

Non-Traditional Growth in Large, Established Firms

by

Suresh Sunderrajan

Submitted to the System Design and Management Program

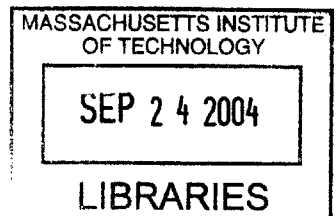
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Abstract:

Firms must continuously strive to grow through the creation of new sources of competitive advantage. The challenges to growth are more severe for large, established firms that derive a predominant amount of their present revenue from technology that is mature and that faces imminent substitution through the marketplace emergence of a disruptive technology. In such circumstances, non-traditional growth, through new business opportunities outside of the direct purview of established Strategic Business Units, becomes an imperative.

The primary hypothesis of this study is that problems in achieving growth predominantly stem from the inherent rigidities of large, established firms and, in order to successfully grow, these firms will have to pay particular attention to the structures and processes associated with teams tasked with growth. Accordingly, a theoretical framework for classifying non-traditional growth opportunities is developed. The study is motivated using three examples of non-traditional growth projects in a large, established firm. These examples are used to develop three key dimensions for characterizing such opportunities – technology, market, and organization. The proposed framework builds upon structural contingency theories to develop two independent factors for each dimension – uncertainty and interdependence. A vector mapping applicable to all non-traditional growth opportunities is developed using the two factors and three dimensions. The vector mapping is used to propose a linkage between growth opportunity and organizational form.

A survey administered to 24 project leaders/managers of non-traditional growth projects in a single, large firm is used to test the applicability of the framework developed here. A statistical analysis of the survey results corroborates the significance of market and technology factors. Organizational factors appear to be less significant, but this may be

due to artifacts in the data. Finally, a concept explored in this study is that organizations must become more ambidextrous in their ability to use multiple organizational forms, simultaneously, to exploit non-traditional growth opportunities. Implementation considerations relevant to the recommended organizational forms are discussed within the specific product development process framework in a single, large firm.

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Disclaimer:

The views expressed in this work are solely those of the author and are neither endorsed by, nor reflect, the views of any firm discussed herein.

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“The ability to learn faster than your competitors may be the only sustainable competitive advantage.” – Arie de Geus, Shell

Chapter 1: Introduction

A firm's resources are the source of rent creation. As such, in all but the most stable environments, resources lose their ability to generate rent over time, which is due to competition, obsolescence, etc. Firms must thus continuously strive to grow through the creation of new sources of competitive advantage.(Wernerfelt 1984) It is not easy, however, for a large, established firm to grow. The business literature over the last two decades has documented in considerable detail the typical evolution of a firm from a small, flexible, entrepreneurial entity with informal linkages and “system knowledge” to a small, a medium, and, finally, a large, “rigid” corporation with formal linkages and highly specialized component knowledge.(Utterback 1994; Christensen 1997) It has become a cliché to speak of the conversion of core competencies into core rigidities.(Leonard-Barton 1992) However, despite the extensive documentation of the difficulties of achieving growth in large, established corporations, the fact remains that the continued survival of large, established companies substantially depends upon consistently achieving meaningful growth.

The challenges to growth are more severe for a company that derives a predominant amount of its present revenues from technology that is mature and faces the imminent emergence of a disruptive technology. Eastman Kodak Company derives about two-thirds of current annual revenues of \$12.8B from silver halide-imaging photographic products. Digital imaging, as a technology, has developed sufficiently to be able to replace silver-halide imaging in most applications – offering the promise of acceptable quality at lower cost and with higher convenience.(Utterback 1994; Christensen 1997) Kodak has reacted strongly and aggressively in the face of the threat of digital imaging, redefining itself as a leader in “Info-Imaging.” Indeed, it is a pioneer in the digital imaging technology field with a sizable intellectual property portfolio and a wide range of products tailored to the digital imaging value chain. However, the digital imaging business is substantially different from the traditional silver halide business primarily because it is a much more competitive marketplace with participating companies ranging

from consumer electronics giants, such as Sony, to computer technology giants, such as HP and Microsoft, as well as innumerable smaller firms that specialize in offering a solution to a single step in the digital imaging value chain.(Fine 1998) Wide industry participation has resulted in much shorter product lifetimes and significantly smaller margins, making revenue growth in this arena difficult. Kodak has expanded its offerings and improved its capabilities in silver-halide imaging as well – aggressively managing costs and investments while offering improved services. However, it is widely expected that digital imaging will eventually replace silver-halide imaging in most photographic applications, with the only remaining dispute being the speed with which technology substitution occurs. In the face of this challenge, therefore, it is imperative for Kodak to find alternate sources of revenue that will enable it to continue to grow through the technology transition and beyond.

This study will focus on the challenges to growth in large, established firms such as Eastman Kodak Company. Several previous studies have explored the pathways to growth available to large firms. From an organizational strategy perspective, Wheelwright and Clark (Wheelwright and Clark 1992) in their seminal work on product development explain the need for development frameworks and aggregate project plans that focus on a portfolio of projects. Sanderson and Uzumeri (Sanderson and Uzumeri 1995) studied Sony's development of personal stereo systems and showed how Sony was able to successfully develop a product family strategy. Meyer and Lehnard (Meyer and Lehnard 1997) address the need for, and relative success of, product platforms. From an organizational behavior perspective, it is widely recognized that to be successful, large, established firms must find a way to foster entrepreneurial flexibility and creativity while maintaining their success in controlling and coordinating the skills and knowledge of the existing organization. Henderson (Henderson 2003) suggests two key factors that enable this with (a) a senior management team that is ambidextrous, and (b) a choice of organizational form that is suitable to the specific problem that the firm is facing. Advocates of contingency theory (Nadler, Gerstein et al. 1992; Donaldson 1995; Nadler and Tushman 1997) have argued that competitive advantage is derived from a firm's dynamic ability to reconfigure resources, both new and existing, in novel combinations that adapt to competitive changes, while misfit between structure and contingency

reduces organizational performance. In other words, strategy and organizational design need to evolve in concert with their environment in real time to be effective.

In this study, I will view large, established firms as complex systems comprising a set of inter-related parts that combine to perform tasks and functions that cannot be accomplished by the individual parts alone and wherein changes in one part affect the other parts. As complex systems, firms exhibit such properties as internal interdependence, the capacity for feedback, and adaptation, which are difficult to analyze fully from a view of a sub-set of an organization or from a single perspective of a firm. Therefore, in the analysis of growth in large firms, I consider several analytical perspectives, each of which provides insights and understanding into the working of the firm as a whole. Specifically, growth in large firms is viewed from strategic, organizational, and dynamic perspectives.

From a strategic perspective, corporate strategy, technology strategy, and marketing strategy, together, combine to offer a rounded perspective of a firm's resources and how these can be used as a source of competitive advantage. Corporate strategy provides us with an understanding of the nature of resources and capabilities of a firm. The dynamic nature of technological change has strong impacts on a firm and its competitive environment. Technology strategy provides us with an understanding of the firm's effectiveness to creating, capturing, and delivering value by way of its products. Marketing strategy provides us with an understanding of how the firm leverages its products to achieve marketplace success.

From an organizational perspective, organizational design is the result of a strategic plan and objectives set. Successful organizational design seeks to fashion a set of formal structures and processes that, together with the appropriate informal structures and processes, enables the organization to achieve its objectives most effectively. Organizational theory is important insofar as managers must design organizations that operate effectively under a given set of contingencies – which is changing constantly.(Donaldson 1995)

From a dynamic perspective, organizations and their environments are complex systems that are in a constant state of flux.(Sterman 2000) Complex systems are characterized by

time-based effects and complicated, non-linear, feedback mechanisms. Failure to properly understand and accommodate these dynamics, results in “policy resistance” characterized by the inability of an organization to adapt to its environment.

The combination of the above perspectives allows the treatment of growth initiatives within an organization as a portfolio of development efforts. (Wheelwright and Clark 1992) While the business literature has, in general, begun recently to focus on whole systems and processes rather than individual projects, it does not, however, contain much guidance about how to put such thoughts into action. Simply recognizing product development and business development as a complex system with interdependent elements is of little help. In fact, a substantial body of research shows that human beings perform poorly in decision-making tasks in dynamic environments. (Sterman 2000) In order to further our understanding of such systems therefore, dynamic models are critical. These models are developed using a system-architectural perspective of firms – with a view that there is a mapping from organizational form to organizational function.

I distinguish between revenue growth in large, established firms through new revenue opportunities in new businesses and revenue growth through extensions of existing revenue streams. A very large body of existing literature, part of the standard curriculum at every business school, focuses on the latter. However, large, established firms suffer from a specific set of inertial forces that make revenue growth through new businesses particularly challenging. I will focus on these forces and identify key strategic points of leverage. Specifically, this study will use a system-architectural perspective to construct a linkage between organizational form and growth in a large, established firm. This will be done in three parts, as follows:

Part A: Literature Review –

- (a) Firm analysis using three strategic lenses – corporate, technology, and marketing
- (b) An analysis of the relationship between strategy and organizational structure
- (c) A review of common organizational issues peculiar to large, established firms
- (d) Frameworks for growth in large, established firms

Part B: Motivation –

- (e) A description of three key growth projects in a large, established firm
- (f) This study's hypothesis: Large, established firms seeking new business growth need to strategically, organizationally, and culturally embrace multiple-growth modes and concomitant multiple organizational structures that match the relevant growth modes.
- (g) Analysis of the three key growth projects using the proposed framework

Part C: Empirical Study –

- (a) Survey of 24 Project Leaders/Managers involved with new growth projects
- (b) Survey results and analysis
- (c) Conclusions and Recommendations for Implementation
- (d) An analysis of the generic product development framework from the perspective of new business growth

Appendix: System Dynamics Model –

- (a) An introduction to system dynamics simulation models of firms
- (b) Growth inhibition model – Project perspective and System perspective
- (c) General model insights

Chapter 2 presents strategic and organizational perspectives of growth in a large, established firm. The strategic perspective on growth is provided using three lenses – corporate, technology, and marketing. The strategic perspective provides the framework within which an organizational structures and executes growth plans. The organizational perspective of the firm links organizational structure and processes to organizational tasks. As a firm seeks to change or modify tasks, in this case engage in non-traditional growth activities, organizational structures and processes need to evolve in lock step. Organizational responses that drive growth are discussed and frameworks for growth discussed in the literature are presented.

Chapter 3 presents the motivation for this study through a description and analysis of three key growth projects in a large, established firm. Each project is analyzed using the

strategic and organizational perspectives discussed previously. This analysis is used to present the hypotheses for this study – a new framework for analyzing non-traditional growth opportunities and the necessary linkages between organizational form and growth opportunity. Each of the three growth projects presented previously is analyzed using the suggested growth framework with concomitant linkage to organizational form.

Chapter 4 presents the results of a survey of 24 Project Leaders/Managers involved with new business growth projects in a large, established firm. Survey results are analyzed and used to test the hypotheses presented in Chapter 3.

Chapter 5 presents the conclusions of this study. Implementation considerations are discussed in some detail – addressing specifically structural, cultural, and dynamic issues, as well as the implications of suggested changes on generic product development processes.

Appendix A introduces system dynamics simulation models of firms. A system dynamics model of “Growth inhibition” is presented from an individual and a system perspective. Model results are summarized and conclusions discussed. Appendix B summarizes the survey results and analysis.

Chapter 2: Literature Review

An analysis of non-traditional growth in large, established firms requires an understanding of how a firm utilizes its resources as a source of competitive advantage. In this chapter, I review the relevant literature on firm strategy from three perspectives: corporate strategy, technology strategy, and marketing strategy. I also review the relevant literature on organizational structure and structural contingency theory, to understand the interplay between strategy and organization. Building upon this, I explore the inherent rigidities and systemic antibodies that stand in the way of non-traditional growth in large, established firms. Finally, I review the relevant literature on growth frameworks for large, established firms.

2.1 The Strategic Perspectives of a Firm

2.1.1 The Corporate Strategy of a Firm:

A firm's resources and products, together, largely define its identity. Resources are typically anything that can be thought of as a strength or weakness of a given firm, including tangible assets such as production equipment, land, buildings, etc., and intangible assets such as brand, know-how, and culture. The traditional concept of corporate strategy is based upon the resource position of the firm characterizing its strengths and weaknesses. More recently, the resource-based view of the firm has developed two separate but related schools of thought. (Westerman 2002) The first school emphasizes the role of firm-specific resources in promoting diversification and innovation. The second school focuses on how firm-specific resources can provide competitive advantage in a particular context. The intent in either case, however, is to clearly establish the role of a firm's resources in value creation and value capture. To the extent that the firm's resources are highly specific, differentiable, and of multiple use, they can be used to generate higher value. Typically, however, resource advantages tend to be ephemeral; firms must continuously search for new sources of competitive advantage.

In the face of continuously changing environments, therefore, long-term competitive advantage rests on the ability of the firm to adapt to such changes. Adaptation involves

renewing existing assets as well as absorbing new assets along with unique combinations of these adaptations. Resources are necessary but not sufficient. A body of literature in this field is focused on the concept that there exists in each firm a core set of capabilities that differentiate the firm strategically. Core capabilities (Leonard-Barton 1992) are best defined as a set of differentiated skills, complementary assets, and routines that provide the basis for a firm's competitive capacities and sustainable advantage in a particular business. Insofar as the core capabilities are relevant in the face of changes in the business environment, the firm enjoys a dominant technical depth; an understanding of product and managerial systems and processes; and a key set of values and cultures that improve its chances of success. However, in the face of radical changes in the business environment, the same competencies become rigidities that display weaknesses, which reflect strengths in the previous business climate – poor technical breadth, inability to adjust to changing systems and processes, and cultures and values that are outdated.

A subsequent body of literature focused on the learning organization and the need for dynamic organizational capabilities. These capabilities are defined as routines that enable a firm to absorb new technologies, generate new knowledge, and integrate internal resources. The ability to scan the environment and to integrate external technologies with internal resources is deemed a more enduring competitive advantage than an instantaneous resource position. Long-term competitive advantage comes from a firm's dynamic ability to reconfigure resources, both new and existing, in novel combinations that adapt to competitive changes. Indeed, consistent with the introduction of the fourth generation R&D practices (Miller and Morris 1999), the interplay between knowledge creation/organizational capability and organizational architecture is now the focal point of attention.

2.1.2 The Technology Strategy of a Firm:

Given that this study is focused on the issues surrounding growth in a large, established, technology-oriented firm, particularly one subject to disruptive technological change, I begin with a description of pertinent literature focused upon disruptive change and the difficulties incumbent, large firms face in attempting to grow in such challenging environments.

Technology S curves, graphs that plot the relationship between effort put into improving a product or process and the results associated with that effort, have been extensively used to map the maturity of technologies.(Foster 1986) Although somewhat stylistic, nevertheless, S curves often provide a useful representation of the stage of evolution of a technology set and the advent of competitive technologies for similar applications, particularly when viewed in hindsight. Technology discontinuities are particularly difficult transitions for incumbent, large firms. While relatively easy to spot, it is much harder to actively invest in discontinuous technologies with the clear intention of cannibalizing the incumbent older technology, as numerous examples over the past 50 years have repeatedly shown.

The Fosterian S-curve framework is complemented by Clayton Christensen's work on disruptive technology.(Christensen 1997) Christensen describes disruptive innovations as technologically straightforward innovations, often consisting of off-the-shelf components put together in novel architectures, that actually perform poorer than the incumbent technology in many key metrics but are able to distinguish themselves from the incumbent technology in three key ways – (a) they show superior performance on at least one dimension that meets a key customer need, (b) their performance on key attributes is well within the “customer needs” trajectory and (c) they are substantially cheaper in at least some dimensions than the cutting-edge incumbent technology. Aggressive, customer-oriented, seemingly well-managed, incumbent organizations crumble in the face of disruptive technology. Christensen explains that at least one source of this dilemma is the fact that explicit demands from leading-edge customers have tremendous power on the resource allocation process, directing resources repeatedly toward meeting existing leading-edge customer needs that push the company to exceed the needs of a majority of their customers. Indeed, often the needs met by the disruptive technology are latent, making the justification of resources difficult within incumbent firms, resulting ultimately in delayed market responses when disruptive technologies do, indeed, become commercially mature. Incumbent firms appear to lose the ability to successfully confront uncertainty, particularly in finding new applications for new products that are peripherally similar to their own.

Abernathy and Utterback (Utterback 1994) similarly found that firms evolve with their technology to create highly specialized production infrastructures and processes that, while extremely adept at incremental improvements, are unable to adapt to technologies that require new or changed processes. Tushman and Anderson (Nadler and Tushman) frame technology innovations as “competence-enhancing”, those that enable incumbents to evolve with the technology and “competence-destroying”, those firms that require skills, processes, and infrastructure that is radically different from those that exist already. Henderson and Clark (Henderson and Clark 1990) present the dilemma of architectural innovations, the reconfiguration of an existing system to link together existing components in a new way, and how such innovations disrupt key communication channels, information filters, and problem-solving strategies in managing architectural knowledge. Since such communication channels, filters, and strategies are embedded in the organization of established firms, these firms are often unable to make the transition to a new orientation from one of refinement within a stable architecture to one of active search for new solutions within a changing context. Attempts are often made to modify existing channels, filters, and strategies rather than build new sets from scratch. It is difficult to determine which strategies are to be changed and by how much, making such attempts problem-fraught.

There is a clear linkage between the above literature and the core-competency concept elucidated by Prahalad and Hamel (Prahalad and Hamel 1990) and Leonard-Barton.(Leonard-Barton 1992) Core-competencies are those that differentiate a company strategically and comprise a set of differentiated skills, complementary assets, and routines that provide the basis for a firm’s competitive capacities. These include employee knowledge and skills, technical systems, managerial systems, values, and norms. When taken in concert with the dynamics of innovation described by Utterback (Utterback 1994), a firm, as it evolves over time from a fluid phase – characterized primarily by product innovation, to a specific phase – characterized primarily by process innovation, develops organizational structures, skills, and processes that embody the communication channels, information filters, and problem-solving strategies utilized by the firm. In striving continuously for higher efficiency in each of these transactions, the organization evolves a set of core competencies that make it highly capable of dealing

with the existing technology and business environment – these competencies are institutionalized. When confronted eventually with a changing environment, the ability of an organization to evolve with these changes is almost inversely related to the efficiencies they attained in the previous environment. Higher efficiencies and greater success in previous environments typically translate to lower adaptability.

Recognizing these disadvantages, recent literature has recognized the role of the “learning organization” and the potential for the most defensible competitive advantage being an organization’s capacity to improve its existing skills and learn new ones. William Miller and Langdon Morris, in their book titled “Fourth Generation R&D,” (Miller and Morris 1999) explain that future growth for large, established companies seeking to expand their top line, will become the fusion of new market knowledge and new scientific and technical knowledge. Recognizing that large, established corporations have a low tolerance for risk, Miller and Morris mention that these firms need a business process focused on innovation rather than a business structure focused on more traditional competencies of R&D, technology and product development, and marketing.

2.1.3 The Marketing Strategy of a Firm:

A marketing orientation to growth in large, established firms is focused on the choice of the right *product markets*. Most managers agree with the basic precepts of revenue segmentation – revenues are easier to capture in some product markets than others. Typically, new customers are harder and more expensive to acquire than retained customers. Also typically, new products are harder and more expensive to sell than established products. The 2 x 2 matrix below segments products and markets into existing and new.(Friedman and Furey 1999)

Fig 2.1: Product Market Segmentation

		Products	
		<i>Existing</i>	<i>New</i>
Markets	<i>New</i>	<i>Customer Acquisition</i>	<i>Missionary Growth</i>
	<i>Existing</i>	<i>Customer Penetration</i>	<i>New Product Introductions</i>

Growth of existing products in existing markets constitutes the low-hanging fruit, in terms of growth. Improved market share and customer penetration typically provide the most cost-effective path to revenue growth. The cost of acquiring new customers is typically three to six times that of retaining existing ones. Accordingly, product markets that require customer acquisition may be necessary for revenue growth but are typically bad bets for short-term profitability. New product introductions similarly are costly. Beyond development costs and failure rates, the cost-to-sell new products is substantially higher than existing products because the sales force must be trained and the customer base educated, forcing a larger sales cycle and requiring higher levels of support. Careful screening, selection, and piloting of new products are critical to successful new product introductions. Large, established firms in relatively mature industries typically consider it risky and unprofitable to rely on new product sales for more than ~25% of revenue.(Friedman and Furey 1999) Product markets that are completely new to the company are the highest risk ventures. Wary, new customers often will not buy untested new products from a new vendor. The costs associated with finding new customers and

introducing new products usually exceed any profits that may be realized from the venture for several years. Companies pursuing this kind of growth typically do not target more than 5 to 10% of their revenues from these types of sales.(Friedman and Furey 1999) In summary, successful market strategies involve: deeper penetration of existing accounts with existing products, the selective acquisition of new customers with market-validated products, and the selective introduction of well-screened offerings into the installed base.

