive tool for identifying and understanding a critical area of development that has not been adequately addressed. This research finds a dynamic interplay between roles to accomplish tasks that are not well understood in practice or the literature. The implications of this research are far-ranging. It suggests that companies must understand the challenges in the valley, must develop the skills, and must make resources available to master the front end of product innovation. Recognizing roles, providing resources, and establishing expectations and accountability in this area of development become manageable in light of these results. Theoretically, this research informs role theory of a dynamic set of relationships previously treated as static. It also empirically investigates an area of product development where there is limited data. This paper opens profitable inquiries by focusing on an area of development not adequately researched yet drives the activities and investment made in subsequent steps of product development.

Introduction

New product development (NPD) is key to maintaining a competitive advantage, and companies struggle to convert technology concepts into products. A major reason is that taking new ideas to market is not a seamless process. Multiple contributing factors play into this struggle, including social, political, and cultural transitions as well as material resource limitations. These barriers to commercializing technology frequently occur during the intervening period between research and NPD. In between the two more well-defined activities of research and NPD there is a more nebulous phase, re-

ferred to as the "Valley of Death" (Branscomb and Auerswald, 2001; Markham, 2002; Merrifield, 1995). This phase functions as the corridor between research and NPD, and although it is critical to realizing the commercial viability of products, it is an often overlooked element of success.

Recent writings identify that research is needed on preentry into the new product development (NPD) process (Khurana and Rosenthal, 1997; Koen et al., 2001; Reinertsen, 1999; Smith, Herbein, and Morris, 1999; Smith and Reinertsen, 1992). Concepts that address this area of pre-NPD include the fuzzy front end (Reinertsen, 1994, 1999; Smith and Reinertsen, 1991) and the front end of innovation (Khurana and Rosenthal, 1997, 1998; Koen et al.). These concepts describe activities in the space between research and NPD; however, they do not develop theoretical

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frameworks to explain the phenomenon. Other researchers have discussed practical tools used in this space, such as voice of the customer (Griffin and Hauser, 1993) and lead user techniques (von Hippel, 1986). As helpful as these tools are, they do not provide a structure that identifies or explains the range of activities in this region of development.

The important difference between the Valley of Death and these fuzzy front end of innovation concepts is that they are narrower constructs, focusing on the preparatory tasks (Cooper, 1997) that must be done before a concept is admitted into formal new product development or is absorbed by the organization (Cohen and Levinthal, 1990; Reid and de Brentani, 2004). The valley analogy recognizes the importance of pre-NPD idea preparation as well as the impact of the whole organizational environment (Khurana and Rosenthal, 1998) successfully engaging in these activities.

The valley analogy hence provides a framework for a specific segment of the development process. It elucidates the research-to-NPD organizational gap phenomenon that could impact finance, legal, production, and supply chain management. As an identifiable phenomenon, the Valley of Death identifies rich areas of research where new knowledge can dramatically improve practice. The valley construct identifies resources, roles, and processes not found in technological research or in NPD programs.

Scientists and engineers might argue that what NPD professionals call the "front end" is really the back end of their innovation process. The valley perspective recognizes the elements that perpetuate the tensions between invention and commercial innovation within the organization. The valley suggests that preparing ideas for commercial development is not just a function of research and NPD but also depends on organization-wide variables. As such, the question arises as to whether applying standard NPD stages and gates directly to emerging research is the optimal approach.

By understanding the "front end" as being aspects of a valley or gap between parts and roles of the organization rather than as set of preparatory tasks, practitioners are better able to design processes to cross that valley. For example, the people and the roles they play in transitioning an idea from one part of the organization to another part differs from simply preparing ideas for entry into NPD systems. This paper reviews the literature about the fuzzy front end, characterizes the valley, develops propositions about aspects of activities and roles within the valley, and then reports the results of survey research as a step to validate the valley as an innovation model.

BIOGRAPHICAL SKETCHES

Dr. Stephen Markham received his Ph.D. from Purdue University and is professor of management, innovation, and entrepreneurship in the College of Management at North Carolina State University and is president of the Product Development & Management Association (PDMA) Research Foundation, founder of the PDMA New Product Development Professional Certification Program, past PDMA officer and board member, and past director of the Technology, Entrepreneurship and Commercialization Program (TEC) and Center for Innovation Management Studies (CIMS). His research focuses on the roles and processes in the front end of innovation, concentrating on the role champions take in early commercial development of technology. Dr. Markham has been a founding board member or officer of numerous high-technology start-up companies and consults with numerous global technology-based companies.

Dr. Stephen Ward received his Ph.D. from North Carolina State University and is a partner with SWA Consulting. He advises on training evaluation, test development and validation, and statistical modeling to both governmental and private-sector organizations. His current research focuses on goal orientation, training outcomes, intercultural competence, and latent variable modeling.

Dr. Lynda Aiman-Smith received her Ph.D. from Purdue University and is professor of management, innovation, and entrepreneurship in the College of Management at North Carolina State University, where she also serves as research associate for the Center for Innovation Management Studies. Prior to her doctoral work, she worked at Raychem Corporation in a variety of positions in operations management. In the past few years she has engaged in research and educational activities with a number of organizations, including Air Products, Alcan Packaging, Cisco, IBM, and Red Hat. She is currently doing research and writing on innovation, managing technical professionals, services, and organizational culture.

Dr. Angus Kingon received his Ph.D. from the University of South Africa and is the Barrett Hazeltine University Professor of Entrepreneurship and Organizational Studies and professor of engineering at Brown University. He is the past executive director of the Technology, Entrepreneurship and Commercialization Program (TEC) at North Carolina State University, where he was professor of materials science and engineering with a joint appointment in the College of Management. In 1996 he was elected as a fellow of the American Ceramic Society. Dr. Kingon has chaired numerous material science conferences specializing in ferroelectric and dielectric thin films. His managerial research focuses on early technology commercialization processes. He advises global semiconductor companies on thin films and consults with numerous companies on technology commercialization issues. He has published approximately 300 reviewed papers.