When the three strategic perspectives are taken together, a clear picture emerges. Large firms, victims of past success, have stultified processes and methods that are unable to adapt to changing market needs and/or changing technology. Recognizing this, firms should restructure their processes to adapt better to disruptive changes, and they should do so by “sticking to their knitting” – identifying and exploiting their core competencies and markets while jettisoning any non-core pursuits. Unfortunately, since this is nothing short of transforming the firm, this proves to be extremely difficult to do in practice. The business literature does not clearly describe how the dynamics of organizational architecture and organizational capability can be leveraged to achieve strategic objectives. Typically, cultural and environmental aspects of each firm differ substantially from other firms, even those within the same industry, making any recipe for business transformation fraught with missteps. Indeed, firms that are confronted by disruptive change may be forced to resort to high-risk strategies that look to new markets and new products for revenue growth. I look beyond strategy, therefore, at the organizational perspectives of a firm to better understand the details that may be relevant to achieve organizational transformation.

2.2 An Organizational View of the Firm

When viewing a firm as a complex system, strategy and organization are closely linked. Numerous organizational theories exist, but this study will focus on contingency theories that emerged over 40 years ago, after attempts failed repeatedly to find the single-most efficient organizational structure for all business environments. The central premise of contingency theories is that there is no single best-way to organize – the design of an organization should match the task contingencies facing it.

The contingency approach was the outcome of research studies conducted by Tom Burns, G.W. Stalker, John Woodward, Lawrence Lorsch, and others.(Donaldson 1995) Through their analysis they correlated the structure of an organization to the surrounding environmental conditions. In the 1950s, Burns and Stalker (Burns and Stalker 1961) analyzed the environments and structures of several firms and identified two types of organizational structures – Mechanistic and Organic, against two categories of environment – Stable and Dynamic. Their studies revealed that mechanistic structures were found to be common in organizations operating in stable environments, while organizations operating in dynamic environments tended to be organic in structure. Mechanistic structures include formal roles, strict hierarchy, concentrated power and knowledge, and vertical communication, all characteristics of highly bureaucratic organizations. Organic structures include less-formally defined roles, more discretion at all levels, decentralized power and knowledge, and extensive horizontal communication, typically the characteristics of organizations with high levels of task uncertainty.

Several different contingencies have since been identified, including size, strategy, and technology, but these can all be interpreted through the lens of structural contingencies that drive organizational design. Specifically, structural contingency theory advocates that the organization fit its structure to the task contingency to yield operational effectiveness – a better fit improves performance. The organizational structure may be more participatory or more centralized as a function of – operational technology (Woodward 1958); rate of environmental change and product diversity (Lawrence and J. W. Lorsch 1967); size (Pugh and Hickson 1976); and strategy(Chandler 1962). As primary and structural changes follow strategy change in time, organizational structure is deemed secondary to strategy. Organizational management, as the main maker of both strategic and structural decisions, is assumed to act rationally on behalf of the organization. The time lag, while the organization is in misfit, is seen as arising from incomplete knowledge by management. Driving misfit are two major contingencies – uncertainty, which drives design and differentiation, and interdependence, which drives the amount and type of integration.

Numerous attempts have been made to characterize and quantify uncertainty and interdependence in organizations and organizational sub-units. The ideas that information

processing underlies contingencies (such as uncertainty and diversity), and information-processing needs give rise to the required organizational structures, have been developed theoretically and empirically.(Galbraith 1974) Different tasks pose different information-processing requirements. Different organization designs provide different types of information-processing capacity. In order to increase organization performance, information-processing requirements should be reduced, or information processing capacity increased, until there is a fit between the information-processing capacity of the organizational structure and the requirements imposed by the tasks at hand. Research has also been undertaken on the critical issue of whether or not the fit between a given contingency and a structural variable affects organizational performance, and there has been an increasing tendency to examine multivariate models of more than one contingency, structure, or performance variable.(Gresov 1989)

Despite the large body of literature and theories on contingency, however, there are three main issues that remain to be addressed:

- a) the subject of multiple contingencies and organizational responses to such eventualities is only been touched upon,
- b) the systemic comparison of one response versus another to the same set of contingencies has not been examined, and
- c) the theories are still primarily equilibrium-oriented – there is a strong need for dynamic theories that allow a firm to maximize its effectiveness in the face of constant uncertainty and change.

However, there has been considerable work on organization design, particularly with respect to organization design for growth. In the next section, I review the primary organizational structures for product development and growth-related activities.

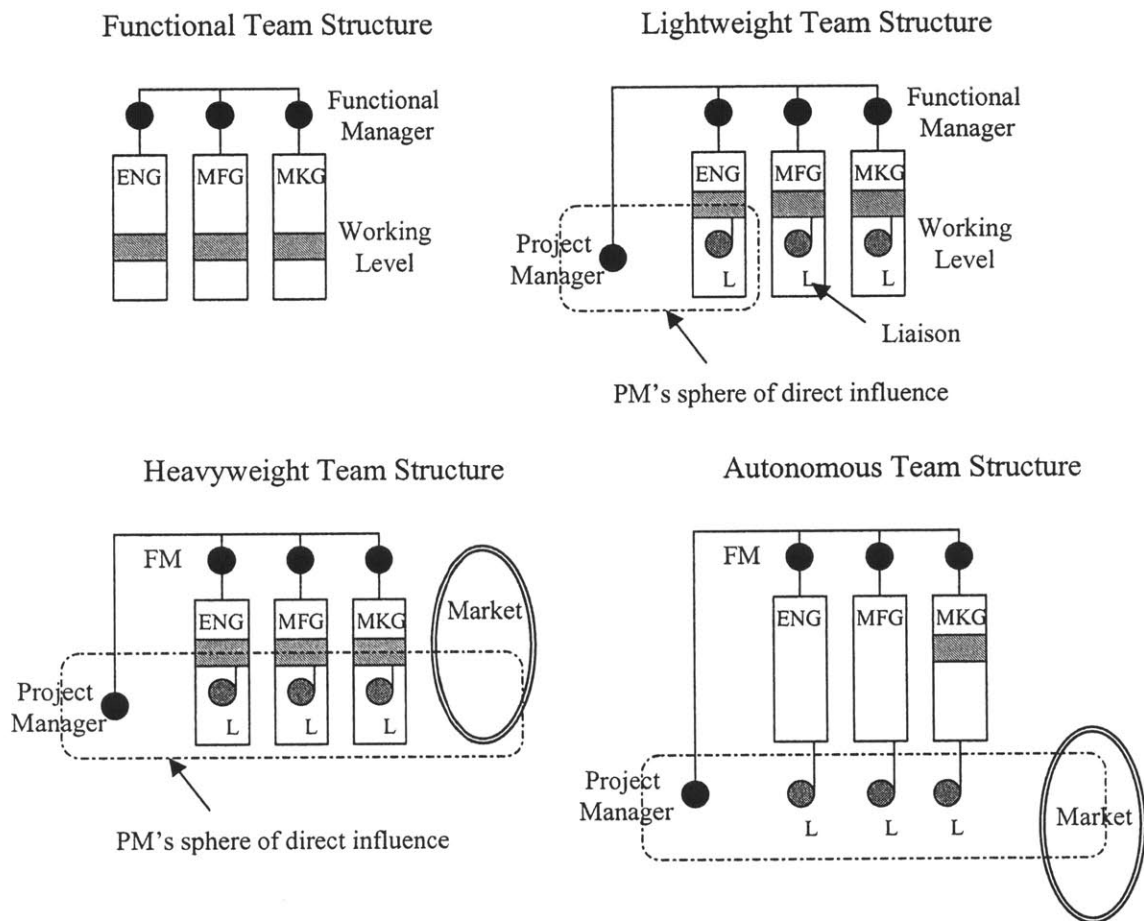
2.3 Organizational Forms for Growth

While there exists a spectrum of growth options, including external development (acquisitions, joint ventures, and corporate venturing) and internal development (internal R&D, innovation teams, internal ventures), for reasons of alignment of incentives and

priorities, as well as execution speed and capability, there exist improved efficiencies in operation through specific organizational forms over other organizational forms.

Wheelwright and Clark (Wheelwright and Clark 1992) identified four dominant structures around which product development activities are typically organized. These are shown in Figure 2.2.

Fig 2.2 Team Structures



The functional team structure is typically found in large, mature firms where people are grouped together by discipline under the direction of a functional manager. The work of the different functions is to coordinate ideas through a set of detailed specifications agreed to by all parties at the start of the project and reinforced through periodic meeting. Over time, the primary responsibility for the project passes sequentially through the functional areas. The primary strengths of this approach are (a) managers that control resources also control performance of project tasks making resource allocation within the

sub-tasks less of an issue, (b) most career paths tend to be functional until one reaches a general management level so career progression is less of an issue, and (c) specialized expertise is brought to bear on key technical issues. However, there are several weaknesses of this approach that make this form of structure particularly poor for growth initiatives. These include (a) the neat division and sub-division of tasks into independent activities at the onset of a complex development project is almost impossible, (b) functional focus severely limits the perspective of the individuals, and (c) there is an over emphasis on local optimization instead of system or sub-system optimization.

The lightweight team structure is another organizational form typically found in large, mature firms. Like the functional structure, the team members physically reside in their functional areas, but each functional organization provides a representative (or liaison) to the project team. The project manager, who is typically chosen out of the function that is most vested in the development process, has the responsibility for coordinating the activities of the different functions. The project team members, however, remain under the control of their respective functional managers; the project manager has no direct power in reassigning people or reallocating resources. While this tends to be an improvement over the functional team structure because there is a person who looks over the entire project, nevertheless, power still resides within the functions, and as a consequence, improved efficiency, speed, and quality over the functional team structures are rarely observed.

Heavyweight project managers, in contrast, have direct access to, and responsibility for, the work of those involved in the project. The core project group of heavyweight team structures is often dedicated to the project and physically co-located. The assignments of functional team members tend to last for the duration of the project with the members returning to their functional homes after the project is complete. On the one hand, they provide high levels of ownership and commitment among the core team members, enabling tough issues to be addressed in a timely and effective fashion. Their singular focus is often superior in tackling significant challenges. They are able to also effectively address system solutions to customer needs. Conversely, such teams may get carried away as they extend themselves and seek to redefine what needs to be done to achieve success. There is often a constant challenge in balancing the resource needs of the

individual project with those of the broader organization. There is also a question with technical depth, as such teams typically seek less specialized solutions in an effort to deliver a system. Heavyweight team structures typically tend to be more difficult to adopt in large, mature firms. These teams often require fundamental changes in the way that development works, and that responsibility has to be defined. In large, mature firms, functional responsibilities tend to be well defined and home turf fiercely defended. A heavyweight team structure makes task responsibility definitions far more diffuse – the team as whole feels ownership.

The autonomous team structure involves individuals from different functional areas that are formally assigned, dedicated, and co-located to the project team. Removed from the existing organization, the main advantage of this team structure is focus. Such teams tend to do well at rapid, efficient new product and new process development. Cross-functional integration is particularly effective. However, such teams typically are extremely difficult to re-integrate into the mainstream organization. Their solutions tend to be unique, and over time, they develop their own stand-alone culture.

From the descriptions given above, it is easily seen that functional and lightweight teams are more effective in evolutionary development, whereas heavyweight and autonomous teams tend to be more effective in non-traditional settings such as platform development. Typically, innovation teams tasked with growth in large, mature firms tend to be lightweight or heavyweight teams, depending upon the past history of the organization and the success that they have had incorporating the two team structures. The autonomous team structure tends to be more common when dealing with joint ventures and/or acquisitions, which are more externally focused. However, despite the obvious differences in the effectiveness of different team structures for different development opportunities, **organizations tend to adopt a dominant orientation or a standard approach to organization regardless of the objectives of the task at hand.** Typically driven by past successes with projects and cultural as well as political issues within firms, organizations gravitate, over time, to adopt a single organizational structure, with some small degree of variation, regardless of the task. The dominant orientation, in turn, determines the effectiveness of the organization at specific tasks that may be a misfit to the strengths of the specific orientation. As explored in the next section, large firms are

typically characterized by an “active inertia” that exhibits mean-reversion behavior – a return to status quo whenever change is imposed upon the organization.

2.4 Inherent Rigidities in Large Firms

Processes within large, established firms are conditioned to reduce risk and prevent decisions being made that are predicated on large levels of uncertainty. Growth opportunities, however, inherently require the assumption of risk at levels that exceed those deemed acceptable in large, established firms. To achieve sustained and profitable growth, large, established firms need to create organizational structures and processes that resolve the above paradox.

2.4.1 Organizational Rigor Mortis:

Christensen and Overdorf (Christensen and Overdorf 2000) build upon the core competency concept to highlight how an organization’s capabilities may become growth inhibitors as it matures. Specifically, as a firm matures, its processes, including patterns of interaction, coordination, communication, and decision making, are increasingly streamlined for efficiency. When the same processes are used to tackle different tasks however, they are likely to perform sluggishly. Organizations confronted by disruptive change are able to redefine the more visible processes such as manufacturing, customer service, logistics, etc., relatively quickly, but the less visible, background processes that support decision making, resource allocation, and prioritization are often embedded much deeper within a firm’s processes. For example, the negotiation of plans and budgets, resource allocation realities, and decision-making paradigms, such as those made previously within a hierarchy, market analyses, financial modeling, and interpretation, etc., are processes that require organizational change at more fundamental levels. Many organizations find such processes most difficult to change. Additionally, over time, the firm’s processes reflect upon its cost structure. Critically, the cost structure that evolves now begins to dictate a company’s ability to profitably pursue existing and new opportunities. As stated by Christensen and Overdorf (Christensen and Overdorf 2000), if a company’s overhead costs require it to achieve gross profit margins of 40%, decision rules embedded within the company’s processes encourage killing ideas that promise gross margins below a threshold that is at or close to 40%.

The above paradigm is particularly critical to firms seeking new growth. Existing cost structures could end up as tremendous burdens for new opportunities to achieve, making such efforts predestined to failure. For large, established firms, there is the additional burden of opportunity size – a \$40M company that wishes to grow by 20% needs to find \$8M in new revenue, but a \$40B company wishing to grow by the same rate needs to find \$8B in new revenue. The point here isn't that it is unreasonable for large firms to grow at the same rate as small firms, but growth opportunities for large firms are simultaneously subject to two daunting filters (a) potential gross margins, and (b) opportunity size. Opportunity size and opportunity uncertainty are typically directly correlated – the larger the opportunity, the higher the uncertainty. Opportunities that are large enough and exhibit the potential for sufficiently high margins inherently tend to be more risky. Since large, established organizations are typically poorly conditioned to handle high risk, these projects tend to survive the early filters only to fail subsequent filters that focus increasingly on the viability of the business and technology opportunity. Filters that are set up to eliminate opportunities below a certain size/margin and above a certain uncertainty may ultimately find that the effects are mutually exclusive with the remaining opportunities being few (if any) and narrow in scope, ultimately defeating the purpose of revenue growth.

Typically, opportunities that survive the early filters (size and margins) tend to be inherently uncertain from either a technology perspective, or a business perspective, or both. The efficiency of organizational processes for improving technology and business understanding now effectively determine the fate of the opportunity. If such processes, conditioned during the maturation of the firm, are focused primarily on reducing technology risk, technology uncertainty reduction will proceed efficiently but at the expense of business uncertainty that proves increasingly daunting. Conversely, if such processes are focused primarily on reducing business risk, business uncertainty reduction proceeds efficiently at the expense of technology uncertainty. In practice, as uncertainty grows, firm management is conditioned to react by elevating the decision making to ever higher levels. This serves to delay decision making and magnify uncertainties further, as an ever-growing set of questions are repeatedly asked, prompting evermore-frantic activity at lower levels. Delayed decision-making results, at one extreme, in missing key

windows of opportunity or, at the least, in increasing the amount of money being spent in clarifying details that may or may not be knowable.

Donald Sull (Sull 1999) characterizes the problems of large, established firms as “active inertia” – arising from an inability to take appropriate action rather than an inability to take action. Active inertia, defined by Sull, is an organization’s tendency to follow established patterns of behavior – even in response to dramatic environmental shifts. Typically, large, established firms owe their prosperity to a fresh competitive formula – a combination of strategies, relationships, products, and values that sets them apart from customers. As the formula succeeds, the positive feedback reinforces managers’ confidence that they’ve found the one, best way. Strategic frames – mental models and mindsets that shape how managers view the world, including what business they are in, who their competitors are, and how they create value – now become strategic blinders. Processes harden into routines, past positive reinforcement having provided strong incentives to sacrifice creativity with predictability (something necessary to coordinate the activities of a complex organization). This routinization of processes prevents employees from considering new ways of working; relationships become shackles, and values harden into dogmas. Sull suggests approaching the problems from a perspective of understanding the hindrances to growth, which in itself requires a fresh perspective. He advocates that new leaders be found from outside the company or from within the company but outside the core business to find this fresh perspective.

Any large, established firm is engaged in multiple concurrent projects. The importance of aggregate-project (portfolio) planning has been described in considerable detail by Wheelwright and Clark.(Wheelwright and Clark 1992) These plans lay out the sequence of projects that the firm plans to undertake, as well as those that will be actively supported at any one time. It specifies in considerable detail the types and mix of projects that the firm plans to undertake over the planning horizon. In theory, portfolio planning allows:

- a) prioritization of projects according to previously defined criteria that align with corporate and technology strategy,

- b) clear development and commercialization timelines that permit close alignment with marketing strategy,
- c) effective management of resources to prevent overcommitment or undercommitment, and
- d) planned enhancements of organizational skills and competencies that enable continuous corporate renewal over the product life cycle.

Wheelwright and Clark go on to describe optimum portfolio planning strategies that balance, on aggregate, the types of projects between the categories incremental, platform, and radical projects as well as advanced R&D (blue-sky research), and alliances/partnerships. Each of these project types provides different growth impetus and requires different levels and mixes of resources. The relative mix of each of these project categories is a function of forces in the firm's environment, the firm's capabilities, and its strategy. As an industry matures, opportunities for advanced development and breakthrough projects decline; conversely, breakthrough projects become increasingly risky. Incremental and derivative projects constitute increasingly higher fractions of the mix. The authors suggest several steps that can be followed in the development of an aggregate plan: (1) define types or classes of development projects that are to be covered; (2) define the representative project of each type, the critical resources, and cycle time required for complete development; (3) identify existing resources available for development efforts; (4) compute capacity utilization; (5) establish desired future mix of projects by type; (6) estimate the number of projects of each type that can be undertaken with existing resources; (7) decide which projects to undertake; and (8) determine and integrate into the project plan changes that are required to improve development performance over time.

While portfolio planning offers a logical and seemingly straightforward process for firms to plan their growth portfolio, actually carrying out the plan, as the authors admit, takes hard choices and discipline. Typically, it is difficult to estimate the cycle time for a development project, particularly for one that is in early-stage development. Resource identification is usually not difficult; however, it is far too common to have these resources significantly overloaded – particularly when considering projects that may be

substantially different in terms of their stages of development. Despite wide recognition that the efficiency of a resource, human, or machine drops off precipitously as its utilization increases beyond a threshold-utilization rate, there is a tendency to add tasks far in excess of this threshold. Practical difficulties in limiting this tendency include the absence of system-level prioritization, resulting, for example, in resources supporting competing business units jockeying for critical experimental and testing resources, poor ability to forecast requirements early in the project, a proclivity to underestimate resource requirements, over-ambitious project timelines, aggressive project leaders that are able to manipulate the system to achieve their ends – often at the expense of other projects with less well-connected leaders, the built-in inertia of budgeting systems that results in automatic allocations for certain activities that may or may not be strategically aligned, poor speed of decision-making – decisions that are relatively trivial often need to be elevated to the appropriate level of management to get formal approval, etc.