Literature Review

The Front End of Product Development

Formal processes, such as Cooper's Stage-Gate® systems (Cooper, 1983, 1994, 1997; Cooper and Klein-

schmidt, 1993) and its many offshoots, have proven effective at driving ideas through NPD. Nevertheless, formal processes do not guarantee safe passage across the valley since they are often disconnected from front-end issues such as effectively developing seed ideas. Some firms have integrated pre-NPD activities into their overall formal NPD processes. These processes have been referred to as "Stage-Gate® zero" or "pre-Stage-Gate®" (Cooper, 1997; Khurana and Rosenthal, 1997). Some authors counter that formal processes, by default, cannot sufficiently accommodate front-end needs (Nobelius and Trygg, 2002), particularly for discontinuous innovations (Reid and de Brentani, 2004). These pre-NPD activities are designed to prepare ideas for adoption by the formal process but do not address all the issues associated with early innovation.

Formal processes and formal roles necessary for successful product development have been adopted as part of formal NPD processes and have done much to rationalize product development. This paper, however, aims to investigate the nature of informal roles, processes, and resources—not formal ones. An organization cannot formalize every role and responsibility for every possible project in which the company might be engaged. Therefore, informal role-taking is critical to innovation, especially to get ideas across the Valley of Death.

Valley of Death

The phrase *Valley of Death* was employed by Bruce Merrifield (1995) to refer to the challenges of transferring agricultural technologies to Third-World countries. The phrase was subsequently applied to describe the resource gap between R&D labs or units and commercialization within organizations (Branscomb and Auerswald, 2001; Markham, 2002). Since then, the term has been further extended to describe the funding handoff from governmental to private sources of renewable energy technologies (Murphy and Edwards, 2003). In this paper the valley is that gap between the formal roles, activities, and resources poured into research and the existing formal NPD roles, activities, processes, and resources that lead toward commercialization. Tensions between formal R&D units and commercial sides of the business are well documented (Fisher, Maltz, and Jaworski, 1997; Gupta, Raj, and Wilemon, 1986; Souder, 1988). Roberts (2004, p. 9) observes, "Most large firms are deficient in bringing the marketing vice president and marketing organization . . . into a compat-
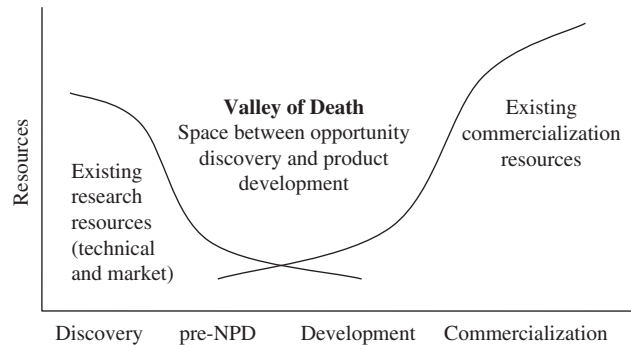

Figure 1. Valley of Death

ible and parallel role with the CTO . . . ." Roberts notes similar gaps between the chief financial officer (CFO) with the R&D business unit. This communication gap between research and commercial business units has also been identified in the fuzzy front end literature (Moenaert et al., 1995). The valley acknowledges the gap between organizational units, and other vital gaps between research and formal NPD.

Consistent with previous uses of the concept, in Figure 1, the y-axis maps resource availability, while the x-axis reflects the level of development. The outcomes demonstrate that adequate resources are available during research but then often drop precipitously. On the other side of the valley, resources appear again for developing ideas for entry into commercialization. As Figure 1 suggests, if an idea makes it through the valley to NPD, there is adequate resource availability to take the idea to market. The valley analogy represents a macro view of the structures, processes, people, and resources associated with moving innovation across the gap.

The basic valley concept of gaps, however, does not address who actually moves projects from idea to NPD or the relationships between participants. Neither does the valley specify the activities or process people engage in to move those ideas from research into formal NPD. To describe both the macro view as well as specific activities in the front end this paper integrates the literature on roles and activities into the framework of the valley.

Role Theory in Innovation

Role theory is used as a theoretical foundation for populating the various activities in the valley since role players animate action. Role theory facilitates observation not only of the roles themselves but also of the

ancillary processes and resources over which the respective role players have influence. Role players assume a position or an associated position in any given relationship, such as seller–buyer, boss–employee, or costumer–designer–actor. Role theory examines a wide array of role-related behaviors, such as expectations, norms, performance, evaluation, and sanctions. The sociologist George Herbert Mead (1934) was among the first to suggest that person-to-person relationships predispose an individual to a course of role-appropriate behavior and thought (Perdue, 1986, p. 237). According to Mead the essence of self is being reflexive. The individual self is an individual only because of relationships with others. Drawing on Mead's work, Coser (1977, p. 334) argued that social units (e.g., organizations) "... must be understood as a structure that emerges through an ongoing process of communicative social acts, through transaction between persons who are mutually oriented toward each other." Roles are described in terms of relative positions that occur in a given relationship: one person takes a focal position, and the other person assumes a counterposition (Shaw and Costanzo, 1982). Thus, counterrole partners (e.g., teacher and student; mentor and mentee) are formed.

Numerous roles in innovation have been proposed by notable authors. Roberts and Fusfeld (1982) discussed a series of roles in the innovation process, including idea generators, idea exploiters, champions, and sponsors. Friedman and Podolny (1992) discussed the roles of organization members who reach outside the organization, those who are idea brokers, and those who are gatekeepers.

The relationship and division of labor between innovation role players have also been examined. Chakrabarti and Hauschildt (1989) noted a variety of roles throughout the entire process of innovation, from idea generation and research through commercialization. They also found that there tended to be a division of labor across the process, although at times a single individual could play multiple roles. Ancona and Caldwell (1992) noted that product development teams had external-facing informal roles (scouts and brokers) as well as internal team management roles. Markham (2000) found not only champions but also the role partner of antagonists played key roles in development processes. The valley construct is marked by the emergence of informal, rather than formal, role players.

Formal roles have often been a focus of research, since they are the occupational category with explicit organizational expectations (Ilgen and Hollenbeck, 1992). These explicit expectations may be in writing and are often articulated by superiors and from peer messages. Furthermore, a formal role is embedded in reporting relationships within an organizational structure. Fondas and Stewart (1994) describe individuals in these roles as fulfilling the organizations' expectation enactment. Hence, formal roles are regularly included as part of selection, performance, and reward systems. Informal roles, on the other hand, are done by an individual as a response to a perceived need for action. Informal roles, even though they may be vital to proper functioning of an organization (Organ, 1988), are not formally recognized as being an official part of the organizational structure and system. As such, they are not noted or included as part of selection, performance, and reward systems in an organization.

These informal innovation roles have been variously described in the innovation literature, making clear-cut definitions and delineations difficult. Nevertheless, this paper uses three key informal roles commonly found in the innovation literature and notes that their activity sets interact with each other to cross the valley: (1) a *champion* to adopt and advocate a project; (2) a *sponsor* to provide project sanctioning and resources; and (3) a *gatekeeper* to establish criteria and make decisions about the future of the project. Much of the literature describing these three roles operates under the assumption that these various roles remain static throughout the entire innovation process (i.e., from idea to commercialization). Little research has examined how roles might change and interact as the innovation process progresses. A notable exception is Van de Ven and Grazman (1985), who found that activity levels among different role holders vary dramatically over the life of a project. Other researchers have noted that roles through this innovation process are likely to be linked, and those playing these roles coordinate their efforts (Utterback, 1971). The present study suggests that these three roles must interact to cross the Valley of Death.

For example, the champion who finds and advocates a project will seek out sponsors who will decide whether to support the project. The champion depends on the sponsor for support, and the sponsor depends on the champion for good opportunities. Similarly, after developing and supporting a project, the champion and sponsor will try to get the project approved by the gatekeeper for further development. The interaction between these roles, where the champion seeks support and then champion and sponsor seek acceptance of the project through a gatekeeper, is depicted in Figure 2.
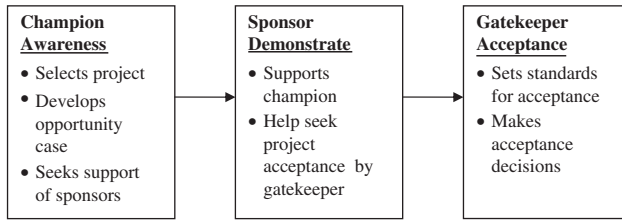
Champion Awareness	Sponsor Demonstrate	Gatekeeper Acceptance
• Selects project • Develops opportunity case • Seeks support of sponsors	• Supports champion • Help seek project acceptance by gatekeeper	• Sets standards for acceptance • Makes acceptance decisions

Figure 2. Relationship among Champion, Sponsor, and Gatekeeper

Champion. A central figure in many innovation projects is the champion (Chakrabarti, 1974; Day, 1994; Howell and Higgins, 1990a, 1990b; Howell and Shea, 2001; Lawless and Price, 1992; Maidique, 1980; Markham, 2000; Markham, Green, and Basu, 1991; Rothwell et al., 1974; Schon, 1963; Shane, Venkataraman, and MacMillan, 1995). Champions are seen to operate throughout the innovation process (Van de Ven and Grazman, 1985), but some authors suggest champion behaviors are key at the front end of the project in getting the project approved and protecting it through its initial development (Schon). This often requires the champion to accept risk in promoting the project to other people in the organization (Markham).

The champions' major contribution is identifying and becoming aware of the value of the idea. Champions then prepare ideas for acceptance by selling the ideas to other people (Howell and Higgins, 1990a; Markham, 1998). After identifying, adopting, preparing, and selling ideas the champion seeks support from people (sponsors) with the needed resources to demonstrate the viability to people (sponsors and gatekeepers) that can accept and support their project for further development.

Sponsor. Another commonly acknowledged informal role is the sponsor (Roberts and Fusfeld, 1982). A sponsor provides project support, protection, or resources (Tighe, 1998), important in helping projects traverse the Valley of Death. The sponsor refers to a person taking the informal role of providing assistance in demonstrating potential for projects that are not yet formally accepted by the organization. The sponsor may be higher, lower, or at the same level in the organization as the champion. As long as a person provides support, defined broadly, that person is acting as a sponsor. Projects may have multiple sponsors, but often there is a single person that provides overall support and resources (Smith, 2007).

Sponsors make resources available to champions and their projects informally to demonstrate the value of the idea to others. Pinto and Slevin (1987, 1989) and Baker et al. (1983) identify critical resources needed to help innovative projects, including top-management support, access to technical resources, marketing advice, and financial resources and analyses. Some firms have formal structures established for applying resources to ideas in the early stage; others encourage unofficial skunkworks projects and get resources to them in subtle under-the-radar ways (Cooper et al., 2004; Rich and Janos, 1994). Cooper et al. also found that the best-performing firms provide creative employees with support and time off to work on informal projects. Some case study examples include companies like ABB and 3M. ABB provides one-month funding (opportunity grants) for a selected number of projects (Das, 2002), and 3M dedicates 15% of their researchers' time resources to developing innovative seed ideas (Kanter, Kao, and Wiersema, 1997, ch. 2). Some firms use incubators to provide support to new ideas outside the regular structure of the organization (Grimaldi and Grandi, 2005; Udell, 1990).

These formal early innovation policies are rare. Most firms depend on less formal processes for innovation. However, some firms allow managers discretionary funds for helping worthy projects (Kanter, 2004). Similarly, many managers simply make funds available for promising projects (Roberts and Fusfeld, 1982). Note that, within these informal approaches, the sponsor's support of the champion becomes even more imperative (Tighe, 1998). The champion must rely on the sponsor to provide requisite support, and the sponsor must use competent discretion in assessing the opportunity presented by the champion and in allocating resources based on that assessment. Using these variable informal innovation support methods result in variable level or timing of innovation.

Gatekeeper. The work of the champion and the support of the sponsor are goal directed. They want to complete development of the idea to the point where it can move into the formal NPD process. To do this the champion and sponsor need resources and must prepare and present their idea to the people who can access those resources. Gatekeepers are those people.

Roberts and Fusfeld (1982) refer to the gatekeeper as a person who collects, sorts through, and channels information to others. Farris and Cordero (2002) identify the gatekeeper as an informal role and expand the definition to include spanning internal boundaries and in-

tegrating different functional units. The gatekeeper also has been described as the one who, in the innovation process, mediates the information flow from an individual level to an organizational level (Reid and de Brentani, 2004). In the present study, the gatekeeper is defined as a person in the NPD organization who sets decision criteria and who provides access to resources for projects that meet their criteria.

In summary, the champions become aware of new ideas and promote awareness of the idea to other organizational members. Champions seek sponsors to provide support to demonstrate the idea's potential to gatekeepers who can provide the resources needed to get the idea ready and move it into the formal NPD processes. The present study's view is consistent with Farris and Cordero (2002) and Reid and de Brentani (2004), where the gatekeeper is the person who make decisions about idea criteria and seeks acceptance of a project into the formal NPD system. As such, the gatekeeper is in an associated role with both the champion and the sponsor.