2.4.2 Key Causes of Failure of Growth Ventures:

A very long list of causes of failure has been compiled in literature documenting growth attempts in large, established firms.(Gee 1991; Wheelwright and Clark 1992; Baghai, Coley et al. 1999; Mason and Rohner 2002). Some of these causes are listed in Table 3.1 – at a system level and at an individual project level. The existence of “corporate antibodies” – institutionalized responses that stifle new growth ventures, has also been recognized in the literature.(Christensen 1997; Christensen and Overdorf 2000; Mason and Rohner 2002) At the root of this is the corporate culture that serves to minimize risk, resolve conflict, maintain focus, and preserve continuity. These antibodies manifest themselves in terms of restricting the innovation team’s access to resources – human resources, equipment, funding, etc., requiring excessive risk reduction (excessive from the perspective of a start –up, which requires much time and effort to be focused around justifying the planned course of action instead of executing it, requiring the innovation team to follow corporate policies on matters peripheral to the business), which may result in much slower order fulfillment and much longer justification processes as the team struggles to get the attention and priority of service from organizations within the parent organization that assess the team’s progress using existing guidelines – using the previous metrics to similar progress report formats that may really be more akin to comparing

apples to oranges. Recognizing the existence of these antibodies is the first step toward achieving non-traditional revenue growth in large firms. The second step is in actually combating these antibodies in a fashion that renders them ineffective without actually eliminating them, since they serve a strong purpose within the existing business.

Table 2.1 Common Causes of Failure to Achieve Non-Traditional Growth in Large Firms

At a system level:

1. Lack of top management commitment
2. Non-acceptance of charter by staff and operating manager
3. Unrealistic expectations
4. Improper implementation strategy/execution
5. Absence of influential, high-level champion
6. Flawed decision-making structures
7. Inappropriate risk/reward environment
8. Unbalanced growth portfolio
9. Wrong people/skills in place

These also include, *at an individual project level:*

1. Incomplete/mistaken opportunity assessment
2. Misalignment with corporate strategy
3. Resources spread too thin
4. Wrong personnel
5. Premature transfer to operating division
6. Politics
7. Nascent technology
8. Corporate capabilities are limited
9. Inadequate representation/participation by landing organization

10. Misjudging resource and time needs

Typical corporate antibodies:

- Financial
 - Don't have a negative impact on short-term earnings
 - Don't change existing incentive policies
- Staff
 - Don't recruit our best people
 - Don't recruit from the outside
 - Don't distract top management
- Strategic
 - Don't partner with competitors
 - Don't cannibalize current revenues
 - Don't jeopardize current trading relationships
 - Don't damage our brand
- Operational
 - Don't move ahead quickly without further analysis
 - Don't violate existing corporate policies

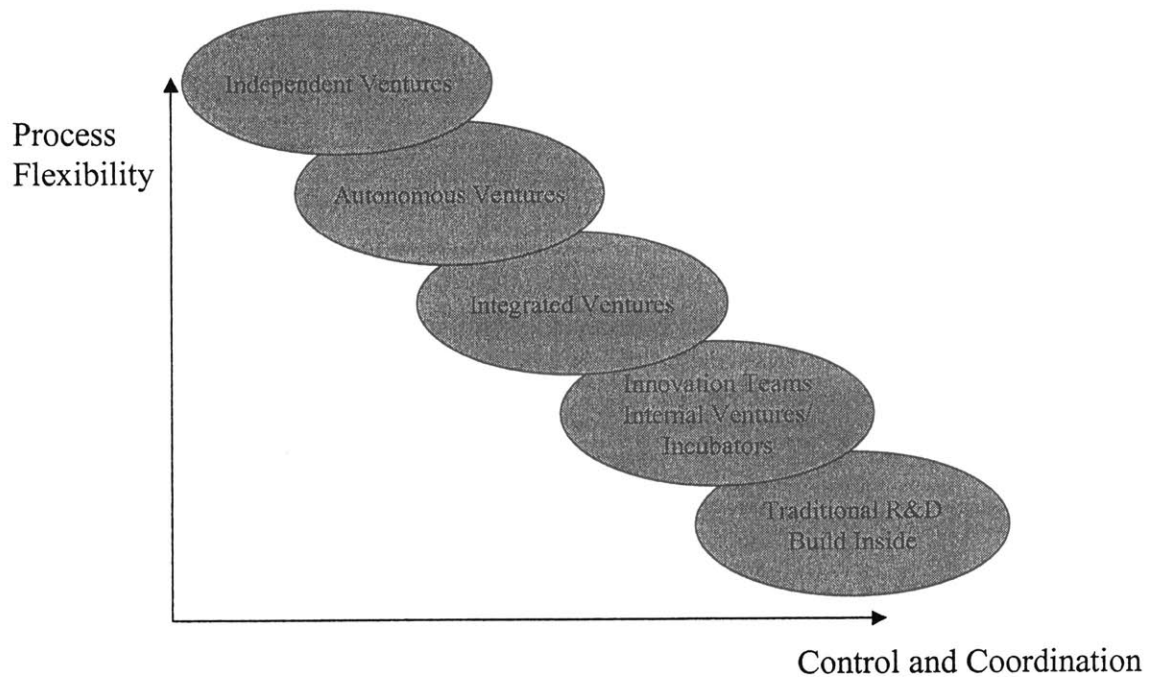
The above reasons characterize several of the predominant causes that large organizations find impede their growth prospects through non-traditional markets and technologies. To successfully achieve growth, firms must recognize the inherent rigidities and systemic antibodies and actively combat these through policy and execution.

2.5 Frameworks for Growth in Large, Established Firms

Organizationally, firms have a continuum of approaches that they use to respond to the need for non-traditional growth.(Henderson 2003) As shown in Figure 2.3, these include *independent ventures*, where the only relationship to the parent firm is investment;

autonomous ventures, which typically include separate divisions or SBUs (separate business units) that report direct to executive management (often directly to the CEO), work autonomously from the parent, and are often geographically separated to maximize independence; *integrated ventures*, separate organizations with Profit/Loss responsibility that are encouraged to leverage the existing infrastructure and integrate with existing lines of business; *innovation teams*, focused and dedicated teams that work to develop a system, including technologies, architecture, and business model but within the existing SBU framework; and *traditional R&D*, where efforts are conducted within existing functional sub-units in existing businesses.

Fig 2.3: Growth Modes Available to a Firm



Large firms can, and do, use the spectrum of above approaches to achieve growth. Typically, however, there is a failure to fully recognize the need for alternate organizational structures that perform each of the above effectively. In the first part of this chapter, I describe a few growth frameworks that have been suggested in the literature. In the second part of this chapter, I describe the typical operational application of these frameworks.

2.5.1 Frameworks for Classifying Growth Opportunities:

Roberts and Berry (Roberts and Berry 1985) suggest a framework for selecting optimum entry strategies for diversification in existing firms. They propose a framework, shown below, for considering entry issues related to the degree of familiarity or newness of a technology or service, as well as the degree of familiarity or newness of a market. Familiarity is characterized by the degree to which the characteristics and patterns associated with the technology and/or market are understood, while newness is characterized by the degree to which the technology or markets have been addressed in or by existing products. They propose that internal development is (and/or acquisition and/or licensing are) the preferred entry strategy for technologies and markets that are familiar, while venture capital and educational acquisitions are the preferred strategies for unfamiliar technologies and markets. For combinations of familiar technology and unfamiliar markets or vice versa, joint ventures appear to be most suitable. "New style" joint ventures refer specifically to ventures wherein one firm (normally the smaller) provides the technology, while the other firm (normally the larger) provides the marketing, distribution channels, and sales. In addition to the framework itself, this study highlights the need for large, established firms to adopt a multi-faceted approach encompassing internal development, acquisitions, joint ventures, and venture capital investments to make available a broad range of business development opportunities at the lowest risk.

Fig 2.4: Roberts and Berry Growth Framework – Market and Technology

New Unfamiliar	Joint Ventures	Venture Capital or Venture Nurturing or Educational Acquisitions	Venture Capital or Venture Nurturing or Educational Acquisitions
New Familiar	Internal Development or Acquisitions or Joint Ventures	Internal Ventures or Acquisitions or Licensing	Venture Capital or Venture Nurturing or Educational Acquisitions
Base	Internal Development or Acquisitions	Internal Development or Acquisitions or Licensing	'New Style' Joint Ventures
	Base	New Familiar	New Unfamiliar

Courtney et al.(Courtney, Kirkland et al. 1997) provide another framework for growth in large, established firms. Their framework is based upon characterizing the level of uncertainty surrounding strategic decisions and tailoring strategy to the uncertainty present. They characterize information relevant to business decisions, such as industry trends, market demand, political stability, etc., as knowable and unknowable. Residual uncertainty is defined as the uncertainty that remains after the best-possible analysis is done. They define four levels of residual uncertainty:

Level 1: Residual uncertainty is trivial and/or irrelevant (a strategy for an incumbent against a low-cost airline entrant).

Level 2: Alternate, discrete outcomes define the future (capacity strategies at chemical plants).

Level 3: A range of possible outcomes define the future (continuous, as opposed to discrete) (emerging technologies in consumer electronics).

Level 4: True ambiguity (entering the Russian market in 1992).

The authors suggest that after analyzing the residual uncertainty using the appropriate tools, the next step is to choose a strategic posture: as a Shaper (Leader), an Adapter (Follower), or Reserving the right to play (Options). Shapers aim to drive their industry toward a new structure of their own devise. Adapters take the current industry structure and future evolution as givens, and they react to the opportunities that the market offers. Reserving the right to play is a form of adapting where the company consciously makes incremental investments that put it in a position to act or react, based upon future decisions. Having determined a strategic posture, the authors suggest that the next step is to build a portfolio of actions that matches the posturing strategy. These are categorized as: Big bets (large commitments such as a major capital investment or acquisition), Options (asymmetric payoffs that protect losses on the downside but offer big-payoff on the upside), and No-regrets moves (that pay off regardless of the outcomes).

Jay Galbraith (Galbraith 1974) and Tushman and Anderson (Nadler and Tushman) used information-processing arguments and contingency theory to develop a framework that can be applied for growth opportunities. As shown in the Figure 2.5, they map the task's information-processing requirements with the team's information-processing capability. Where there is conflict between the information processing requirements and capabilities, they predict lower performance. Building upon the information-processing concept, it is possible to use a design structure matrix (Eppinger, Whitney et al. 1994) framework to map the information-processing needs versus real capability, and iterate through modified organizational structures with different information-processing capability to a better fit that yields higher performance.

Fig 2.5: Galbraith Information Processing Framework

		<i>Task Uncertainty (Info Proc. Req)</i>	
		<i>Low</i>	<i>High</i>
<i>Horizontal Dependence Info Proc. Cap.)</i>	<i>Low</i>	<i>No conflicting contingencies Fit with both possible Higher performance</i>	<i>Conflicting Contingencies One misfit inevitable Lower performance Greater design variation</i>
	<i>High</i>	<i>Conflicting Contingencies One misfit inevitable Lower performance Equifinality of design</i>	<i>No conflicting contingencies Fit with both possible Higher performance</i>

2.5.2 Organizational Responses for Growth:

From the work done with organizational forms for growth, it is evident that the greater the degree of independence from the organizational bureaucracy, typically, the faster the team is able to move forward. Conventional wisdom advocates organizational separation in times of intermittent technological change – to overcome organizational antibodies that would otherwise overwhelm nascent efforts – through resource allocation, prioritization, and politics, which may otherwise prove to be discontinuous to the existing business. Past practice has been to isolate disruptive R&D teams to allow them the freedom to develop

the technology, products, and even markets without the shackles of the existing organizational structures and processes.

However, recent literature suggests that organizations that completely separate their innovation teams tend to starve the innovation team of resources that are available within the main organization, reduce their chance of success, and are, ultimately, unable to integrate the learnings of the innovation team back into the mainstream organization. Westerman, Iansiti, and McFarlan, in a paper entitled “The Incumbent’s Advantage,” explore the management of innovation in over 200 companies in several sectors of the computer industry. They conclude from their analysis that organizations that mounted integrated responses to technology change obtained critical advantages in the productivity of their organizations, in the quality and performance of their products, and in their ability to achieve sustained response to change. Specifically, the authors conclude that integrated ventures and innovation teams appear to be superior structures for the organization of innovation in established organizations. The authors focus on the importance of structures that integrate people, processes, and technologies in a balanced way. Highly differentiated, innovating approaches appear to provide early signals of effectiveness, particularly since they may enable firms to act quickly, but they tend to encounter difficulty in scaling and sustaining in the long term. (Westerman, Iansiti et al. 2002)

Leifer et al. (Leifer, O'Connor et al. 2001) discuss the process of radical innovation. In addition to market and technology uncertainty as defined by Roberts, they discuss two more sources of uncertainty: organizational and resource uncertainties. Organizational uncertainties include such questions as project team capability, management support, etc., while resource uncertainties include questions on funding, access to the right resources, etc. They focus particularly on managing organizational and resource uncertainties as the keys for radical-innovation success. They suggest the creation of a radical-innovation hub to reduce these uncertainties. Similar in concept to internal venture organizations or incubators, these hubs comprise individuals trained in new-business development – that are able to translate an idea into a business proposition and nurture the development process until it is ready for commercialization. They state that radical innovation

incubated in mainstream organizations achieve greater success than Skunk-Work projects that develop in isolation from the rest of the organization.

In summary, the inherent conflicts between the requirements for non-traditional growth and those for traditional growth/operational excellence present large, established firms with a problem that they are simply ill suited to tackle effectively. Since growth is an imperative for large, established firms, however, it is a problem that they ignore at their peril. In this study, I focus on experiences to achieve growth within a single firm.

Through an analysis of three typical growth projects and the results of a survey administered to 24 project leaders of non-traditional growth-related efforts, I develop a new framework for characterizing growth opportunities and the key linkages necessary to operationalize this framework.

Chapter 3: Motivation and Hypothesis

3.1 Growth from a First-Person Perspective

In this section, I describe three key growth projects executed in a large, established firm. These projects were selected for two main reasons (a) they sample different modalities for non-traditional growth available in a large, established firm, and (b) I was personally involved in each project and have access to reliable data for each. The objectives and technology associated with each project is first described. This is followed by a chronological listing of key events, over the duration of each project from inception through July 2003. These projects are analyzed using three dimensions – technology, market, and organization. Within each dimension, I characterize project uncertainty and project interdependence. The resulting project vector is linked to the project organizational structure. The data and resulting analysis are used to develop the hypotheses for this study.

3.1.1 Project M: Internal Venture (Skunk Works):

Objectives:

- a) Investigate the application of supercritical fluid technology to the generation of nanomaterials
- b) Investigate and establish the potential of using the above technology as a marking technology.
- c) Investigate and establish the potential of using the above technology as a thin film coating technology.
- d) Secure intellectual property for the applications involving nanomaterials processing from supercritical fluids.
- e) Drive revenue growth through one or more commercial applications of the above.

Technology:

All fluids have a thermodynamically defined state of temperature and pressure called a critical point. Fluids that exist at temperatures and pressures above their critical point are

called supercritical fluids. Supercritical fluids exhibit properties that are simultaneously similar to that of a gas and a liquid – for example, they exhibit liquid-like density and hence the capability of dissolving materials of interest; they also exhibit gas-like diffusivity and surface tension. Carbon dioxide is the most commonly used supercritical fluid because of its low cost, non-toxicity, and relatively low critical point (73 bar, 33°C). Supercritical carbon dioxide is used commercially today to decaffeinate coffee and for dry cleaning of clothes. It is also being investigated for a variety of applications including purification of pharmaceuticals and nutraceuticals, cleaning of silicon wafers, microlithography, etc.

Project M was exploring the use of supercritical carbon dioxide as a marking and as a thin film coating technology. As mentioned above, supercritical fluids have liquid-like ability to dissolve materials within them. By dissolving a dye material into supercritical carbon dioxide and then significantly and instantaneously reducing the pressure and/or temperature, the dye materials rapidly supersaturates the solution and precipitate as nano-sized particles. If the precipitation occurs through an appropriately designed orifice/nozzle, the precipitated nanoparticles may be guided onto a substrate, just as an inkjet printer, with the key difference being that, in this case, the solvent evaporates prior to the “ink” striking the substrate. Such a process, appropriately engineered, can be used for marking as well as for thin film coating, producing thin uniform coatings that rival the quality of currently practiced vacuum deposition processes.

Table 3.1: Chronological Event Listing for Project M

Date	Event	Explanation
Feb, 2000	Ideation	Hallway conversation between two scientists sparks an idea. Organization Director walks by and stops to ask about the excited buzz in the room. Suggests that scientists contact him later if they want to pursue the idea some more. Scientists refine the idea with the help of some background research.
Mar, 2000	Seed funding	Scientists approach Org. Director for some funding to pursue proof of concept. After a couple of meetings, obtain \$5K for a business trip to a university that had the appropriate equipment available.
June, 2000	Preliminary proof	Results from university experiments suggest several

Date	Event	Explanation
	of concept	intriguing potential opportunities
Sept, 2000	Budget allocation	Two full-time equivalents assigned to Project M
Oct, 2000	Team expansion	Team expands to include partial equivalents of 2 other scientists/engineers within the organization
Nov, 2000	Follow-up experimentation	Additional experiments at University verify initial results and add new potential possibilities
Jan-May, 2001	'Selling'	Series of presentations to key layers of organization management in several functional and BU silos in search of strategic fit and funding. Lukewarm interest from two BU communities.
June, 2001	Received small capital funding	Funding allocated to equipment purchase (~\$65K). Two key pieces of equipment purchased.
Oct, 2001	Team expansion	Team expands further to include another 2 partial equivalents.
Jan, 2002	Equipment received, installed and commissioned	In-house experimentation begins in earnest. Key development goal is to demonstrate inkjet printing capability as the proof-of-concept for a 'print' engine'
April-Aug, 2002	'Selling'	Funding for next budget year sought. BU Management related to one application area denies further investment citing technology development horizon as outside their investment window. Some renewed interest from BU Management related to second application area with specific and different needs from current project goals.
Oct, 2002	Team changes	Two part-time and one full-time equivalent exit the project while another two full-time equivalents begin participation
Nov, 2002	Co-location	Project team co-located near lab
Dec, 2002	More capital investment	Third capital equipment item, with related capability, is purchased and installed
Mar, 2003	Renewed attention to business applications	Addition part-time equivalent added to drive business assessment
July, 2003	Workshop with key participants to ideate new machine concepts	Project struggling to find strategic fit and direction. Team leadership disagrees strongly on the path forward.

Analysis of Project M:

Technology: Project M builds upon the firm's technical core competencies in the areas of particle precipitation and the associated fluid mechanics, organic and polymeric chemistry, and coating process technology. The technology underpinnings of Project M

are novel, as evidenced by the over 40 intellectual property applications and over 8 granted applications at the time of this writing. It is important to note, however, that while the technology requirements do overlap with the firm's core competencies, nevertheless, they require additional advanced technology development beyond existing know-how in related but different areas, such as high-pressure processes, nanomaterials characterization, etc.

Market: While Project M has the potential to create products and market opportunities within several markets, the relatively early and fundamental stage of technology development precludes an obvious market outlet. Despite attempts by the Project Team and Sponsoring Management to create market alignment with existing markets, multiple efforts to position this alignment failed to create a lasting alliance between the Project Team and a Strategic Business Unit.

Organization: The Project Leader and Project Team were able to create a strong push for this technology within the Process Research Organization of the firm. However, resources were typically hard to come by because of the "Skunk Works" nature of the project. The Project Team was best characterized as a Lightweight Team. Key technical human resources were borrowed on a part-time basis while key marketing and sales human resources were simply unavailable to the project team over the duration of the project covered by this study. The Project Team was expanded, mostly through the informal networks of the Project Leader with the implicit approval of immediate management. Given the differences in the technology requirements between the existing technical resources that were available and the required technical expertise, however, part-time technical resources were slow to progress the understanding necessary to further the technology. Process equipment was made available but was capped at a small-capital level that could be approved by the Sponsoring Management without having to go to higher management levels within the firm. Again this limited the pace of technical progress. Project exposure to higher levels of management failed to produce lasting strategic impact on the project objectives, which was due primarily to conflicting direction. For example, the Team worked on the specific application of this technology to Inkjet Printing for over a year before receiving clear signals from the appropriate SBU that this technology was not in consideration for future product platforms. Attempts to

identify and leverage prior paths to success by Skunk Works activities were short-lived, as successful parallels were not found.

3.1.2 Project L: Internal – R&D

Objectives:

- a) Through appropriate materials and process technology enhancements, reduce the cost of an existing imaging support technology platform by 33% without compromising the current product feature set or requiring accommodations to the existing downstream processes. (Given the fact that this technology platform has used the existing product architecture for almost 40 years during which the platform has evolved, matured, and been subject to several iterations of cost optimization, this is a stretch objective.)
- b) Explore additional growth opportunities that leverage this technology platform being developed.

Technology:

An investigation into the current product cost structure revealed that the program objectives could only be achieved through a combination of materials and labor savings. An all-synthetic support made from foamed polyolefins using a multi-layer web architecture was shown to be able, under specific process conditions, to achieve the desired objectives.

Foaming of polyolefins is an established technology practiced by companies such as Cryovac-Sealed Air, Down-Corning, Berwick, etc, for products such as packaging materials, building insulation, ribbons, etc. However, the foams made using the above processes, unmodified, have inferior properties for imaging support applications. The thrust of this investigation therefore is process-product codevelopment to make foams with the appropriate properties with minimal capital investment. The specific foaming technology of interest here is endothermic (versus exothermic), chemical (versus physical) foaming. Program L comprises the technology and business investigation of the product and process technologies involved in the creation of this new technology platform. In addition to creating a new platform for existing product lines, this

technology process could enable new opportunities in other related but non-traditional markets, such synthetic paper markets, electronic imaging products, and in packaging.

Key to progressing this program was the purchase of suitable pilot capital to validate the process and product architecture assumptions in the business model. There was no pilot asset available to the project team that was capable of producing the product at the projected manufacturing speeds or width. In fact, capabilities that did exist were known to have poor scalability. As the first step toward an overall capital investment of ~\$200M, the technology team recommended the purchase of a suitable pilot machine for ~\$10M - \$15M. This machine would have been capable of being scaled-up to be the first manufacturing asset making the new product for commercial application while enabling an investigation into the robustness of the proposed new technology platform.

Table 3.2: Chronological Event Listing for Project L

Date	Event	Explanation
Aug, 2000	Project launch.	Three concurrent parallel technology investigations launched
Sept, 2000	Program Leader appointed	Program leader appointed to oversee technology investigations and integrate results. Project Team grows from ~8 part time technologists to 6 full time and 30 part time technologists.
Nov, 2000	Program Review (one/two prototyping cycles)	Matrix comparison of technologies on vectors of performance, timing, and potential savings. One technology emerges as a front-runner but multiple approaches remain in consideration and under investigation.
Feb, 2001	Program Review (additional prototyping cycle)	Matrix comparison repeated based upon more detailed investigation. Front-running technology investigation discontinued – deemed to require too much capital investment, foster too much dependency on manufacturing partner corporation, and not quite meet timing requirements with capital investment deemed to be 3-5 years away from full commercialization. One sub-technology investigation emerges from each of the two other technology investigations as the lead candidates.
June, 2001	Program Review	Second technology investigation discontinued. This technology was shown to be incapable of meeting performance requirements without radical new inventions that were, in turn, deemed to be unlikely. Remaining technology investigation emerges as only

Date	Event	Explanation
		remaining technology.
July, 2001	Business Team investigation launched	Foam extrusion technology investigation and development of detailed business model to study product features/performance, materials, manufacturing process, supply chain, purchasing, capital, and corporate relationship implications by Cross-functional Team commissioned for this purpose.
Aug/Sept, 2001	Business Team investigation concludes; Executive Reviews held	Business model results show that with existing proposed product architecture and materials, savings target cannot be met. Additional opportunities identified and prioritized.
Oct, 2001	Investigation scaled-back, Learnings spun out to begin alternate investigations	Business model results in reduced funding for core foaming technology investigation for Y2002. Opportunities in the use of alternate process technology (coextrusion coating) and alternate materials (polypropylene) spun out into separate investigations to take advantage of potential savings within the current commercial product architecture.
Nov, 2001	Multiple separate technology investigations launched	Three separate programs launched – an investigation of foaming technology, an investigation of coextrusion coating, an investigation of polypropylene materials technology. The latter two have a charter to complete technology investigations and begin commercialization by YE, 2002, and Mar, 2003, respectively.
June, 2002	Business model re-visited	Technology investigations report significant progress. This leads to a substantial swing in project NPV.
July, 2002	New Program Manager appointed	To progress project investigation, new program manager appointed. Project Team expanded to accommodate increased priority given to this program.
Aug, 2002	Executive Review held	Business model results presented to Company Executives (Vice Presidents in Development, Manufacturing, and Business Unit). Aggressive progress recommended through investment in dedicated pilot capital (to validate product and process). Results of executive review foster creation of 60-day plan to investigate manufacturing details (pilot location, capability and costs), transition plan (from one set of materials and suppliers to the future set – platform switching costs) and macroeconomic factors that affect materials choice (global

Date	Event	Explanation
		commodity market pricing cycles).
Nov, 2002	Executive Review follow-up	Results of 60-day plan presented to Executive committee. Requests received for follow-up reviews with each sponsor separately. Manufacturing VP stakes position that project risk is too high at this stage of technology development for Manufacturing to request capital expenditure (for pilot and manufacturing). Responsibility of carrying program capital falls on R&D and BU.
Dec, 2002	Strategic shift in Business Model pitch	Decision made by Project Team to pitch pilot capital as a real option instead of static NPV. Individual meetings with R&D and BU Executive sponsors. Path forward crafted to approach Corporate Capital Committee.
Jan, 2003	Executive Reviews held again	Debate upon pilot requirements – cost versus features.
June, 2003	Project Preview with CEO	At the annual strategic review, the SPG manager reviewed the project with the Firm's Executive Management Team. Decision made to hold a separate review meeting focused specifically on this project – deep-dive into the technology and business case.
July, 2003	Project Cancellation	Due to (a) intensive capital expenditure projection and (b) strategic misalignment with stated growth directions, project is cancelled.

Analysis of Project L:

Technology: Project L builds upon the firm's technical core competencies in the areas of polymer science, materials science, polymer processing, and imaging support development. The technology underpinnings of Project L are novel as evidenced by the over 20 intellectual property applications and over 6 granted applications at the time of this writing. It is important to note, however, that while the technology requirements do overlap with the firm's core competencies, nevertheless, they require additional advanced technology development beyond existing know-how in related but different areas, such as foam extrusion, machine-direction orientation, materials processing using different materials sets than existing technologies, etc.

Market: Project L was able to leverage the strong pull from an existing SBU as well as attempt to exploit platform synergies with other SBUs interested in product applications

within their markets of interest. The pull from within the existing SBU was, however, a double-edged sword – whereas, on the one hand, there were no conflicts about target markets and customers and the appropriate technical objectives for these customers, on the other hand, there were considerable constraints placed upon process and product architectures explored as well as the schedule requirements. Customer needs were well understood and deviating from existing needs was not considered a viable option.

Organization: The Project Team was best characterized as a Lightweight Team. The Team Leader was primarily tasked with coordinating technology development with all market-related decisions outside the purview of the team. Technical human resources were relatively easy to come by for technology development primarily due to the strong pull from the existing SBU. Roles and responsibilities were defined early and built upon previous projects that dealt with various component technology-related development projects. A well-established decision-making structure existed for all tactical issues.

3.1.3 Project P: Internal Venture (Incubator)*

(* - it is noted that substantial changes in the organizational form for this project have been made since July, 03 – the following description and analysis review only the data preceding the organizational changes and project changes in July, 03)

Objectives:

- a) Investigate revenue growth opportunities in the 2-5 year timeframe in the field of Packaging. Specifically, identify opportunities where the firm's existing core technology competencies may offer some specific advantage through leverage.
- b) Develop a business through matching technology offerings suitable for the Packaging industry with current technical capabilities.

Technology:

Unlike the other programs wherein the technology is either partially or wholly internally developed, this program began as an investigation of business opportunities and tried to match opportunities to technical competencies. The firm had an internal venture organization called the Systems Concept Center (SCC). The SCC was funded through an

internal venture board modeled on typical venture capital driven processes. Programs are selected based upon their individual merit but attempts are made to classify ongoing projects into broadly defined domains. One such domain that was identified about two years ago was Packaging.

As investigations into packaging evolved, two opportunities – a shorter-term play in labeling and a longer-term opportunity in the field of active packaging emerged. The labeling opportunity evolved from the combination of a new thermal imaging printer and a thermal imaging media, both of which had been previously developed through other programs. Given the existence of both printer and media, the focus of this investigation was in finding the best application of this “solution.” An investigation into active packaging opportunity revealed opportunities in oxygen barrier, moisture barrier, and antimicrobial packaging for food applications through the use of internal competencies in organic/polymer chemistry, inorganic chemistry, and high-speed, roll-to-roll multi-layer coating technology.

Table 3.3: Chronological Event Listing for Project P

Date	Event	Explanation
Jun, 2001	Project launch.	Project emerged as the result of an ideation session that produced a suggestion that the sponsoring team review options related to Packaging since there appeared to be a good fit from a technology perspective
Sept, 2001	First Venture Board Presentation	A review of Packaging strategies reveals a possible opportunity in making high-end labels – this was attractive from the viewpoint that projected revenues were fairly near-term.
Oct, 2001	Business Consultant interviewed	Day-long session with Packaging Industry analyst identified several opportunities for further investigation.
Mar, 2002	Opportunity Assessment	Continued investigation of the labeling opportunity reveals a fair business case for revenues of ~\$50 Million/year through the sales of a high-speed thermal print engine and label stock consumables to professional print-houses. Development of the thermal print engine was practically complete as was development of the thermal media. Further development activities were focused on the finishing/conversion of media and on coating an

Date	Event	Explanation
		adhesive layer (both of which were low technical risk issues)
Sept, 2002	Third Venture Board Presentation	Primary focus of this presentation was the labeling opportunity. With the Professional Imaging Business Unit expressing an active interest in taking the product to market, the commercialization process was accelerated. A secondary effort focusing on long-term opportunities in Packaging was initiated.
Oct, 2002	Transfer	Project transferred to BU along with key project personnel to provide continuity
Dec, 2002	Focus narrowed to Active and Intelligent Packaging opportunities	Two specific opportunities were identified a) Materials for active packaging b) Coatings for active packaging
Mar, 2003	Market Research	A consultant from an Ivy League School's Food Science department was retained for concept-related discussions. The result was renewed activity related to materials and coatings efforts. This was followed with a burst of experimental activity culminating in a series of tests that showed promising results.
June, 2003		A second visit from the consultant reviewed the testing protocols used and the implications of the results.
June, 2003	Movement of the project into the Accelerator SPG	Reorganization of the System Concept Center into an Early Stage Ideator and an Accelerator/Incubator resulted in the partitioning of projects between the two. A determination of where a project was to be positioned was made as a function of the time before new revenues could be generated as a direct result of commercialization activities related to the project.
July, 2003	NEXT Team Review with the CEO and Executive Council	Project received an infusion of interest and renewed attention.

Analysis of Project P:

Technology: Project P builds upon the firm's technical core competencies in the areas of imaging science, printer, and media development for the shorter-term opportunity while building upon materials science, formulary expertise, and large-scale small particle manufacturing for the longer-term opportunity. The technology underpinnings of Project P are novel as evidenced by the over 15 intellectual property applications at the time of

this writing – over 10 for the shorter-term opportunity and over 5 for the longer-term opportunity. Technology development for the shorter-term opportunity was, however, largely complete by the time this project began. There was a substantial overlap between the firm’s technical capabilities and the product requirements for the shorter-term opportunity. It is important to note, however, that while the technology requirements overlap with the firm’s core competencies, nevertheless, with respect to the longer-term opportunities from this project, the application areas of these technologies (and related product formulation, testing, and validation issues) were significantly different from the areas of traditional expertise within the firm. For example, there was little understanding of specialty material needs for food packaging, EPA and FDA regulations, food industry guidelines, etc.

Market: Project P, as previously mentioned, began through an exploration of the fit between the firm’s technical competencies and market needs. As such, the market mapping activities were critical to project progress. Early involvement of appropriate business research resources helped progress this project quickly through the initial stages of opportunity exploration. For the shorter-term opportunity, there existed overlap between the firm’s existing customer base and the target customer base, resulting in a strong pull from an existing SBU. Additionally, the firm’s brand and reputation provided powerful leverage for business development. However, for the longer-term opportunity, there existed poor overlap between the firm’s customer base and the target customer base, as a result, there was no direct interest from any existing SBU. In addition, the firm’s brand provided little, if any, leverage.

Organization: The Project Team was best characterized as a Lightweight Team, although with a different flavor than the Teams for Projects M and L. The Team Leader was primarily tasked with coordinating market and business development with all technology-related decisions outside the purview of the team. Business development human resources were relatively easy to come by primarily because of the existing network within the Project Team. Linkages between the project team and the firm’s R&D organizations were weak, at best. There were no previous examples of projects with similar linkage requirements that the Team could build upon. On the one hand, the Venture Board served as a decision making body for the Team but on the other, the

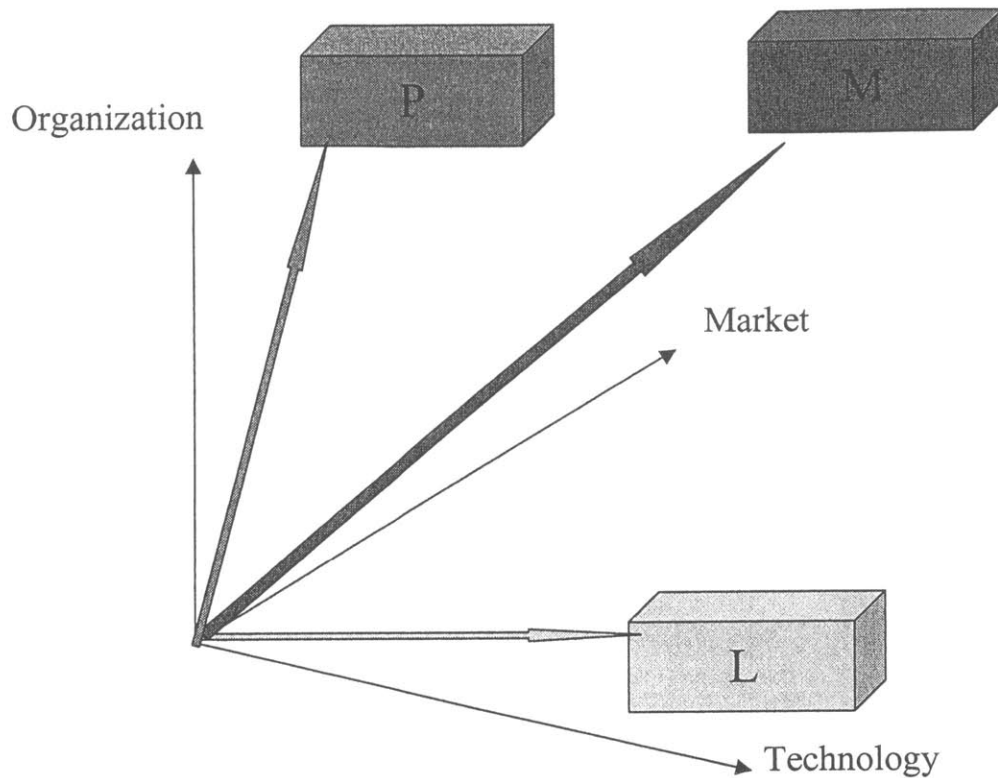
inherent technology development requirements of the longer-term opportunity limited the Venture Board's decision-making influence because of the lack of suitable linkages back into the firm's primary development organizations.

3.1.4 Summary of Projects from a First-Person Perspective

The above analysis is summarized in the figure below. It can be argued, based upon the previous discussion, that each project occupies a distinct position in the 3-dimensional space mapped by the analysis of project-specific technology, market, and organizational factors. It is interesting that, regardless of the vector location of each project in this space, the organization team structure used to execute the project is identical, i.e., lightweight project teams. These observations, taken in combination with the literature summary in Chapter 2 of this study, make it reasonable to ask the following questions:

- a) Does the project vector location predispose the project to success or failure, depending upon firm-specific characteristics?
- b) What firm-specific characteristics are most important?
- c) What can a firm do to improve the odds of project success through careful project selection, i.e., is there a fit between project vector location and organizational structure that can improve the odds of project success?

Fig 3.1: Proposed Growth Framework – Technology, Market, and Organization



I draw the following inferences from the previous analysis that form the basis for this study's hypotheses:

- a) Non-traditional growth opportunities require three independent dimensions for complete characterization – technology, market, and organization.
- b) Within each dimension, there is simultaneously a need for understanding what is known and what is unknown (uncertainty) as well as what is aligned with firm competencies/capabilities and what is not (interdependence).
- c) Non-traditional growth projects characterized using the above dimensions may differ widely in the vector characterizing their position in dimensional space.
- d) Firm-specific capabilities and competencies may predispose the success or failure of projects, depending upon the position of this vector.

- e) If a firm is to be successful in executing projects that occupy different vector positions in this space, it must match the vector position with the organizational structure most suited to the spatial position under consideration.
- f) The firm must consciously expand its capabilities from an organizational structure perspective to go beyond a single, predominant organizational structure for growth to actively nurture the structure that provides the best fit to the contingency at hand.

3.2 Hypothesis:

I hypothesize that the problems in achieving growth in large, established firms predominantly stem from the inherent rigidities of these firms in adapting their structures and processes to deal effectively with the concomitant change in emphasis, from minimizing risk, reducing variability, and maintaining focus to maximizing speed, encouraging creativity, and leveraging uncertainty.

I further hypothesize that in order to successfully grow, large, established firms will have to pay particular attention to the structures and processes associated with the teams tasked with growth.

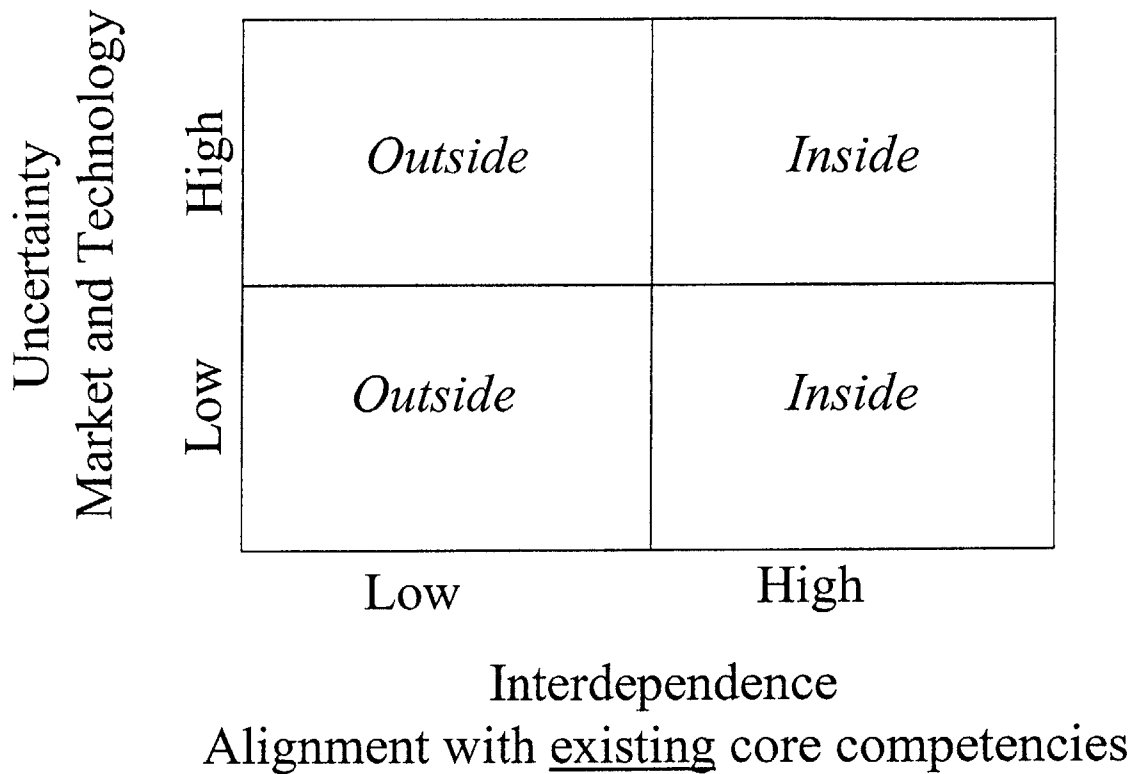
In this study, I build upon previously proposed frameworks for growth, specifically those of Roberts (Roberts and Berry 1985) and Leifer, (Leifer, O'Connor et al. 2001) and also build upon structural contingency theories that characterize growth opportunities based upon uncertainty and interdependence to (a) frame the opportunity strategically and (b) use the strategic framework to provide an analytical link from growth opportunity to organizational form that is most suited to delivering growth, given the uncertainty and interdependence of the opportunity.

3.2.1 A Modified Framework for Exploiting Growth Opportunities

The existing literature on strategic responses to growth opportunities can be summarized using the following 2 x 2 matrix. Specifically, with increasing market and technology uncertainty and decreasing interdependence or alignment with existing core competencies, firms will want to shift the focus of development from within to without –

moving from the use of internal R&D and innovation teams to joint ventures and acquisitions.