Model Development

Role theory identifies actors, their contributions, and the actions they take in the context of organizational pressures. Without understanding the front-end context the role-holders are working in, it would be impossible to understand why the actors behave the way they do. The overall valley analogy describes the context in which role theory is acted out and where in the development continuum a project is. The valley analogy considers the level of development of the projects as well as the resources, policies, opportunities, functional differences, and barriers to innovation—but is silent as to where these role holders get their resources or how they use them. Similarly, role theory does not address the context of innovation or how the informal roles relate to widely used formal NPD processes. To gain a better understanding of how to cross the valley the integrated roles and activities are depicted in Figure 3.

This complete model shows that there is a gap between the formal roles, activities, and resources poured into research and the existing formal NPD roles, activities, processes, and resources that lead toward commercialization. Ideas cross the valley and get moved into formal NPD processes through the activities and influence of three major roles: the champion, sponsor, and gatekeeper. Consistent with role theory, within the context of the valley the champion begins the process of
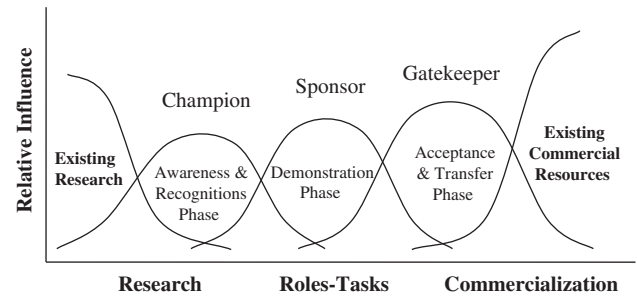

Figure 3. Model of Roles and Activities to Cross the Valley of Death

moving ideas across the Valley. Figure 3 shows champions as predominate in the left side of the valley, indicating they are in contact with the idea originators who are doing technical or market research.

The first role associated with the champion is the sponsor, who works with the champion to develop the idea to the point where it can either pass muster of the gatekeeper and move into formal NPD processes or not. Champions engage with sponsors by seeking to increase awareness of the idea in sponsors who hopefully provide enough resources to demonstrate the potential of the idea. A likely demonstration is showing compliance with some informal standard of acceptability set by the gatekeeper.

The next role is the gatekeeper. Consistent with other research, this paper shows the gatekeeper as having some involvement during the demonstration phase in the valley, where the champion and sponsor seek acceptance of the idea by the gatekeeper to gain acceptance and thence access to the formal NPD process.

Hypotheses

In this study, it is argued that the Valley of Death is the space between research and formal NPD, where a significant amount of work is actually done via informal roles. The model in Figure 3 suggests that there are three major informal, overlapping roles in early product innovation, that the informal roles are embedded with tasks that regularly manifest themselves across various development projects, and that the relative influence of any role increases and decreases as other role-holders become involved in the project.

Development Activity for Formal Acceptance

Although there are descriptions of activities occurring before the NPD processes starts (Koen et al., 2001;

Nobelius and Trygg, 2002), no empirical evidence could be found indicating that a significant amount of development activity actually takes place before a project enters into a company's product development program. Empirical demonstration that a significant amount of work takes place in the valley helps establish it as an important area of research. Khurana and Rosenthal (1997), Smith et al. (1999), Reinertsen (1999), and Koen et. al all suggest that work be done to prepare ideas for introduction into formal development processes but do not specify those activities or report empirical results for support. Overall, the literature shows early work composed of (1) technical viability of the product, (2) composing product concepts, (3) doing enough market research to validate the product concepts, and (4) showing enough of a business case that convinces others to support the project. Therefore, it is hypothesized that significant amounts of technical viability, product concept, market research, and business case preparation work are done before the project enters a formal development process.

H1a: A significant amount of technical viability work is done on projects before they enter the product development process.
H1b: A significant amount of product concept work is done on projects before they enter the product development process.
H1c: A significant amount of market research is done on projects before they enter the product development process.
H1d: A significant amount of business case preparation is done on projects before they enter the product development process.

Activities and Role-Task Order

Besides knowing that a sizable volume of work is done before formal development, establishing whether an order of activities and roles emerge is also necessary to understand the valley. If activities and roles are coupled, then knowing the order of activities can help us understand role emergence in the front end of innovation. For example, if idea generation must happen before idea support, then the people who generate ideas will emerge before the people who support the idea. Although most pre-NPD models explicitly or implicitly propose an activity order, order has not been examined empirically. For example, Koen et al. (2001) propose five front-end activities: (1) opportunity identification; (2) opportunity analysis; (3) idea generation

and enrichment; (4) idea selection; and (5) concept generation. Nevertheless, Koen et al. argue that the front end is chaotic and that activities are random. Cooper (1997) suggests that front-end activities include idea generation, preliminary assessment, and concept definition. Khurana and Rosenthal (1997) also propose a similar set of sequential activities.

Front-end activities may or may not be sequential. The point is that projects must pass through logical phases of development, even if they must repeat an activity or regress through iterative loops. While activities may be iterative, the project must progress toward a discernable state of development for it to be accepted into the company's formal development process. As shown in Figure 3, the three states of activities are awareness, demonstration, and acceptance and transfer. Thus,

H2a: Awareness and recognition activities will emerge first.
H2b: Demonstration of potential activities will emerge second.
H2c: Acceptance and transfer activities will emerge third.

Relative Role Influence

Each of these emerging activities must have people who perform the activities, or the project does not progress. When a person performs the activities in "idea selection," for example, that person takes on the role of the champion. Role theory predicts that roles form with associated positions. When a champion finds another person to support a project, that person acts in the role of sponsor. The logical progression of a project in the context of early innovation drives the logical emergence of roles. In this way the innovation context, as exemplified by the valley analogy, helps to inform role theory about when different roles may emerge.

The literature generally assumes roles are static across levels of development. A notable exception is Van de Ven and Grazman's (1985) study, which found that four different role holders in NPD participate at higher and lower frequency of interactions, depending on the stage of development. For example, the manager role participated less frequently at the beginning and more frequently at the end of a formal project. Therefore, it is reasonable to suggest that role holder participation is dynamic and variable over different stages of development.