Fig 3.2: Existing Uncertainty Interdependence Segmentation

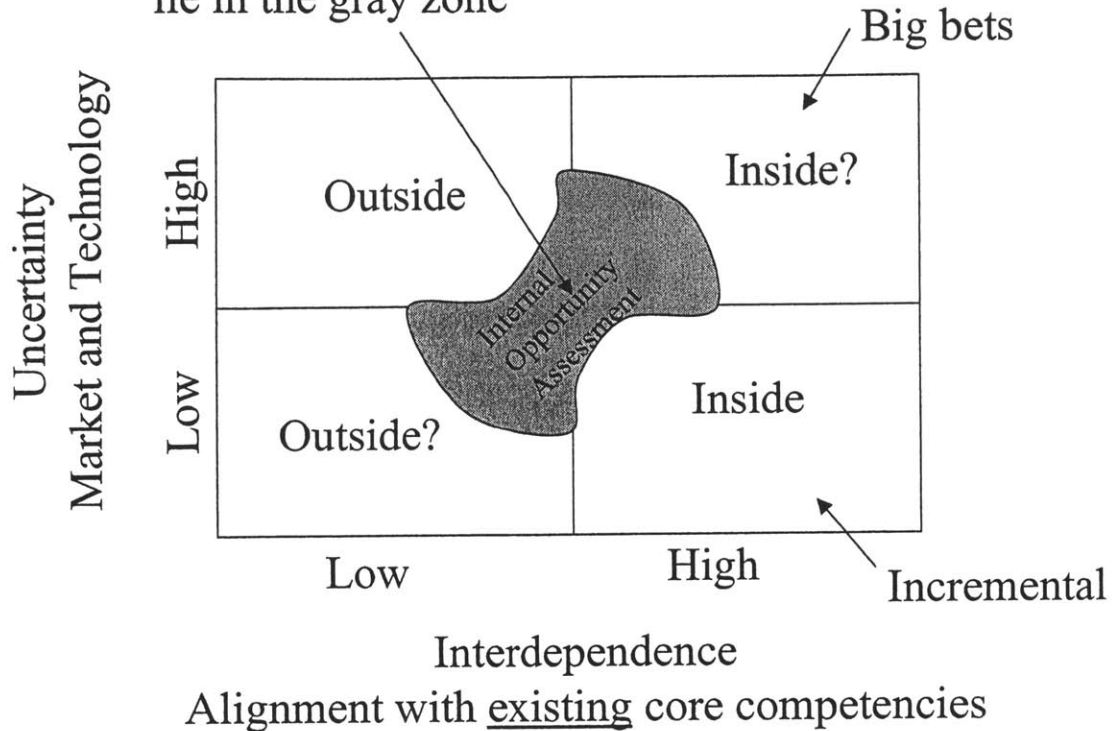


While the above framework appears, on the surface, to be an adequate description of a growth framework for large firms, nevertheless a deeper examination of the typical **non-traditional opportunities for large firms** that survive internal opportunity size, gross margin, and timing filters reveals that such opportunities lie typically at or near the central area of the four quadrants (as shown in the figure below). Opportunities with high interdependence and low uncertainty typically map into the strategic path forward and five-year plans of existing traditional businesses within the firm. Opportunities with low interdependence and high uncertainty typically do not survive internal opportunity selection filters because the risk they embody is too high for large firms conditioned to minimize risk.

Fig 3.3: Drawbacks in the Existing Uncertainty Interdependence Segmentation

Non-traditional growth opportunities

lie in the gray zone



Opportunities that pass selection filters tend to cluster around the center of the above matrix. I contend, based upon my experience, that for opportunities that map into this space, the firm almost always goes through a comprehensive internal opportunity assessment and evaluation. I argue that the three projects described in the previous section are typical of such opportunities and that these fall within the central gray area, despite their different vector positions on a three-dimensional space. Substantial time and money is spent in the evaluation of these opportunities. Better strategic characterization up front and improved organizational structure strategies would significantly improve a firm's efficiency in dealing with such opportunities.

Building upon the above framework, therefore, the following analysis process is proposed:

- During the opportunity-assessment phase, determine the uncertainty present with respect to technology, the market, and the organization using a “market-back” approach.
- Also during the opportunity assessment phase, determine the interdependence as characterized by alignment of the opportunity with existing core competencies, existing markets, and existing resources.
- Match the uncertainty and interdependence with the appropriate organizational structure to maximize the chance of success.
- The firm now has two choices – adapt to the use of the appropriate organizational structure or reject the opportunity under consideration.

The analysis is predicated on three key dimensions – technology, market, and organization factored on 2 x 2 matrices into uncertainty and interdependence. Technology uncertainty is defined through the opportunity assessment results in terms of the existence of suitable technology (typically, this is verified through the effort of building successively more detailed prototypes). Technology uncertainty is low when technologies that support the opportunity exist and have a capability to deliver projected requirements. Technology uncertainty is high when technologies that support the opportunity require significant and/or multiple inventions. For example, the technology uncertainty for grid computing would be considered high, whereas that for DRAM would be considered low. Market uncertainty is defined through the existence of a market related to the opportunity. Market uncertainty is low when markets (products, customers, competitors, channels, sales, etc.) exist, and needs are known, for the opportunity being investigated. Market uncertainty is high when markets simply do not exist and/or customer needs are unknown. For example, market uncertainty is low for LCD displays, whereas it is relatively high for waterproof LCD displays. Organizational uncertainty arises from an analysis of (a) the decision-making structures within the organization relative to those on or directly accessible to the (potential) project team and (b) historical predictors of success from similar opportunities. Organizational uncertainty is high when the decision making occurs at levels substantially higher (greater than two levels) above the project leader, and historical predictors suggest a very low probability of success from past

experience (<10%). Organizational uncertainty is low when decision making occurs at or immediately above the level of the project leader and historical predictors suggest a reasonable probability of success from past experience (>25%). For example, organizational uncertainty for projects involving significant capital expense, such as building a new technology platform, is typically high whereas uncertainty for projects involving evolutionary feature improvements in existing product lines is typically low.

Technology interdependence is defined through a mapping of key technology development needs identified for a given opportunity with the existing organizational capabilities (existing abilities) and competencies (potential capabilities). Technology interdependence is high when the organizational capabilities overlap in large part with the technology development needs for a given opportunity. Technology interdependence is low when there is little overlap of the organizational competencies with the technology development needs for a given opportunity. Market interdependence is defined through a mapping of a firm's existing market base with the potential market base for a given opportunity. Market interdependence is high when existing markets (including channels, sales force, etc.) are the primary targets of the new opportunity. Market interdependence is low when there is little or no overlap between existing markets and those targeted by the new opportunity. Organizational interdependence arises from an analysis of the availability and accessibility of suitable internal resources – including human resources, funding, and appropriate tools. Organizational interdependence is low when the availability of key internal resources is severely limited. Organizational interdependence is high when the availability and accessibility of key internal resources is high. The following 2 x 2 matrices summarize the key dimensions discussed above.

Fig 3.4: Proposed Uncertainty Interdependence Segmentation - Technology

Technology

Uncertainty	High	<i>Inventions reqd., Not practiced internally</i>	<i>Inventions reqd., Practiced internally</i>
	Low	<i>No inventions reqd., Not practiced internally</i>	<i>No inventions reqd., Practiced internally</i>
		Low	High

Interdependence

Fig 3.5: Proposed Uncertainty Interdependence Segmentation - Markets

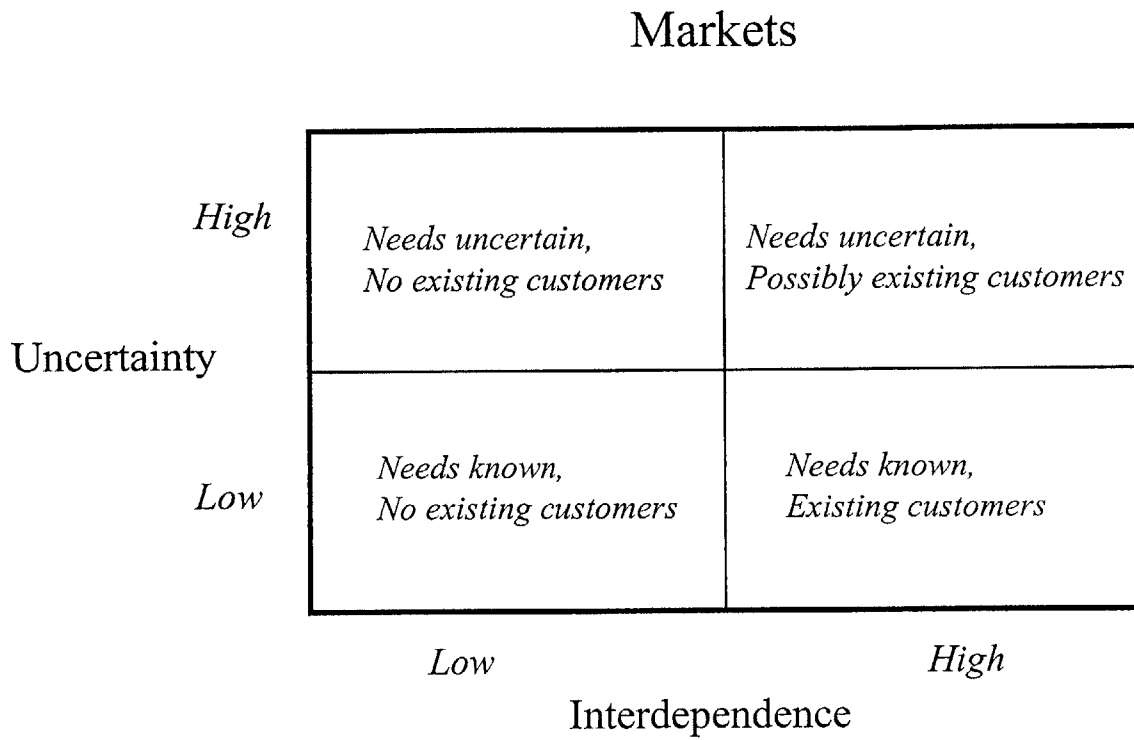


Fig 3.6: Proposed Uncertainty Interdependence Segmentation - Organization

Organization

Uncertainty	<i>High</i>	<i>Low empowerment, Poor history, Scarce resources</i>	<i>Low empowerment, Poor history, Available resources</i>
	<i>Low</i>	<i>High empowerment, Good history, Scarce resources</i>	<i>High empowerment, Good history, Available resources</i>
		<i>Low</i>	<i>High</i>

Interdependence

The above framework, while comprehensive, nevertheless is difficult to use meaningfully, given the relatively large number of combinations (4 x 4 x 4 = 64 possible combinations). In technologically oriented firms, non-traditional growth opportunities tend mostly to include a strong technology component that builds upon existing technology competencies and capabilities. More specifically, each of the three projects described in the previous section can be characterized on a technology dimension as having high uncertainty and high interdependence. I simplify the earlier hypothesis by assuming that this generally holds true in technologically oriented firms that a majority of non-traditional growth opportunities will lay in the same quadrant – high uncertainty and high interdependence. Accordingly, I postulate that **the differentiating dimensions for non-traditional growth in large, technologically oriented firms are those of market and organization.**

When interdependence is high and uncertainty is low, internal development is definitely preferred. When interdependence is low and uncertainty is high, external development, through acquisitions, joint ventures, and/or corporate venture investments, is definitely preferred. Typically, however, as previously discussed, growth opportunities for **large, established firms** are characterized by combinations of high uncertainty and high interdependence or low uncertainty and low interdependence. For such combinations, external development becomes a strategic option instead of an imperative. As such, internal development is typically explored in some, often substantial, detail before making decisions on the possibility and extent of external development. Organizational structure decisions now become vitally important to project success, particularly in the timing of these decisions.

From an organizational perspective, as previously mentioned, development is typically conducted through one of four main organizational forms – functional teams, lightweight teams, heavyweight teams, and autonomous teams. When the opportunity is well defined in terms of scope and scale, and the participation strategy is previously laid out in considerable detail, roles, responsibilities, incentives, and priorities tend to be relatively clear. In such endeavors, functional teams and/or lightweight teams tend to perform quite well. Projects that can avail of existing roles and responsibilities in organizations tend to have high interdependence. When uncertainty is low, functional teams are best suited; when uncertainty is high, lightweight teams are better because the increased level of uncertainty requires better communication and coordination across disciplines, necessitating the role of a project manager.

When the participation strategy is less well –defined, but the opportunity scope and scale is well defined, the need for a project manager who is able to communicate and coordinate across functions is increasingly more important. For such opportunities wherein interdependence is high, as the requirement for new roles is known, these roles can be filled by others in the parent organization. In such instances, lightweight teams are effective. When interdependence is low, however, such roles may or may not exist. Clearly, in such instances, there needs to be much greater flexibility within the team for redefining roles and responsibilities on an on-going basis, as more information is gathered and progress is made. In such instances, heavyweight teams are more

appropriate, particularly as the needs for role definition, cross-functional coordination, and execution speed increase. The actual structure of these teams, in turn, is closely related to the uncertainty type and level. The flavor of a heavyweight team working on a non-traditional growth opportunity with low interdependence, high technology uncertainty, and high market uncertainty is typically different from one with low interdependence, high technology uncertainty, and low market uncertainty.

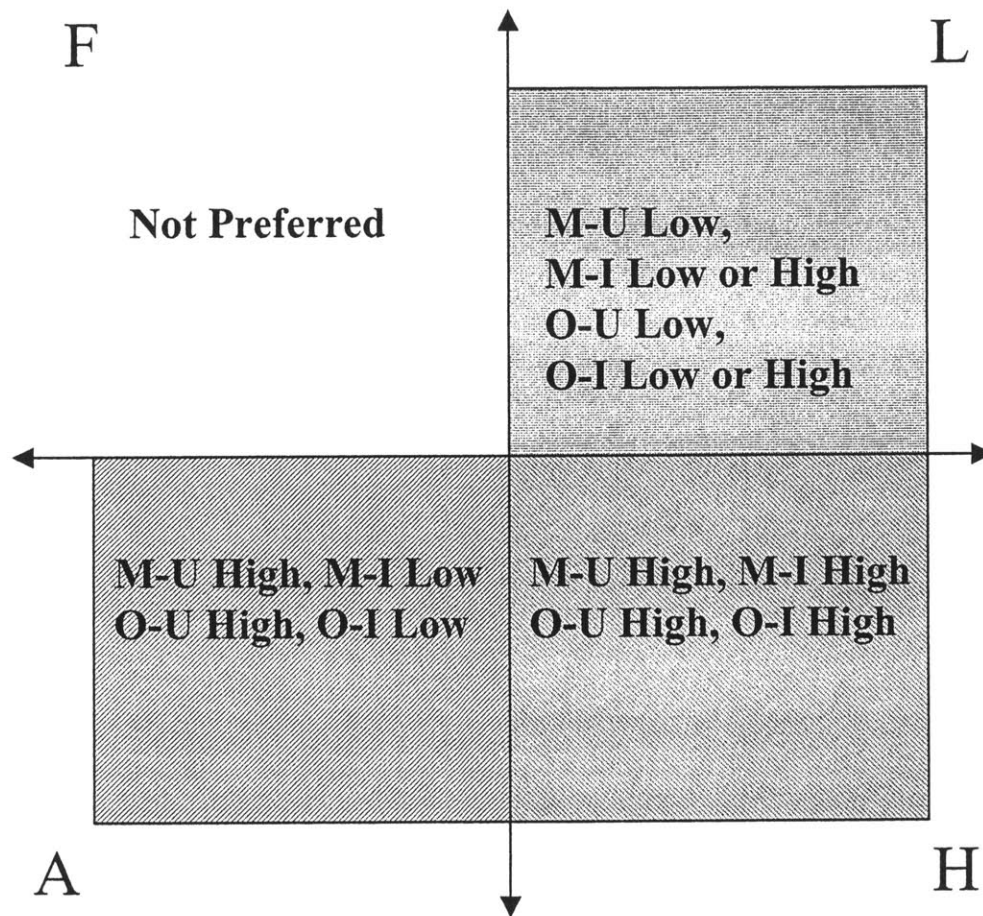
When opportunity definition is part of the team's charter, the scope and scale of the opportunity as well as the participation strategy need to be formulated as the team progresses. In such cases, development, typically, is no longer constrained to internal paths but also includes external development as part of the path to commercialization. Heavyweight or autonomous structures are best suited in these cases because of issues related with flexibility in roles and responsibilities and alignment of incentives and priorities. When opportunity definition is incomplete, and roles and responsibilities are poorly defined, it is typically difficult to obtain the needed priority to work on such projects within large firms. Resources are difficult to obtain, including suitable personnel, access to needed equipment, and money because of the inherently high risk involved with such projects and the inability to directly relate the use of the resource to the impact on the firm's immediate fortunes. Different team members are also, typically, incentivized differently, relative to their perspectives on the project's success. For example, a capital engineer who is incentivized to complete a capital project on time and under budget, may be, understandably, tempted in the case of a non-traditional growth project that requires capital expenditures, to inflate the time and monetary requirements for the project, given the inherent uncertainty in the project, to ensure that he is not penalized for deliverables that are inherently uncertain. Similarly, a marketing manager may be tempted to skew the requirements toward development of new products that are more radical in nature than otherwise because his incentives are related to market share while the manufacturing manager may be tempted to force requirements the other way to improve his commitments to operating efficiency, which are adversely affected by more complex products. Such conflicting incentives are typically at the root of the failure of non-traditional growth projects in large firms. To eliminate the mismatch in incentives, heavyweight and/or autonomous teams are most suited for projects with low

interdependence and high uncertainty on at least one of the two dimensions of market and organization. Such teams, by virtue of the reporting structure, eliminate local incentive mismatches by incentivizing the team as a whole to deliver a project successfully. Local incentive mismatches are now resolved within the team through constructive debate and suitable give-and-take attitudes as opposed to being hidden behind organizational silos typical in large, established firms.

Autonomous teams are most useful after the opportunity assessment phase of a new opportunity. If there is a sizeable opportunity identified, that requires single-minded pursuit, and that is characterized by high uncertainty and low interdependence on market and organizational dimensions, autonomous teams are preferred.

The above discussion is summarized in the figure below. F, L, H and A are the four common organizational forms – functional, lightweight, heavyweight, and autonomous. M and O stand for Market and Organizational dimensions, respectively. U and I stand for uncertainty and interdependence, respectively. Functional teams are not preferred given the high technology uncertainty that characterizes non-traditional growth opportunities in technologically oriented large firms. Lightweight teams are preferred for such opportunities in large firms when the market and organizational uncertainty are low, regardless of the market and organizational interdependence. Heavyweight teams are preferred when market and organizational uncertainty is high while interdependence is also high. Autonomous teams are preferred when market and organizational uncertainty are high while market and organizational interdependence are low. It is recognized that although the figure and discussion refer to hard boundaries between the four quadrants, it is possible, and preferable in the appropriate cases, to have teams, for example, with a predominantly heavyweight character that function more autonomously than other heavyweight teams because of the nature of the opportunity at hand.

Fig 3.7: Proposed Mapping from Uncertainty-Interdependence to Team Structure



3.2.2 Application of the proposed framework:

The three projects discussed in Section 3.1 span a range in scope and scale but share the ultimate objective of growing revenues. A critical analysis of each of these projects is done using the growth framework proposed above. The results are summarized in the tables below.

Table 3.4: Analysis of Three Growth Projects – Dimensions and Factors

Project	Tech. Uncert.	Tech. Interdep.	Market Uncert.	Market Interdep.	Org. Uncert.	Org. Interdep.
M	H	H	H	L	H	L
L	H	H	L	H	L	H
P	H	H	L	L	H	H

First, I look at technology uncertainty and interdependence. Project M is in the early stages of concept proof requiring substantial innovation and invention before delivering a product, which results in high technology uncertainty. However, with in-house expertise in precipitation technology, chemistry, and functionalization, technology interdependence is high. Project L requires substantial invention from a materials and a process perspective to deliver a new imaging support platform, which results in high technology uncertainty. Again, because there is substantial in-house expertise in the system from output manufacture through image processing, technology interdependence is high. Project P has high technology uncertainty in that the primary application to food packaging is not well understood from a requirements or formulary perspective. Again, however, because there is substantial in-house small, particle manufacturing capability, technology interdependence is high.

From a market perspective, Project M has high market uncertainty and low market interdependence, because the market is nascent, if it exists at all, and the customers lie outside the existing customer base for the firm. For Projects L and P, market uncertainty is low in that the market exists and is well established in both cases. However, for Project L unlike Project P, market interdependence is high because the existing customers substantially overlap with the target customers, while for Project P there is little if any overlap in customers.

From an organizational perspective, Project M shows high uncertainty and low interdependence. Decision making is typically more than two levels above the project team leader and resources have constantly been a struggle for this project. Additionally, the organization does not have a good history with commercializing Skunk Works projects. Project L has the most favorable organization ratings, given decision making within two levels of the project leader, excellent access to resources and good history in the commercialization of similar projects. Project P has high organizational interdependence given access to resources and past success, but it also has a high organizational uncertainty in that the project leader is greater than two levels away from key decision makers.

The table below lists by project the actual organizational form along with the organizational form proposed using the analysis recommended in this study.

Table 3.5: Analysis of Three Growth Projects – Organizational Form

Project	Actual Organizational Form	Proposed Organizational Form
M	Lightweight Team	Autonomous Team
L	Lightweight Team	Lightweight Team
P	Lightweight Team	Heavyweight Team

Summarizing the categorization for each project, Project M has high uncertainty on all three dimensions and low interdependence on two of the three dimensions. The fact that technology interdependence is high is perhaps the only reason that this project is being pursued in-house – suggesting perhaps an over-emphasis in technology and an under-emphasis on market aspects in product development within the firm. In light of the above analysis, the most effective organizational form for this application is clearly an autonomous team that can leverage external development, through either a joint venture or a spin out, most effectively. Given the early stage of this opportunity, the firm is highly unlikely to capture value for its investment in the near term.

Project L exhibits high interdependence in all three dimensions and low uncertainty in all but technology. Given this categorization, internal development through a lightweight team is the most reasonable organizational form to pursue development.

Project P exhibits high interdependence in technology and organization while exhibiting low interdependence in markets. Coupled with high uncertainty in two of the three dimensions (the exception being market), this categorization suggests that internal development is most preferred through a heavyweight project team structure.

Chapter 4: Survey of Non-Traditional Growth Projects

The primary motivation for this study was based upon the author's personal experiences with projects dealing with different growth modes in a large, established firm seeking non-traditional growth, as discussed in Chapter 3. However, I believe that the framework and results presented in Chapter 3 may be extended beyond the projects discussed. To test the applicability of this framework, a survey was designed and administered to 24 project leaders/managers involved with non-traditional growth in a single, large, established firm. The survey was conducted in the form of personal interviews. Project leaders/managers of non-traditional growth projects were expressly sought, with projects defined as non-traditional revenue opportunities that meet the threshold criteria that (a) each opportunity provides/provided the potential, given favorable outcomes, for greater than \$100M in revenues by year five after commercial launch and (b) each opportunity is/was focused on products and/or services that did not appear in or overlap with the five-year product roadmaps of existing, established Business Units.

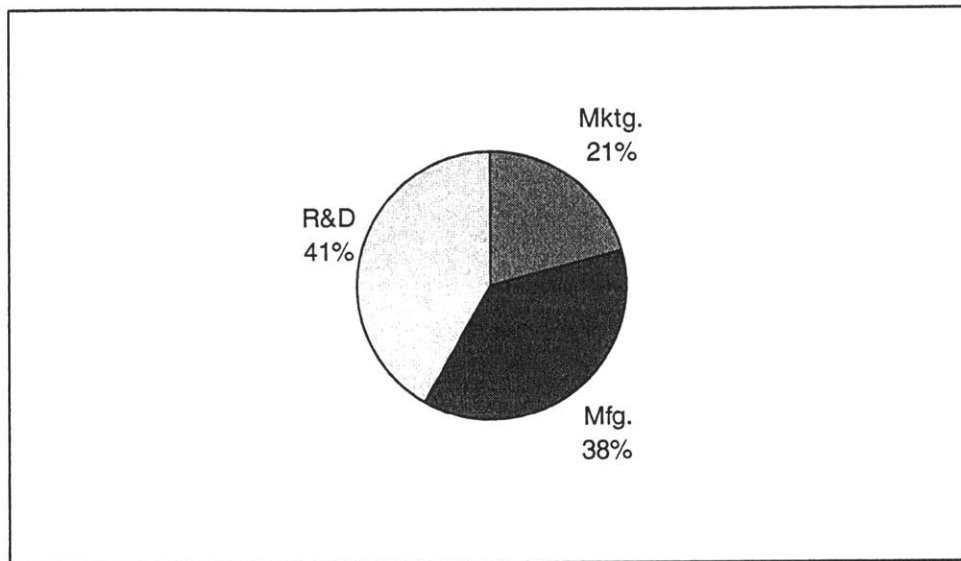
4.1 Survey Results

The survey comprised 15 questions, 14 of which were offered in a multiple-choice format with the last question being open-ended. Appendix B provides a copy of survey questions and the raw results data. A summary and analysis of this data is discussed in this section.

Efforts were made to obtain a sampling of projects and interviewees from R&D, Manufacturing, and Marketing organizations within the firm, the three functions that provide leadership for an overwhelming majority of non-traditional revenue opportunities. The project leaders/managers were primarily selected from amongst the author's network within the firm and through references offered by interviewees – as a result of which, the results may be biased by the sampling process. The pie chart below shows the distribution of the functional alignment of the interviewees. Although the distribution is not even across the functions, I believe that the sampling distribution is reasonable for this firm, when compared with the universe of actual project leadership associated with growth projects. A majority of the project leaders are derived from the R&D or Manufacturing functions. It is noted that in this particular firm, the applied R&D

and Process R&D functions are aligned with the Manufacturing function rather than with traditional R&D.

Fig 4.1: Interviewee Distribution by Organization



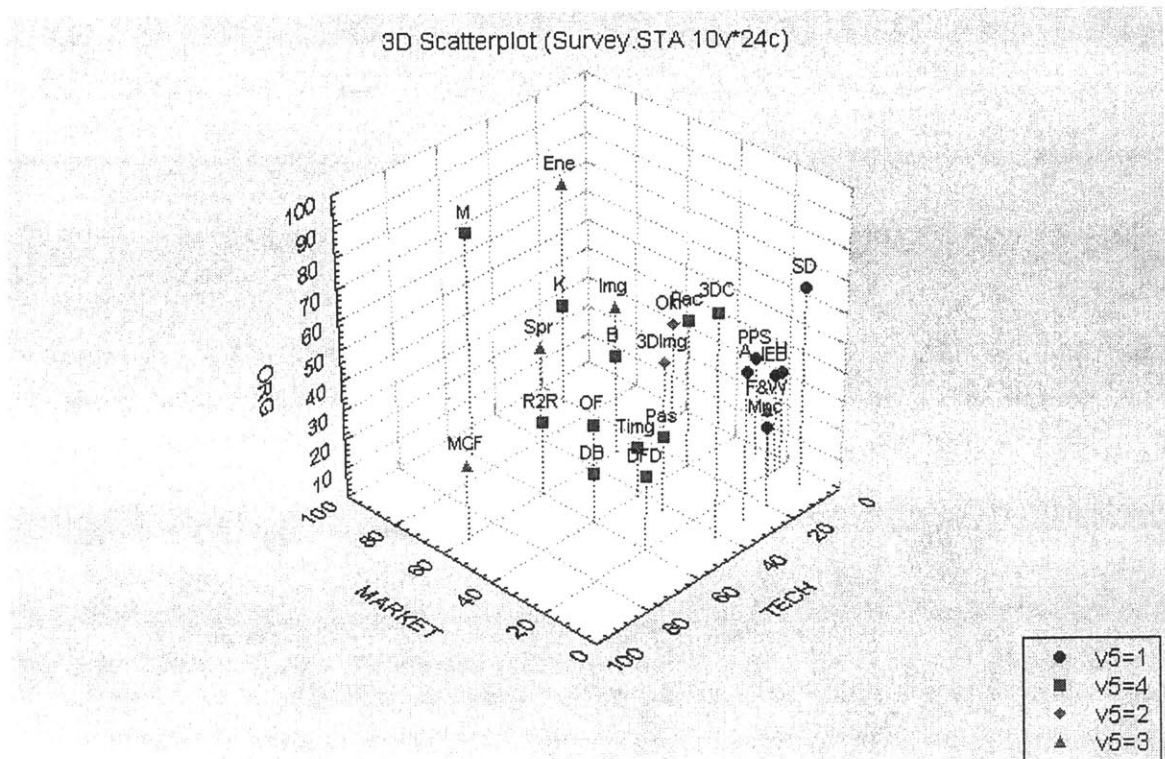
Interviewees were asked to answer the questions based upon the results of a single non-traditional growth project that they were involved with, regardless of how many they may have been involved with previously. Project code names were obtained in each case to ensure that the each interview results-set was unique, i.e., the results were not biased with multiple results –sets, based upon the same project. There was no effort made to distinguish between the stages of the project investigation/execution, i.e., the sampling of projects ranged from completed projects to projects that were in the opportunity-assessment phase to those in various stages of technology development and/or commercialization. Potential sampling bias and the small number of interviewees are also recognized as key limitations in generalizing the results of this survey.

A project is said to have been completed if there was a product launch (success) or if the project was aborted (failure). It is noted also that there are specific instances when aborting a project in an early phase of investigation could actually be considered a success as opposed to a failure – this study is not sensitive to this characterization. Project sizes varied from as few to as ~5 full-time equivalents to as high as ~25 full-time equivalents.

The questions were targeted toward creating a vector position for each project in the three dimensional space mapped by the technology, market, and organizational factors specific to the project. Within each dimension, questions were focused on getting a semi-quantitative measure of uncertainty and interdependence. The survey responses were converted to a scale of 100 for each factor by combining uncertainty and interdependence. Appendix B provides a summary of the results and the numerical conversion factors used.

The figure below summarizes the results as a function of technology, market, and organizational factors. The blue circles correspond to projects that resulted in commercial launch. The red squares correspond to projects that are in progress. The green diamonds are projects that were stopped after a commercialization process began. The pink triangles correspond to projects that were stopped prior to entering a commercialization process.

Fig 4.2: Surveyed Project Results Plotted in 3-Dimensional Framework



The “success” rate, where *success is defined as commercial product launch* (and not related to marketplace success), is 46% (6 out of 13 completed projects) with 11 out of 24 projects in progress at the time of the interviews. Of the remainder of the completed projects, 2 were halted after a commercialization process was begun, while 5 were halted before a commercialization process was started.

From a technology perspective, a majority (75%) of the new growth projects require inventions suggesting that the technical uncertainty is, for a significant majority of projects, high. 46% (11/24) projects sampled require capital investments of greater than \$10M, requiring executive management approval. In all but one case, there was good or, at least, some alignment between the project’s technical requirements and the firm’s core competencies.

From a market perspective, 71% (17/24) of the projects had some or good definition of customer needs. Only 38% (9/24) of the projects or just over half the projects with some or good definition of customer needs, had good definition around market segmentation and sales and distribution channel requirements. A significant 29% of the projects did not have any assessment of customer needs, market segmentation, and sales channels. 33% of the projects surveyed did not overlap significantly with the firm’s existing markets and sales and distribution channels with over half the remainder (10/16) having some overlap with existing markets and channels.

From an organizational perspective, 19/24 projects or over 79% of the projects require key decisions be made at least 2 levels higher than the level of the project leader/manager. In 9/24 or 38% of the projects, the project leaders/managers were able to cite an example project similar in uncertainty and interdependence to theirs that resulted in commercial launch. In only 3/24 or 13% of the cases, were resources (team members, funding, and equipment) very difficult to achieve.

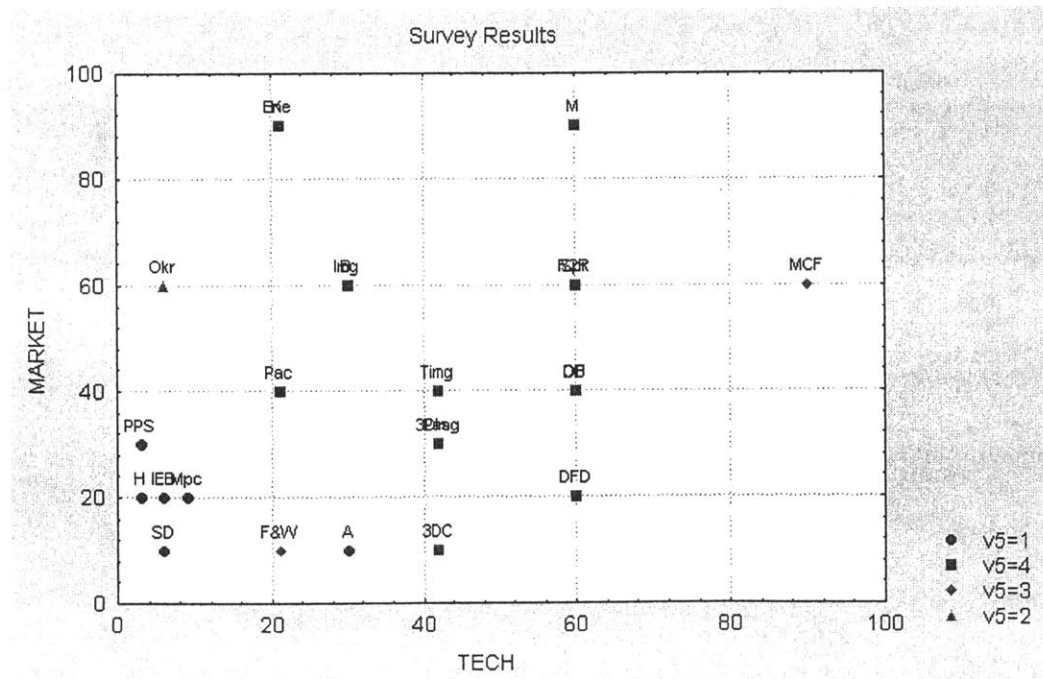
Of the 24 projects samples, there were no projects that were run using a functional-team structure and only one project run using an autonomous-team structure. A majority of the projects (17/24 or 71%) were run using a lightweight team structure with the remaining 25% of the projects (6/24) being run using a heavyweight-team structure. A majority of the projects (15/24 or 63%) worked in some fashion with external resources such as other

firms, governmental agencies, and/or universities. Only 5 of the 24 projects surveyed did not use a Kodak standard development or commercialization process. Of these, 3 were completed over 3 years ago and the remainder are still in early-stage development (pre-development process).

4.2 Analysis and Conclusions:

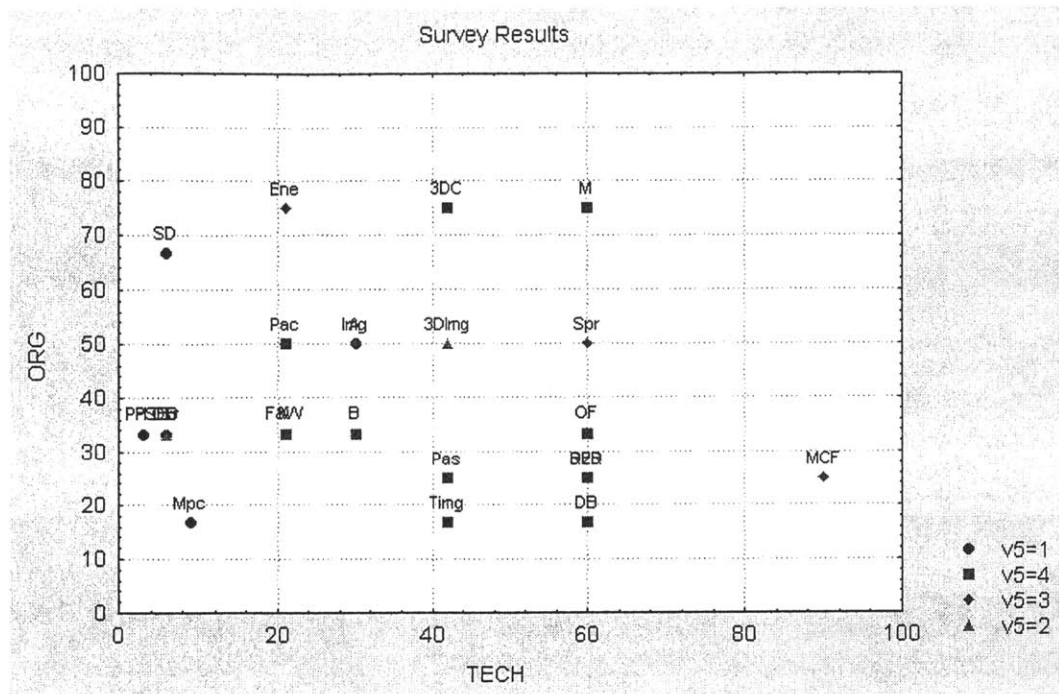
1. The firm’s bias towards choosing tough technical challenges is clearly shown by the fact that 75% of the projects require inventions. Recognizing that this may be an artifact of the author’s selection of interviewees, nevertheless, opportunities to use existing technology in new applications and reduce the technical hurdles that new non-traditional growth projects face may provide the firm with some leverage.
2. A review of just the “successful” projects shows that of the projects sampled by the survey, those that resulted in commercial launch all have relatively low technology and market factors, as shown in the figure below. Of the successful projects, the highest factor for both market and technology is only 30, while that

Fig 4.3: Survey Results - Market versus Technology Factors



for organization is below 50 for all but one project (for which it is 67).

Fig 4.4: Survey Results - Organization versus Technology Factors



A multiple regression analysis (performed using the statistical analysis software package Statistica) of the completed projects yields the following results summarized in the table below.

Table 4.1: Multivariate Regression Summary

Regression Summary for Dependent Variable: SUCC

N = 13

R = .80193343

R² = .64309722

Adjusted R² = .52412963

F(3,9) = 5.4057

P < .02108

Std. Error of estimate: 32.908

	BETA	St. Err. of BETA	B	St. Err. of B	t(9)	p-level
Intercpt			116.8420	27.80888	4.20161	.002301
TECH	-.439272	.220249	-.8052	.40371	-1.99443	.077243
MARKET	-.497079	.231936	-.9140	.42647	-2.14317	.060707
ORG	-.073442	.212396	-.2126	.61486	-.34578	.737454

Correlation coefficients are listed in the table below. Bivariate correlations between project success and each of the dimensions – technology, market, and organization, are also plotted. Clearly, each of the dimensions, which are composites of uncertainty and interdependence, are inversely correlated with project success – the higher the uncertainty and lower the interdependence, the lower the project success. Market and Technology factors are both significant at the 90% confidence level, while Organizational factors appear to be less significant. I believe that the lower significance of Organizational factors is an artifact of the survey results, however, given the predominance of a single organizational structure (i.e., lightweight teams comprise 71% of the overall projects and 62% of the completed projects).