Figure 2 suggests that champions are the first actors to emerge through their recognition of a commercial

idea/project, which then seek to promote greater awareness of or recognition for within the organization. The sponsors emerge next, as they respond to the champions' ideas and requests for support to demonstrate the potential of the project. Finally, the gatekeepers engage as they respond to the champions' and sponsors' requests for information about how to get the project accepted into the development process. This dynamic role and activities emergence determines when another role-holder is needed and also how much influence that role has on the project.

The order in which role–activities combinations emerge suggests that as champions succeed in getting other people to be aware of and to support the project, they must share their control over the project. Research examining completed projects revealed that champions are not directly related to the market success of a project, although they do tend to be related to initiation and resources allocation (Markham et al., 1991). In other words, champions' major contributions may be at the front end rather than at the back end of development. They may share control in the case of sponsors that provide substantial support for a project. The sponsors may want to share decision making with the champions. Similarly, if gatekeepers accept the project for continued support, they are likely to submit the project to multiple levels of review and to assign various resources to parts of the project. As the project progresses it requires more people to support it; thus, the relative influence of the champions decreases as others become involved and have a say in the project.

Champions see their contributions to the project as much greater than team members who joined the team after the project is accepted into development (Markham, 1998). It is proposed here that this is due to a shift in influence over time. At the awareness stage, champions have almost complete control over the project. Often, when the project makes it to a formal process, champions are not a part of the committee that decides whether the project should move from one stage to the next. As they share decision making with other people, champions' relative influence on the project declines.

Champions' influence diminishes not only as resources are accepted from other people but also as their projects are inducted into the formal process. When a project enters the formal process, it is subjected to formal reviews for continuation and funding. It is also often assigned a team with its own ideas about the direction of the project. Champions' relative level of influence is greatest at the awareness stage and declines

as the project progresses. Champion contributions may remain high in absolute terms, but the relative influence declines as other people and processes begin to contribute to the project.

> *H3a: Champion level of influence is greatest during the acceptance phase and decreases over the other two phases.*
> *H3b: Champions have higher levels of influence than either sponsor or gatekeepers during the acceptance and transfer phase.*

Sponsor Influence

After champions develop an idea, the next activity in Figure 2 is demonstrating that the idea can work. They must find sponsors to provide the appropriate support to demonstrate the viability of the idea. This may be a market or technical demonstration or both—or it may be something different, such as ability to make it at a low enough cost or at a high enough quality or to find distribution partners. Jolly (1997) suggests that a supporter of a project at this stage does not actually have to develop the whole product or business plan; they only have to show enough promise to convince other people to go to the next stage.

The requirements to show viability will vary from project to project, depending on various factors, such as the level of risk of the whole project, the proponent's track record, and the company's ability to deliver. Therefore, each project requires its own unique set of critical support to show viability. Pinto and Slevin (1987, 1989) discuss critical support factors such as suitable workspace; problem-solving expertise; prototype materials; market research support; and funds for project materials or information.

In the space between champion proposal and formal development, critical support must be appropriately applied to the project to show viability. During this phase of demonstrating viability of an idea, critical support provided by the sponsor has the highest importance relative to the champion or gatekeeper. Once the project is accepted into the firm's formal product development process, and hence garners formal funding, the idiosyncratic application of resources becomes less important.

Thus, the level of importance and influence of the sponsor finding critical support becomes more important when champions need to demonstrate the commercial viability of the new idea and diminishes as the project is accepted into the firm's product development process.

H4a: Sponsor influence will be greatest during the demonstration phase.
H4b: Sponsors will have relatively greater influence than the champion or gatekeeper during the demonstration phase, with influence diminishing when the idea is accepted or transferred into formal development.

Gatekeeper Influence

After a new idea has been proposed and demonstrated to be feasible, it must complete development to ready the idea for production and the market. Formal development programs are the recipients of these ideas. It is at this point that the influence of the gatekeeper should be highest. As such, they set the criteria that new ideas must meet for the ideas to be accepted into the formal processes. This makes the gatekeepers of formal development programs influential throughout early development. When a project is actually accepted, the formal process has much more control over the project, and the relative influence of the champion diminishes. As well, the acceptance of the idea into the formal process denotes a higher level of resources than the few resources available to demonstrate the viability of an idea. Consequently, both the champion's and the sponsor's influence decline. The level of influence of the gatekeeper is highest relative to the champion and sponsor as the project nears and finally enters formal development.

H5: The relative gatekeeper influence is greatest for the acceptance or transfer decisions after the champion devises the proposal and the sponsor provides support to demonstrate the viability of the project.

In summary, it is argued that there is significant development work being done outside the formal development programs of the firm. The present study also argues that a set of informal overlapping roles and activities form a continuous development path across the Valley of Death. Finally, it is suggested that the overlapping roles are more important in different parts of the valley and that influence of roles changes as the idea progresses toward entering formal NPD processes.

Survey Methodology

Subjects and Design

E-mail invitations were sent to 1,276 new product development practitioners from the Product Develop-ment & Management Association (PDMA) to participate in the study. Participants were asked to visit a website embedded in the e-mail to complete an on-line survey. After the first e-mail, 167 individuals responded to the survey. One month later, a follow-up email was sent asking those who did not respond to please complete the survey. This induced another 105 new people to answer the survey. In total, 272 practitioners completed the online survey for a 21% response rate. Analyses of the two respondent groups did not find any significant differences between the first and second group of responders.

The participants averaged 11 years of experience in NPD and 6 years of experience working on projects before they entered NPD programs. They also averaged 6 years of experience making resource decisions for product development. Of the 272 respondents, there were 8 from engineering, 29 from general management, 49 from marketing, 1 from production, 109 from product development, 41 from research and development, 2 from sales, and 33 from other areas.

Materials

Great care was taken in developing these measures. Survey items were developed with help from numerous expert practitioners. This process went through several iterations, leading to the administration of 51 questions. The survey was extensively pilot-tested to ensure that participants could easily understand the questions and instructions and that they could complete the survey without technical error. A total of 27 graduate students, taking coursework in NPD, also completed different versions of the survey. These pilots led to several wording and ordering changes to ensure that the survey performed as expected. The survey was tested again with 12 product development professionals. Again, some changes were made to the survey to make sure respondents understood the questions.

Within the context of this study single-item measures were appropriately used, because attitudinal questions were not asked but rather questions about organizational activities and roles. These aspects are not psychological affective responses (e.g., satisfaction with a supervisor) but are based on observations and clear to the respondents (Bergkvist and Rossiter, 2007; Sackett and Larson, 1990). Recent work by Gardner et al. (1998) and Wanous and Hudy (2001) indicates that in some research single-item measures of constructs can be as valid as multi-item measures and are less fatiguing for the respondents.

When participants went to the survey site, they first saw an introduction page explaining the purpose of the study, with contact information so participants could ask questions directly of the investigators. Participants completed nine pages of questions that were widely spaced to make it easy to answer. Each page included only as many questions as could be easily viewed on a single screen using a standard 15 inch monitor. Definitions of all terms were provided on each page to ensure respondents understood the questions.

Survey Items. The first questions in the survey sought to determine if the participants' organizations had a standard NPD process. This was important since by definition the pre-NPD activities occur before a formal or standard NPD process. If no formal NPD process exists there can be no pre-NPD.

The next questions addressed whether the individuals recognized the existence of activities before the formal processes. This must be established since an individual cannot answer questions concerning phenomena they do not believe to exist. The next set of questions sought to determine the type and amount of work that was conducted before NPD programs, for example, "What percent of each activity occurs before a product enters into your product development process or significant resources are committed to it: (1) technical; (2) product concept; (3) market research; and (4) business case development."

After establishing whether the respondents recognized the existence of pre-NPD activities, the next section asked participants to place the emergence of the activities in temporal order from the beginning of pre-NPD work to adoption in a formal process. The participants were asked, "What order do you think these activities happen in? Recognize the commercial potential of a new opportunity, demonstrate the potential of a new opportunity, and transfer the new opportunity to formal development." Respondents were offered choices of first, second, or third for each activity. These activities represent specific tasks within each phase.

Last, the survey asked participants to rate the importance of the champion, sponsor, and gatekeeper roles within the awareness and recognition; demonstration; and acceptance and transfer phases. Respondents rated each role in each phase. The hypothesized pattern was that champions would be most important for awareness and recognition, the sponsor for demonstration, and the gatekeeper for acceptance and

transfer. It was not expected that roles being important only in their stated phase area but that their importance would be highest in their respective phases.

Results

This section reports the results concerning whether survey participants indicated there are activities in the valley, how much activity occurs, in what order the activities occur, and how the importance of champions, sponsors, and gatekeepers changes as the project progresses. H1 stated that a significant amount of (a) technical viability, (b) product concept, (c) market research, and (d) business case preparation is done on projects before they enter the product development process. Table 1 shows the number of respondents by level of NPD process crossed with the level of pre-NPD process. This table shows that, while most respondents indicated that their companies had formal NPD processes, the majority of these did not include a formal pre-NPD process. The table shows that companies where formal NPD processes are regularly used had more respondents that claimed they also had a formal pre-NPD process.

To determine what work was done before formal development, the survey also asked respondents to indicate what percentage of the four hypothesized activities (i.e., demonstrate technical potential, demonstrate concept potential, market research, and business case development) occurred before the project was accepted into the NPD process. Table 2 shows the average percentage of a particular activity that respondents indicated occurred before entry into the formal NPD process by the type of pre-NPD process within the respondents company. Generally, the table shows that respondents indicated from between 27% and 51% of

Table 1. Number of Participants with NPD and Pre-NPD Processes

	No pre-NPD Process	Informal pre-NPD Process	Formal pre-NPD Process	Total
No Standard NPD Process	21	17	1	39
Standard NPD Process but Not Documented	11	17	5	33
Documented Process	10	28	15	53
Documented Processes in Actual Use	16	61	70	147
Total	58	123	91	272

Table 2. Respondent Determined Percentage of Activities Done before Formal NPD Programs

	No pre-NPD Process	Informal pre-NPD Process	Formal pre-NPD Process
Demonstrate Technical Potential	37	43	51
Demonstrate Product Concept Potential	37	39	50
Market Research	27	25	39
Business Case Development	27	32	47

Table 4. Paired Sample _t_-Tests of Different Phases

Pair	Mean	_t_
Awareness/Recognition–Demonstrate	0.056	8.26***
Demonstrate–Acceptance/Transfer	0.88	15.59***
Awareness–Acceptance/Transfer	1.44	28.10***

[a] df = 271.
*** $p < .001$.

an activity occurring before formal NPD processes. The more formal the pre-NPD process the more activity was indicated to occur before the NPD process.

Since respondents were able to distinguish pre-NPD activities from established NPD (Table 1) and to identify a significant percentage of work being done in the pre-NPD area (Table 2), it is concluded that the first hypothesis is supported.

H2 stated that (a) awareness and recognition activities will emerge first; (b) demonstration of potential activities will emerge second; and (c) acceptance and transfer activities will emerge third. Participants were asked to rank the order of the following three role–activity combinations: awareness of the commercial potential; demonstrating the commercial potential; and accepting the new opportunity. They were allowed to rank if each of these were first, second, or third. H2 suggests the mean rank for awareness of the commercial potential should be 1.0, while results indicate mean = 1.33, and standard deviation (SD) = 0.58. Similarly, the mean for demonstrating potential should be 2.0, while results indicate mean = 1.88, and SD = 0.63. Finally, the mean for accepting the opportunity should

Table 3. Respondent Ranking the Order of Pre-NPD Activities

	First Activity	Second Activity	Third Activity	Mean
Awareness and Recognition of the Commercial Potential of a New Opportunity (Champion Activity)	**198**	59	15	1.33
Demonstrate the Potential of a New Opportunity (Sponsor Activity)	71	**162**	39	1.88
Accept and Transfer the New Opportunity into Formal Development (Gatekeeper Activity)	6	52	**214**	2.76

be 3.0, while the results indicate mean = 2.76, and SD = 0.47. Table 3 displays the mean rank of when respondents believed the phases occur.

The Friedman test was used to determine whether these means were significantly different. This test was used because the same respondents rated each activity, creating related or dependent responses. Further, since the responses are rankings they are not suitable for analysis of variance; therefore, chi-square is used. As hypothesized, the means are significantly different (χ^2 (2, N = 272) = 288.47, $p < .001$).

Table 4 shows paired sample _t_-tests used to find which means in Table 3 were significantly different from one another, suggesting that pre-NPD phases do occur in the hypothesized order. As seen in Table 3 the mean for respondents rating awareness being first is 1.33, and the mean for demonstration being second is 1.88. The mean difference reported in the table is 0.56 (note rounding error of 0.01) with a _t_-score of 8.26 that is significant at less than 0.001 probability with 271 degrees of freedom. The differences between demonstration and acceptance as well as between awareness and acceptance are found in Table 4. The large _t_-scores indicate support that most respondents see an order of activities with some clarity, thus supporting H2.