Table 4.2: Correlation Coefficients

	SUCC
TECH	-.638189
MARKET	-.696648
ORG	-.224251

Fig 4.5: Surveyed Project Success Correlated to Technology Factors

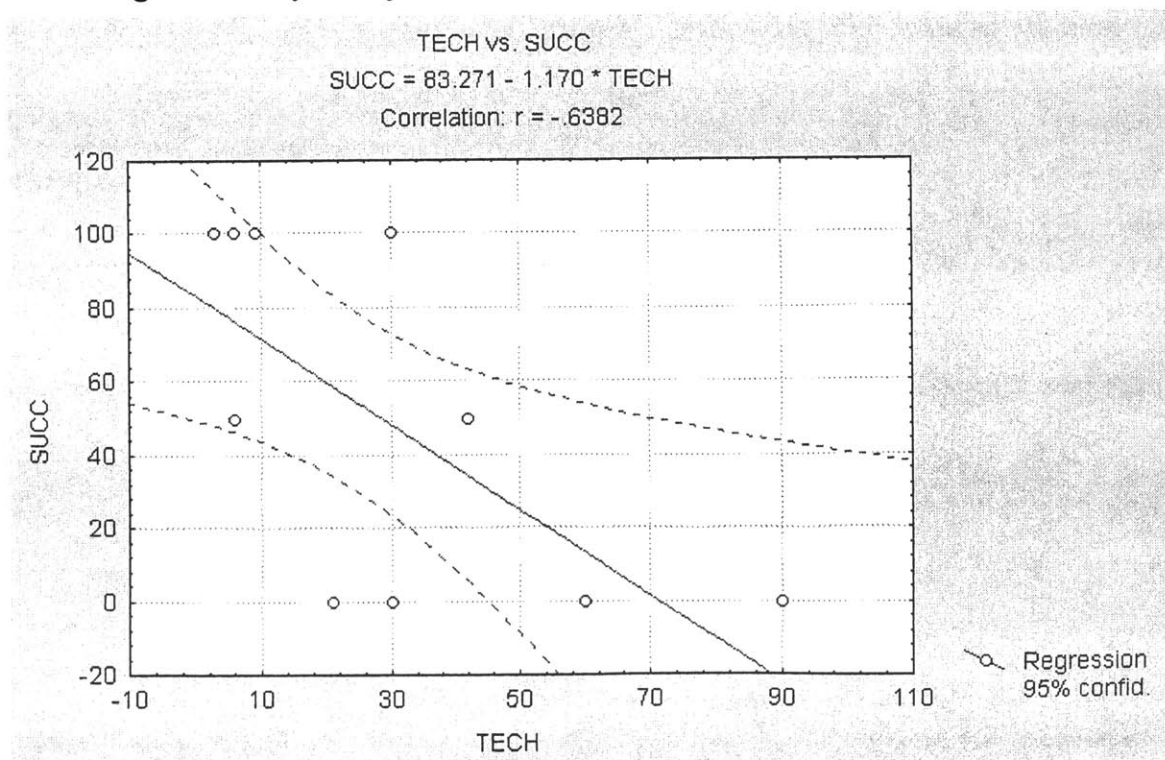


Fig 4.6: Surveyed Project Success Correlated to Market Factors

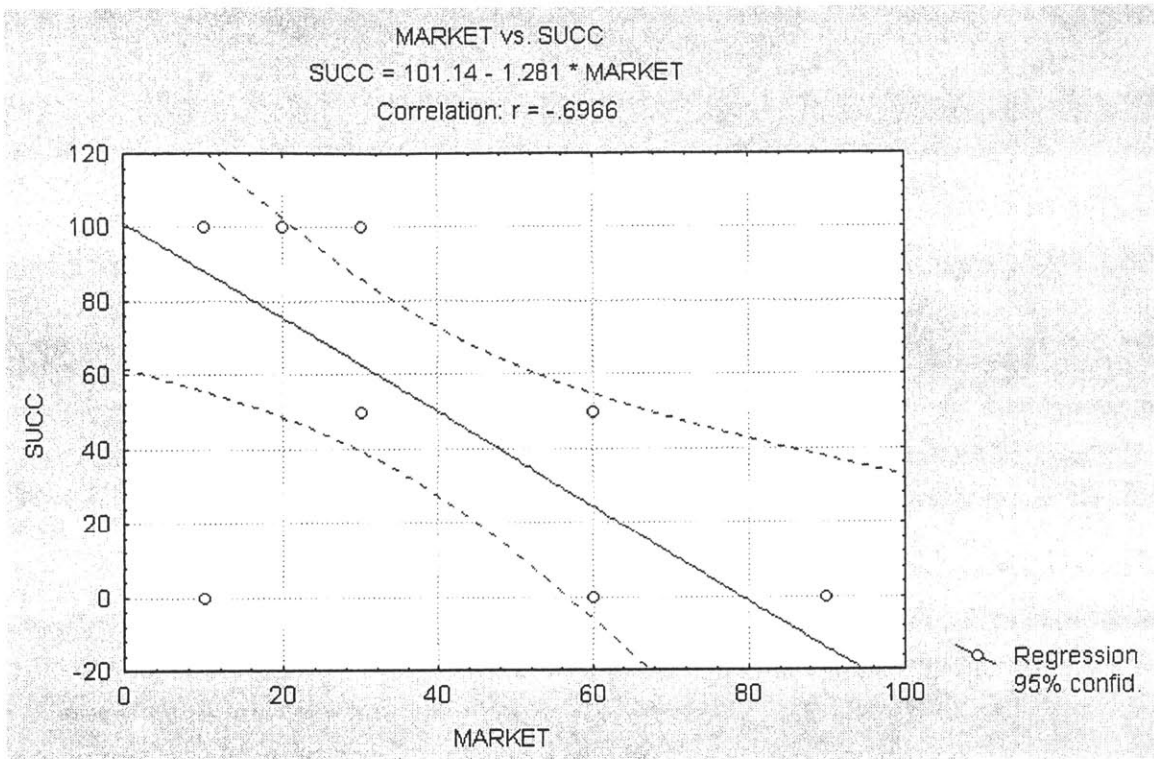
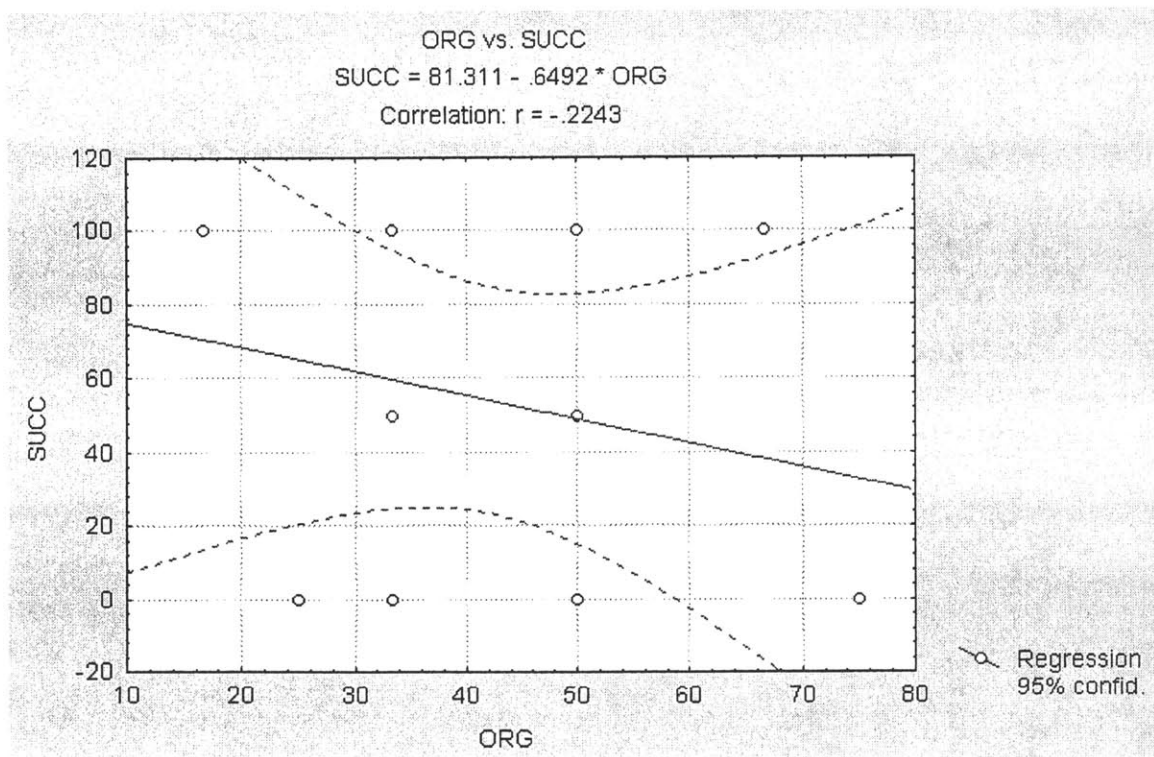


Fig 4.7: Surveyed Project Success Correlated to Organizational Factors



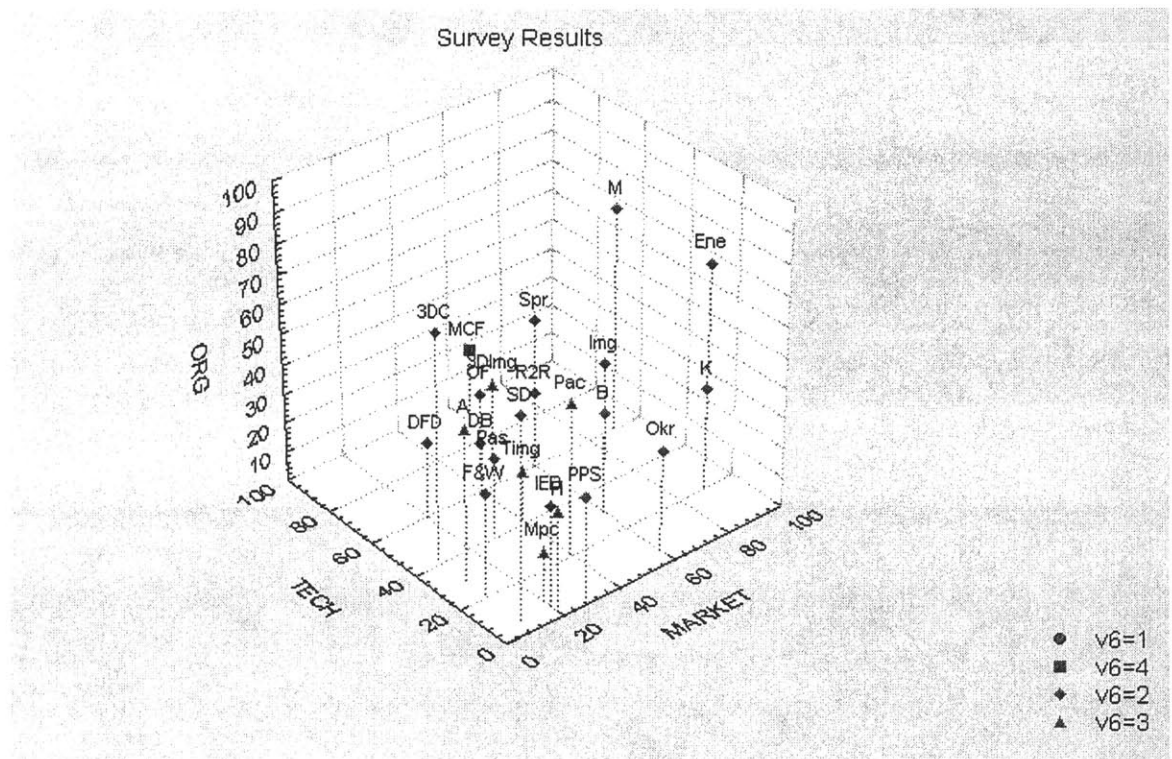
3. A significant number of projects (11/24) require a sizeable capital investment. Capital investments typically require long lead times for purchase, installation, and commissioning and concomitant investments in advance of returns. The higher risk in such cases, therefore, needs to be a key consideration when considering a portfolio of growth projects. Senior management will want to be involved in portfolio-balancing decisions wherein the growth portfolio is adjusted according to capital availability, time horizon for investments, and acceptable risk.
4. Large, technology-oriented firms that work in cross-disciplinary fields can claim technology core-competencies in a significant array of disciplines. This is evidenced by the fact that all the interviewees, regardless of technology uncertainty, claimed at least some interdependence between the technology requirements for the project and the firm's core competencies. For example, for a company like Eastman Kodak Company that has traditionally been the world leader of photographic science, core competencies extend from small particle technology, synthetic chemistry, and polymer science to large-volume plastics processing and specialized coating to image science and digital image processing to optical device manufacturing (cameras, digital projectors, and printers). When looking for new growth opportunities, such firms have a vast array of technology strengths to rely upon. Careful selection of the technologies that provide competitive differentiation while simultaneously affording growth in a risk-managed portfolio of projects requires senior management involvement and direction. In the absence of direct involvement from senior management, the potential for a lack of focus can seriously undermine the entire project portfolio by spreading existing resources too thinly.
5. From a market assessment perspective, there appears to be careful consideration of customer needs in a majority of the projects (17/24). However, there appears to be less consideration of how the product or solution will be delivered to the customer (15/24). Business development needs a system perspective with careful

consideration given to aspects of the business such as sales, logistics, etc., beyond technology development and market assessment.

6. As technology competencies may be leveraged, market competencies such as brand and supply chain/logistics functions may also be leveraged to a firm's advantage. Only 6 out of the 24 projects claim strong market interdependence. The survey results suggest, recognizing the potential bias through sample selection, that an opportunity exists in taking advantage of market competencies in a similar manner to the way the firm leverages technology competencies.
7. Decision-making authority appears to be removed from the project team with 19/24 (79%) of the projects requiring that key decisions be made at least two levels above the project team manager. As well established in organization behavioral studies, the hierarchical decision making structures reduce the speed of decision-making while also reducing risk. For firms that are focused on non-traditional growth, faster decision making and higher risk tolerance may be desirable.
8. Resource availability does not seem to be a significant consideration in almost 90% (21/24) of the projects suggesting that current resource allocation processes and efforts are adequate. Taken in concert with the extant decision-making structures, the survey results seem to suggest that decision making may be a key structural constraint in the system.
9. Only 9/24 (38%) of the project leaders/managers were able to claim knowledge of successful past project similar to theirs, suggesting an opportunity in popularizing successes. This serves two purposes (a) improving morale and (b) providing the impetus for the creation of informal networks and connections within the firm that can serve to provide advice and guidance to project teams undertaking the difficult task of new business growth.
10. A majority of the projects (17/24) employed the lightweight team structure regardless of the technology, market, and organizational factors. This observation supports one hypothesis of this study that firms default to using a single organizational structure for development regardless of the task at hand. Clearly,

based upon the discussion in the previous section of this study, there is a sizable opportunity for this firm to create and utilize alternate team structures for new business development and commercialization. The figure below shows the projects factored into market, technology, and organizational factors as before but color coded according to team structure – lightweight teams are shown as green diamonds, heavyweight teams are shown as pink triangles, and autonomous teams as red squares (there is only one project using an autonomous team and none using functional teams). The liberal use of lightweight teams, regardless of the combination of factors, is evident.

Fig 4.8: Surveyed Projects as a Function of Team Structure



Using the framework developed in Chapter 3, it is possible to revisit the projects listed to predict a more favorable organizational form, based upon the analysis process developed in this study. Using the simplified hypothesis presented in Section 3.2.1 (using only two dimensions, Market and Organization), I would recommend that only 7 out of the 24 projects (instead of 17/24) be run using Lightweight Teams, while 14 out of 24 projects be run using Heavyweight Teams

(instead of 6/24) and 3 out of 24 projects be run using Autonomous Teams (instead of 1/24). The actual and projected team structures as a function of vector position are shown in the following figures.

Fig 4.9: Surveyed Projects as a Function of Team Structure - Actual

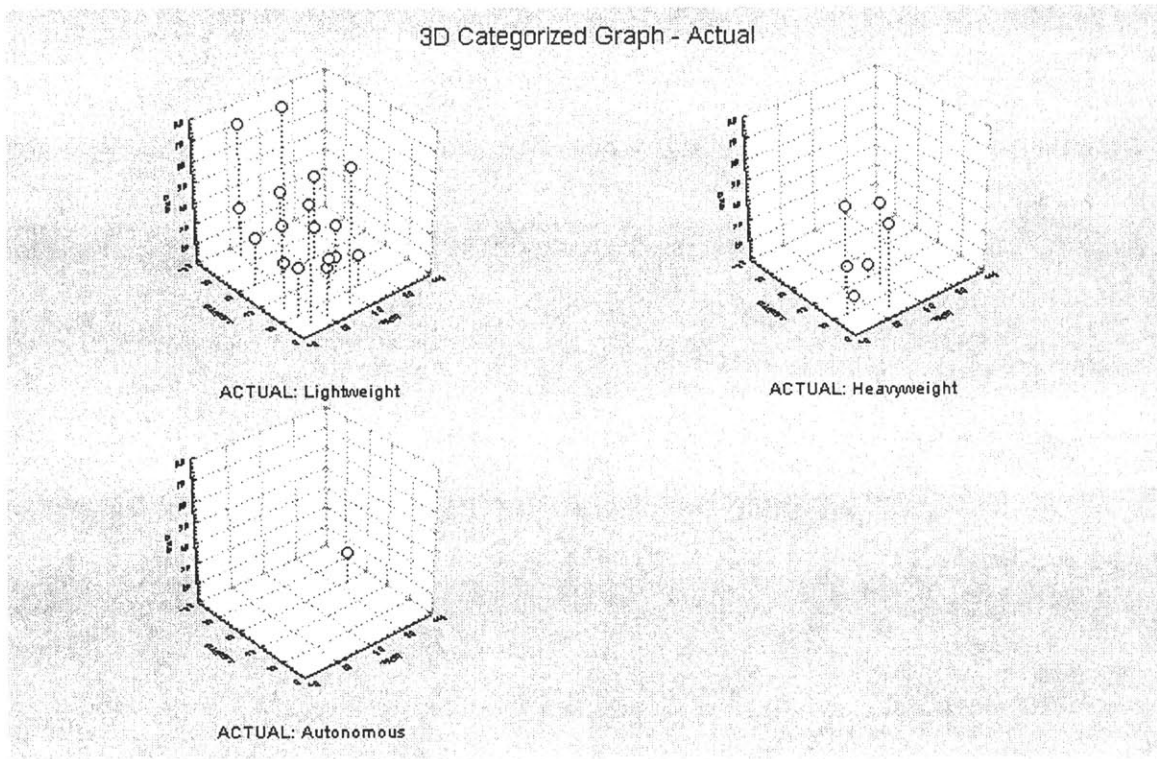
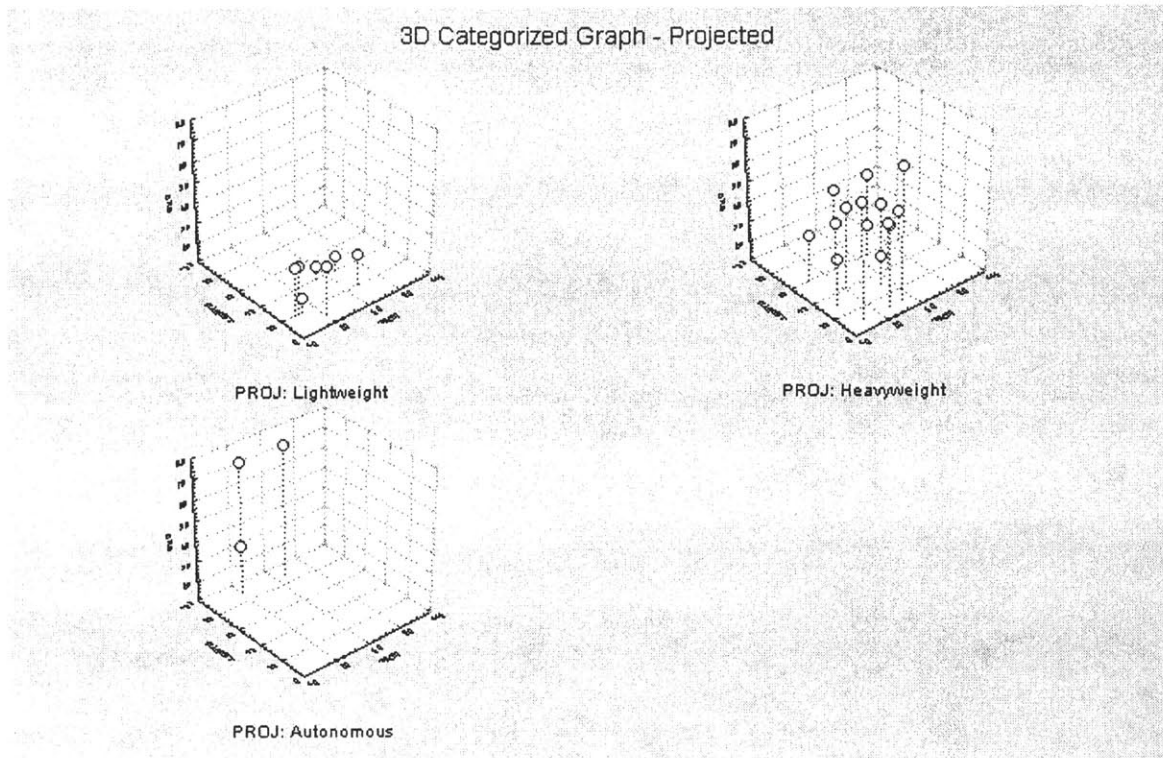


Fig 4.10 Surveyed Projects as a Function of Team Structure - Proposed



11. Over 60% of the projects actively interfaced and used external resources. Given increasing time pressures for new revenue growth, it is anticipated that external partnerships that permit equitable value capture, will provide improved speed to create and deliver value.
12. A majority of the projects were using the firm's standard commercialization processes (19/24), suggesting that the benefits that accrue from similar structures and language of development are being leveraged, i.e., when describing a project as having passed Gate 2 of commercialization, a new team member is able to quickly recognize the project status. Of the remainder of the projects, two pre-date widespread rollout of the standard commercialization processes, while the other three are currently active projects that are still in an early development and exploratory mode.