H3, H4, and H5 assert that a role's influence will change over the course of the activities. Champions' influence will be highest during recognition but will diminish over the following two phases. Sponsors' importance will increase from recognition to demonstration but will decrease in transfer. Gatekeepers' importance will increase from recognition through demonstration, peaking in acceptance.

Table 5 displays each role's mean influence during each phase and the respective paired sample _t_-tests to determine the change in that influence over the phases. Champions' highest level of influence took place during the awareness and recognition phase. Significant decreases were found for champion influence across the phases with champions' importance rating decreasing from its highest score of 5.6 of 6 in awareness and rec-

Table 5. Influence of Different of Roles across Pre-NPD Activities[a]

| | Role Influence Means | | | Paired Sample t-Tests (Mean Difference/t) Change in Influence of Role across Activities | | |
	Awareness/ Recognition	Demonstration	Acceptance/ Transfer	Awareness – Demonstration	Awareness – Acceptance	Demonstration – Acceptance
Champion	5.6	5.2	5.0	− 0.40/ − 7.03***	− 0.54/ − 8.02***	− 0.14/ − 2.28*
Sponsor	5.0	5.1	5.3	0.15/2.60**	0.35/5.54***	0.20/3.11**
Gatekeeper	4.2	4.1	4.9	− 0.01/ − 1.30n.s.	0.69/8.31***	0.78/8.90***

[a] df = 271.
* $p < .05$.
** $p < .01$.
*** $p < .10$.

ognition to 5.2 in demonstration to 5.0 in acceptance and transfer. The decrease from awareness to demonstration has a mean difference of − 0.40 and a t-score of − 7.03 and a mean decrease of − 0.54 ($t = 8.02$, $p < .001$, df = 271) from awareness to acceptance.

At the same time, there were significant increases in the sponsors' level of influence starting at 5.0 in awareness and recognition, increasing to 5.1 in demonstration, and 5.3 in acceptance and transfer. Gatekeepers' level of influence decreased nonsignificantly from 4.2 in awareness and recognition to 4.1 in demonstration but rose significantly to 4.9 in the acceptance and transfer phase. Across pre-NPD activities, the paired sample t-tests found significant support for H3 through H5.

Figure 4 represents these findings graphically showing that champions' level of influence is highest in the awareness and recognition phase and decreases significantly in the demonstration phase and then decreases further in the acceptance and transfer phase. The actual level of influence of the sponsor increases significantly across all three phases. The gatekeeper can be seen to have lower, stable influence in the first two phases and then increase significantly in the acceptance phase as hypothesized.

Figure 4 shows support that champions' actual and relative level of influence is highest in the awareness and recognition phase, decreases significantly in the demonstration phase, and then decreases further in the acceptance and transfer phase (support for H3a and H3b). The actual level of influence of the sponsor increases significantly across all three phases. Since champions' influence has declined to be at the same level as the sponsors, and since gatekeepers' influence is still low, sponsors' relative influence is highest in the demonstration phase (partial support for H4a and H4b). The gatekeepers' level of actual and relative influence is highest in the acceptance phase (partial support for H5). It should be noted that although other roles influence increased relative to the champion the champion still maintained a high level of influence across all activity phases.

Table 6 reports the level of influence of the champion, sponsor, and gatekeeper within the awareness and recognition, demonstration, and acceptance and transfer phases. As suggested in Figure 3 the relative influence of the role-holders varied within each phase.

In the awareness phase the champion's influence level of 5.6 was significantly higher than either the sponsor at 5.0 or the gatekeeper at 4.2. Similarly, the sponsor was higher than the gatekeeper. In the demonstration phase, the amount of influence held by the champion at 5.1 and sponsor at 5.2 were not significantly different, whereas the gatekeeper level of influence at 4.1 remained significantly lower. In the acceptance phase the sponsor's role at 5.3 was significantly higher than that of the champion at 5.0 or the gatekeeper at 4.9. In the acceptance phase the champion and gatekeeper showed no significant difference in their levels of influence.
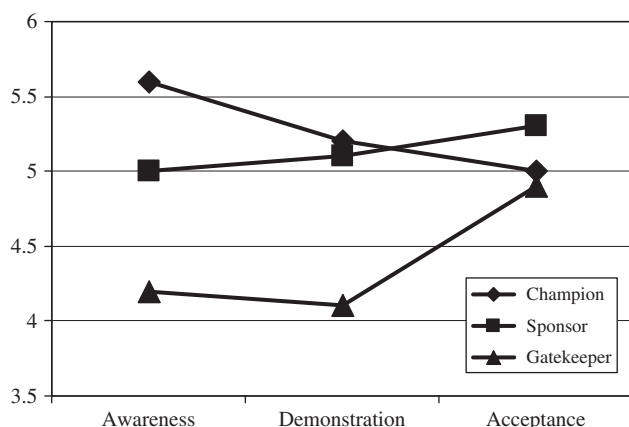

Figure 4. Influence Each Role Has in Each Phase

Table 6. Influence of Different of Roles within Pre-NPD Activities

	Influence Means and Mean Difference/t		
	Awareness/Recognition	Demonstration	Acceptance/Transfer
Champion	5.6	5.2	5.0
Sponsor	5.0	5.1	5.3
Gatekeeper	4.2	4.1	4.9
Champion–Sponsor	0.60/9.46***	0.05/0.68n.s.	− 0.29/ − 4.50***
Champion–Gatekeeper	1.37/16.35***	1.07/10.96***	0.13/1.4n.s.
Sponsor–Gatekeeper	0.77/8.92***	1.02/11.81***	− 0.43/4.97***

*** $p < .001$.

Combining the results of Tables 5 and 6 a pattern emerges. During the awareness and recognition phase, role influences occur as expected with champions displaying the greatest level of influence (H3a and H3b supported). In moving to the demonstration phase, while the champions influence decreases with a corresponding increase in the sponsors influence as hypothesized, these changes are not enough for the sponsor to become the most influential role during this stage. In fact, during this phase both champion and sponsor roles appear to equally influence the project (H4 partially supported). In the acceptance and transfer stage, the results continued to confirm the hypothesized development of each roles relative level of influence but not the absolute level. The acceptance and transfer results show that the sponsor role becomes the most influential with the champion and gatekeeper providing equal levels of influence (H5 partially supported). It appear that champion, sponsor, and gatekeeper share influence in later phases.

H1, H2, and H3 are supported, with H4 and H5 finding partial support. The absolute level of influence of the sponsor was not higher than the champion (H4a) in the demonstration phases even though the sponsor role increased significantly from the awareness phase. Similarly, the gatekeeper role did not exhibit the highest level of influence in the acceptance phase but did increase significantly from previous phases as expected. Even with these two exceptions, since the roles moved significantly in the hypothesized direction support for the model is found.

Limitations of this research include that these data are self-reported and that performance data are not included from independent sources. Although no flaw in the data was detected, during the collection process not many respondents were addressed directly to determine if they fully understood the questions. Multiple places were provided for the respondents to make comments about both the content and nature of the questionnaire. Even though this paper reviewed the literature to identify the major roles in pre-NPD activities, conceptually it is not known if other roles are acting significantly in pre-NPD activities. Similarly, although the activities identified were the result of structured interviews and pilot testing, other important activities could be conducted in the front end.

Discussion

There appears to be substantial activity occurring before NPD processes. An important finding is that pre-NPD work is not just additional technical development; it also includes significant business development activities. The nature of work described in the valley appears to explain a space between research and NPD in which critical commercial decisions are made. The valley analogy connects the back end of research with the front end of product innovation. This research suggests that organizations seeking to improve product innovation must account for development activities that occur before their formal NPD processes begin.

This study also observed predictable patterns of role behavior in innovation. Champions' importance was greatest at the beginning but decreased as the project continued, while sponsors' importance increased across the valley and gatekeepers' increased significantly at the end. Although champion's influence decreased relative to other roles the level of champion influence actually remains high throughout the activities. This suggests that champions may be sharing influence with other people as the project progresses across the valley. This dynamic view of innovation roles must change the way innovation research is formulated and interpreted. Future research must consider the impact of champion, sponsor, and gatekeeper roles at different places in the innovation process. For example, the role of the champion at

the start of an innovation project is focused on developing an appealing concept, whereas toward the end it is focused on getting other people to accept the idea. By extension, other innovation roles not examined in this study may also change with stages of development.

A robust finding in these data, consistent with role theory, is that roles and activities happen together in predictable ways. The three roles were associated with general activities. Furthermore, the general activities were largely seen to happen in a logical order. This finding is useful for devising roles and responsibilities for crossing the Valley. This research also supports the findings of Van de Ven and Grazman (1985), who found wide variation in activity levels over time. This contrasts the general practice of treating innovation roles as a static set of behaviors. Innovation roles are generally treated as a static set of behaviors, but Van de Ven and Grazman found wide variation in activity level over time. This research is consistent with those earlier findings.

Not only did this paper find informal roles, but it also saw them relating to each other differently over time. For example, the sponsor role may change from supporting a champion to advocating for project acceptance. Even the gatekeeper role may change from setting criteria to helping transfer projects into formal development. By extension, all innovation roles should be expected to change as the project progresses across stages of development. Realizing that roles have multiple tasks and expectations during different phases can help increase innovation effectiveness by allowing for, facilitating, and encouraging these changes to occur.

Another innovation characteristic revealed in this work is that pre-NPD activity is not as fuzzy as suggested in the literature. Innovation proceeds through logical steps. This does not mean that these activities occur in a strictly linear manner but rather that each step must be effectively addressed before a given project successfully moves to the next phase. A project that does not fully complete a phase before moving to the next might cycle back to complete or redo what was already done. Key managerial implications include ensuring the availability of sufficient resources for innovation and providing "valley" training to participants. Further research is needed to elaborate on critical activities and on the necessary skills and structures to accomplish those activities.

Another important implication of the valley analogy is that while the idea of the "fuzzy front end" focuses on just preparing an idea to go into development, the valley identifies a specific place on the innovation continuum between research and new product development. As such, it identifies a number of social roles, human and physical resource issues, cultural training, and structural and managerial practices for innovation. This forces recognizing the need to develop theory to explain behavior in this gap and the need to make informed prescriptive recommendations.

Seeing the fuzzy front end or the front end of innovation as being one end or the other of innovation misses the reality that this area of development is a specific segment between other, better understood, organized, and funded areas of development. This segment of the development path poses particular challenges. This gap in resources and capabilities often occurs in official company programs and allocations. As a result, informal role holders emerge to accomplish vital activities and to fill the gap at this point in the development process. Although the valley seems a chaotic place, in reality it is just a place between two better-organized functions.

Future Research

To date, pre-NPD activities are mostly anecdotal or conceptual. Although this research provides some of the first data to empirically validate the existence and nature of these activities, the data also pose many more questions. A large research agenda can be developed to study activities in the valley. Where are the boundaries of the valley? The limits of where traditional disciplines can carry a project to and where they can begin to adopt projects must be understood, as well as the magnitude of the efforts needed to progress a project from research all the way to commercialization.

Fundamental to increasing NPD productivity is defining what activities take place inside and outside NPD programs and what is most effective. It is not known if the innovation that takes place outside NPD processes can be accomplished as part of more formal processes or not. If so, what those activities are and how to accomplish them must be defined. Rational relationships between portfolio management and front-end activities must be established. If the beginning and significant work on projects happen before formal processes one must ask who is managing the front end. If projects emerging from the front end populate a firm's portfolio then the portfolio can be seen as a function of front-end activities rather than as a function of strategic planning.

From a role theory perspective, it was found that roles change across developmental activities. Nevertheless, most innovation role research presents roles as static over the live of a project. To begin to understand the dynamic nature of how projects progress from one step to the next it must be understand how roles are related to each other at different phases of development. Just as critical, it must also be understood how the roles are related to understanding the actual work or activities preformed in the valley.

By recognizing the valley as a gap between more formalized functions in the organization (research, NPD, and commercial units) it is seen that what is commonly referred to as the fuzzy front end is really connected to the back end of research. Thus, it is seen that as fuzzy as this area is along the development cycle, it is not the front end. Calling these activities the "front end" ignores and perpetuates the gap between R&D and the commercial sides of the business. The research challenge is to describe the valley in terms of both product innovation and technical innovation. Identification of innovation roles and pre-NPD activities and how they might fit together in a process to cross the valley is an imperative to increase NPD productivity.

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