Chapter 5: Conclusions and Implementation Considerations

In Chapter 3 of this study, I propose a framework for growth, based upon structural contingency theories, which characterizes opportunities using three key dimensions – technology, market, and organization. Within each dimension, two key independent factors are used – uncertainty and interdependence. Characterizing non-traditional growth opportunities using this framework results in mapping each opportunity to a unique vector within this space. The vector position of the opportunity at hand is linked to organizational form, consistent with the underlying assumption of contingency theories that organizational form must fit the task at hand, given strategic imperatives and environmental conditions. In Chapter 4 of this study, I present the results of an empirical survey conducted within a single, large firm wherein the survey explores the hypotheses of this study. The survey results support the hypothesis that firms default to using a single organizational form for projects regardless of the task at hand. The survey results also support the hypothesis that project success is strongly correlated to technology and market dimensions. As technology and/or market uncertainty increase and technology and/or market interdependence decrease, the probability of project success decreases. While the survey results seem to suggest that the organizational dimension is less well correlated to project success, it is noted that the overwhelming use of a single organizational form makes the data set poorly representative of the organizational dimension.

A recommendation emerging from the theoretical and empirical work in this study is that organizations must become more ambidextrous in their ability to use multiple organizational forms simultaneously to exploit traditional and non-traditional growth opportunities. Whereas traditional growth opportunities may leverage existing organizational interdependencies, non-traditional growth opportunities will require different organizational forms that exhibit superior commitment, focus, and speed. Large, established firms will, therefore, have to learn to accommodate organizational forms that are inherently inconsistent physically, structurally, and culturally – to enable operating in multiple time frames with different interdependencies. In this chapter, I discuss key implementation considerations that improve the firm's ability to engage in non-traditional

growth activities. In order to frame the implementation considerations, it is necessary to gain an understanding of product development processes that are being used for non-traditional growth projects. In the following section, therefore, I provide a brief introduction to a generic, integrated product development system. This is followed, in the subsequent section, with a discussion on implementation considerations. Finally, I present the conclusions of this study and potential future work opportunities to build upon this study's results and conclusions.

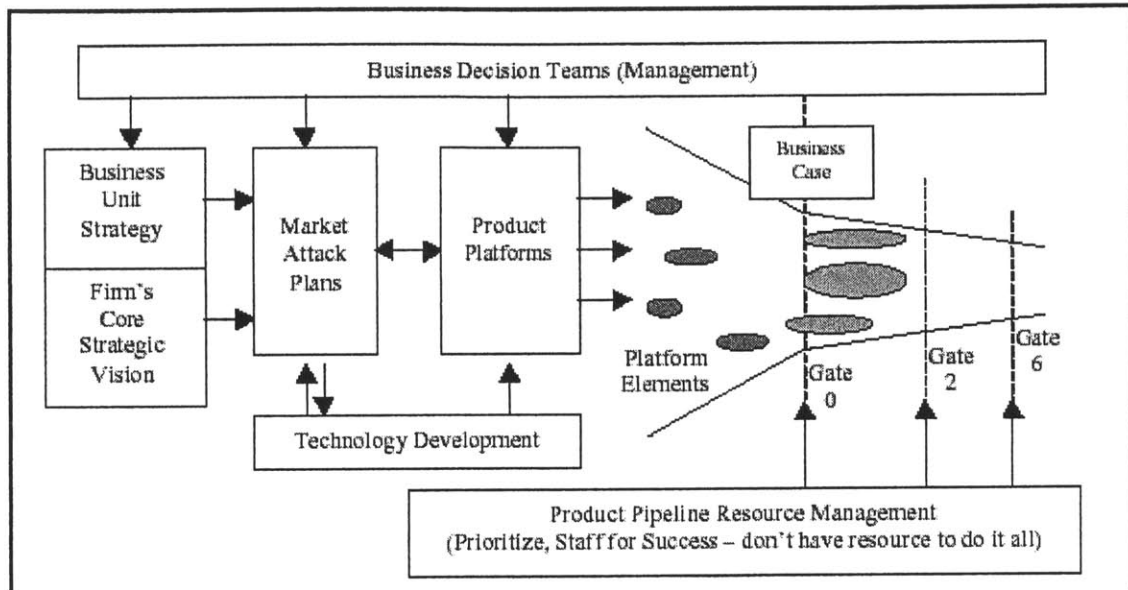
5.1 The Generic Integrated Product Development System

A brief history of the product development processes used at Kodak is available in the SDM thesis by Tom Mackin.(Mackin 2002) Starting in the early 1990s, Kodak successively adopted and institutionalized detailed product development processes including the Kodak Equipment Commercialization Process (KECP), followed by the Kodak Manufacturing Commercialization Process (KMCP), followed by the Robust Technology Development Process (RTDP). Each of these processes was quite successful in delivering effective results in terms of improved product development success rates and shortened time-to-market (TTM), as well as providing the company employees, as a whole, with a common set of standards that spanned across functional or discipline-specific development. However, there remained a problem in the late 1990s with products failing in the marketplace, despite having been delivered on time and, often, within budget. Such failures were linked to poor front-end opportunity identification and assessment. Accordingly, following the recommendations of the product-development consulting firm, PRTM, Kodak instituted, in late 2000, an integrated product development system.

A generic view of an integrated product development system (IPS) is shown in Figure 5.1 below. The IPS is a collection of industry best practices that, together, form an enterprise-wide, business development process. The IPS presents a logical set of processes and activities that, done correctly and in a timely fashion, should result in a product development system that is successful in terms of delivering the right products to the marketplace, on time, and under-budget. It enables three primary benefits beyond those of typical product development processes – a) better forecasts of product performance in

the marketplace, b) management of a vital few instead of an overwhelming number, and c) the identification and pursuit of sustainable vectors of differentiation. A Business Decision Team comprising of key decision makers representing a Strategic Product Group or Business Unit, Marketing, Operations, and R&D, as well as the necessary functional managers (such as finance, etc.) coordinates the set of product development activities guided by the firm's core strategic vision and BU strategy. Key elements of the IPS include the Market Attack plan (MAP), Product Platform plans (PPP), and the Technology Development plan (TDP). The MAP process comprises a set of planning activities that evaluates market opportunities and plans a coordinated strategy that is aligned with corporate and BU goals. Since insufficient management time and attention devoted to product development is known to be one of the critical causes of product development failures, the front-end processes, allow management to focus on key platform decisions instead of individual product decisions, thus reducing the entities actually being managed (often by an order of magnitude – from 100s to 10s, as shown in Figure 5.2), in turn allowing increased focus and attention on those being managed. Product platforms are a collection of common elements, especially the underlying defining technology, implemented across a range of products. Where the MAP is a vertical strategy, enabling the definition of opportunities in a single market, PPP is a horizontal strategy, enabling the application of technology to multiple markets. Technology development plans (TDP) complement the MAP and PPP by enabling the timely development of core technologies and inventions in support of the MAP and PPP. Product development that is appropriately planned through the proper utilization of the front-end processes, proceeds through commercialization, and through a phased stage/gate process.

Fig 5.1: Integrated Product Development System



The IPS provides a logical and thorough process for product line extensions and new product introductions that are aligned with core BU strategy. A product concept or customer need can be quickly and efficiently moved through the front-end processes (MAP and PPP) because of the easy access to established market and platform data. Technology development is aligned with existing needs in anticipating and working on new product and process technologies that support next-generation commercial introductions. The function and architecture of the Business Decision Team is also straightforward – because their roles and responsibilities are well defined. Such product development activities tend to enter commercialization fairly quickly with relatively predictable schedules and budgets.

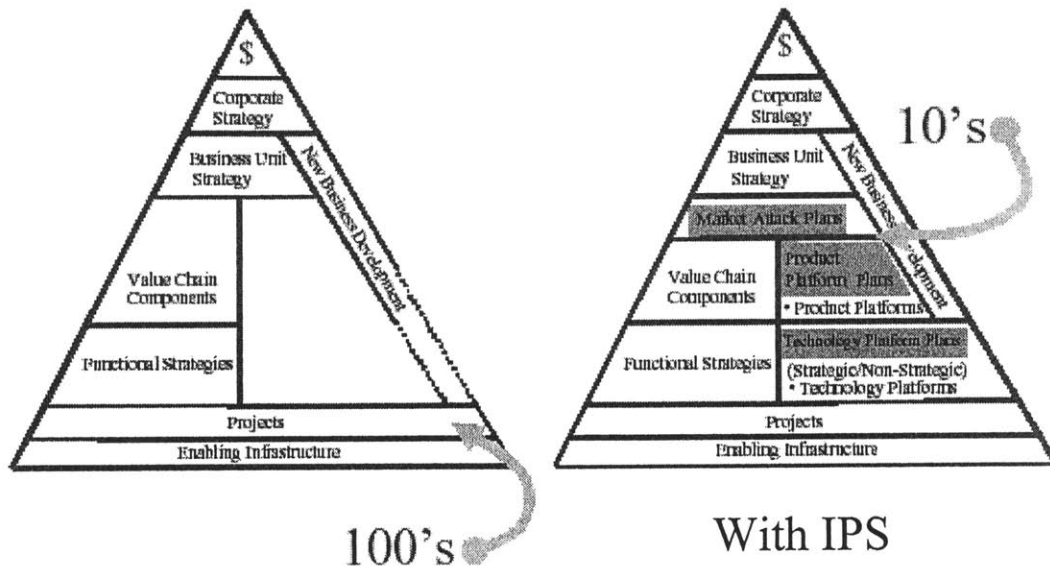


Fig 5.2: Front-End Planning Elements

5.2 Implementation Considerations

Non-traditional growth opportunities present a set of unique challenges in addition to the usual challenges facing traditional growth opportunities. Large firms have to consciously rise up to the challenges of non-traditional growth in addition to existing operational challenges. These additional challenges include:

- (a) Alignment and fit with the firm's strategic objectives - Non-traditional growth opportunities are, by definition, outside the firm's existing SBU strategic foci. As a default therefore, it is imperative that such opportunities receive the explicit approval of senior management early in their progression, before heavy commitment of time and resources. Early validation, followed by periodic verification, by senior management may also be necessary to ensure that new business opportunities continue to evolve within the framework set forth by the

corporate strategic vision. Early validation requires the assumption of some level of risk by senior management, as it is highly unlikely that detailed planning will be possible in the early stages of opportunity assessment.

- (b) Processes for new growth development, including organizational structures, mechanistic processes, and incentives – New business development beyond the early-opportunity assessment phase needs to be able to execute mechanistic business processes such as order entry, order fulfillment, billing, supply chain, and logistics, etc. For traditional opportunities, existing infrastructure is available to be leveraged. This may or may not be true for non-traditional growth opportunities. Infrastructure and business process development is expensive and time consuming. Clearly, early recognition of these needs and activities can ensure they're pre-planned.
- (c) Clearly defined roles and responsibilities – During the early stages of opportunity assessment, resource availability is typically limited. In the case of traditional growth opportunities, existing knowledge bases are available as are suitable human resources who, despite limited engagement, are able to provide the necessary information. In the case of non-traditional business opportunities however, since existing knowledge bases are limited, it is often necessary for a small team of resources to focus simultaneously on technical, market, and business development functions. It is often not possible, in such phases of activity, to clearly demarcate roles and responsibilities within a small resource team – some flexibility and entrepreneurial culture is therefore necessary.
- (d) Access to resources and priority over traditional growth projects – The inherently higher risk associated with non-traditional growth opportunities makes prioritizing them relative to traditional growth opportunities difficult, particularly for shared resources. However, if accommodations are not made, traditional opportunities will always look better on conventional financial metrics such as NPV measures, and as such, will dominate the use of shared resources at the expense of non-traditional opportunities.

Taken in combination with the framework presented in Chapter 3 and the survey results presented in Chapter 4, several implementation considerations emerge for non-traditional growth opportunities in large firms. I discuss these specifically in the context of the existing integrated product development process. The key considerations are:

- a) Senior Management integration – For reasons including strategic alignment, resource allocation and prioritization, and on-going support, senior management involvement as champions, is critical to non-traditional business growth. Through their actions, senior management sets a clear tone regarding the relative priority of activities in the firm. For non-traditional growth-related activities to survive organizational antibodies and overcome organizational inertia, active support from senior executives is an imperative. From a project perspective, the need for the governing BDT architecture to include a senior executive champion is emphasized.
- b) Organizational structure – There are compelling arguments in the literature for non-traditional business development to be undertaken in differentiated organizations that are removed from the existing organizational structures. (Christensen 1997; Leifer, O'Connor et al. 2001) However, there are also studies that show that excessive separation of organizational structures imposes distinct disadvantages such as the inability to leverage needed resources from the mainstream organization and the inability to integrate operations back into the mainstream organization after the opportunity under consideration attains a critical mass. (Westerman, Iansiti et al. 2002) Additionally, the beneficial cultural effects of the non-traditional growth opportunity on the larger organization as a whole are lost without integration at some level. Some integration, at least at a tactical level, therefore, is necessary for projects to be able to leverage existing competencies and capabilities. Insofar as interdependencies exist and are synergistic, integration, at a suitable level, is an imperative. The formation an a New Business Ventures organization that straddles traditional R&D, Manufacturing and Marketing functions in the firm, is recommended.

- c) Organizational integration and incentives alignment: Given tactical integration between the new business opportunity and the mainstream organizations, however, it is critically important that organizational antibodies do not sub-optimize and emphasize lower risk, traditional opportunities at the expense of non-traditional growth opportunities. Accordingly, a reconsideration of incentives – to align functional and operational managers incentives and behaviors with the need to deliver non-traditional growth – is critical to the success of such ventures. Common Incentives based upon cross-platform growth/common-fate results are necessary.
- d) Resource allocation and utilization: The primary focus of this study has been at the project level. The need to match team structures to task contingencies has been emphasized through the examples and results cited. The opportunity to use heavyweight teams more effectively in this particular large firm is emphasized by the survey results. An additional benefit through the use of heavyweight and autonomous teams is the reduced occurrence of key project resources being shared across multiple projects, limiting their effectiveness and project progress. Queueing theory models in operations research show unambiguously that resources loaded to more than 70% of their capacity cause exponentially increasing delays.(Nahmias 2001) Increased use of teams with members that have exclusive alignment and commitment to the project at hand reduces instances of resource overload. An appropriately functioning BDT and a senior management champion can be a powerful influence on relative prioritization to ensure suitable resource allocation.
- e) Business Process modifications: As with any early-stage opportunity development, the uncertainties in technology and market, as well as in organization. are typically high. A small but committed team of cross-functional individuals to assess these opportunities is highly desirable. Using the frameworks developed in this study, for reasons related to ambiguity in roles and responsibilities, as well as in alignment of priorities and incentives, these teams are most efficient when structured as heavyweight teams as opposed to other organizational forms. Since new opportunity assessment has a high probability of

abandonment, the support framework around new opportunity assessment processes such as budgeting and resource allocation processes, need to be flexible. Annual budgeting cycles serve continuously evolving new business opportunities poorly.(Hura 2002)

5.3 Future Work

The following are additional elements that build upon the hypotheses and results in this study:

- a) This study has primarily focused on non-traditional growth opportunity characterization at the project level. Extensions of this study conducted at the SBU level will bring in additional levels of complexity including portfolio management issues and prioritization considerations across different time horizons.
- b) This study did not include any examples of corporate ventures, joint ventures, or acquisitions. Clearly, these represent other growth modes available to large, established firms and contain other task contingencies that impact organizational form. Future studies that include these other growth modes will build upon the conclusions drawn here.
- c) This study has focused on a single, large firm and the non-traditional growth issues it faces. As such, the examples, survey results and subsequent analysis may not be generalizable. Expanding this study across multiple large firms will help verify the applicability of the conclusions drawn here to more general situations.
- d) While the survey method used in this study attempted to get at the results of projects conducted over a period of time, nevertheless, the methods used here focused on a snapshot perspective rather than an evolutionary perspective. A future study wherein a few of multiple projects are influenced by the framework and hypotheses on the organizational form proposed here and the impacts explored in real time will provide a more comprehensive set of methods in evaluating the framework presented here.

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Appendix A

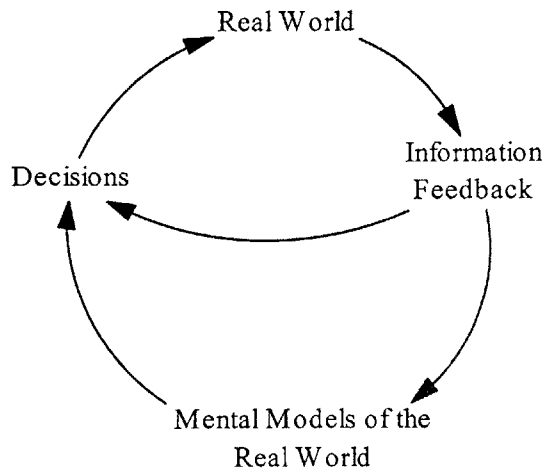
A.1: System Dynamics Simulation Modeling –

A system dynamics model at the project level is used to complement the survey results presented earlier in this study and develop a quantitative understanding of the relative impact of factors such as opportunity-selection filters, resource availability, resource capability, decision-making structures, and expectations on project performance. Model results suggest that key improvements through reducing organizational complexity and improving speed and efficiency of uncertainty reduction can improve project completion times by over 50%. In turn, organizational complexity is reduced by matching the task contingency to the team structure using the process suggested in this study while the speed of uncertainty reduction is increased by working with structures that reduce such factors as communication overhead and staff turnover, and improve decision-making speed by working with the correct levels of management as dictated by the need for capital and other key strategic decisions needed to progress the project.

A.1.1: An Introduction to Learning through System Dynamics Modeling:

All learning depends upon feedback. The double loop shown below has been cited in fields such as psychology, sociology, and anthropology as well as in physics, engineering, and economics as to being the most basic type of learning for humans and for “intelligent” machines.(Sterman 2000)

Fig A.1: Learning through Feedback



We make decisions governing system performance based on our mental models of how the system works. The results of our decisions are available as information feedback. The link in red shows learning that occurs when information feedback from the real world reinforces or alters our mental models. As our mental models change, we make different decisions, which alter the structure of our systems, yielding different patterns of behavior. Barriers exist, however, which can adversely affect the learning process. These include dynamic complexity of the systems – multi-loop and multi-state non-linearity, imperfect information about the state of the real world, confounding and ambiguous variables, poor scientific reasoning skills, defensive routines, implementation failure, etc.(Sterman 2000) To overcome these barriers, we resort to simulations of virtual worlds of known structure and complexity, which offer accurate implementation of policy decisions that result in immediate and accurate feedback. Learning occurs by analogy – mapping the feedback structure and analyzing the dynamic responses in comparison with those of the real world.

Similar learning concepts have been extended from the level of an individual to that of an organization. The concept of dynamic capabilities, defined by Teece (Teece, Pisano et al. 1997) as a firm’s ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments, builds upon prior work on core competencies and forms a major focus of recent theorizing in strategic management and organizational theory. Zollo and Winter (Zollo and Winter 2002) define dynamic ability

as a learned and stable pattern of collective activity through which an organization systematically generates and modifies its operating routines in pursuit of improved effectiveness. Regardless of the precise definition, however, it is clear that firms which have a goal of achieving growth need to exhibit strong dynamic capabilities – they need to embody patterns of activity that are aimed at the generation and adaptation of operating routines to changing environments.

Organizational learning occurs through three primary mechanisms – *experience accumulation* – which is the focus of much traditional literature as skill building based upon the repeated execution of similar tasks; *knowledge articulation* – important for collective learning that happens when individuals express opinions and beliefs in a constructive confrontation; and *knowledge codification* – beyond articulation, codification requires that individuals document their learning in appropriate systems, exposing the logical steps of their arguments and unearthing hidden assumptions to make causal linkages explicit. Articulation and codification require specific costs – direct costs in terms of time, resources, opportunity costs, and managerial attention in the development and updating of task-specific tools, and indirect costs including the potential inappropriate application of routines, and the more general increase in organizational inertia consequent to formalization and structuring of task execution. The benefits of articulation and codification clearly need to overcome the associated costs. Typically, organizations have done poorly in knowledge articulation and codification because of under appreciation of the benefits and over estimation of costs.

However, taking a step back from knowledge and focusing specifically on tasks, it is possible to delineate tasks based upon frequency, heterogeneity, and degree of causal ambiguity. Zollo and Winter (Zollo and Winter 2002) argue that the lower the frequency of tasks, the higher the likelihood that explicit articulation and codification will exhibit stronger effectiveness in developing dynamic capabilities as compared with tacit accumulation of past experiences. Additionally, the higher the heterogeneity of tasks and task experiences, the higher the likelihood that explicit articulation and codification will exhibit stronger effectiveness in developing dynamic capabilities. Lastly, the higher the degree of causal ambiguity, the higher the likelihood is that explicit articulation and codification will exhibit stronger effectiveness in developing dynamic capabilities.

Codification efforts force the drawing of explicit conclusions about the action implications of experience, something that articulation alone does not do. It should aim at transferring “know why” as well as “know how.” Timing is a key ingredient – too early or too late will significantly alter value delivered. Insofar as the codified knowledge is re-used and modified, it continues to add value. System dynamics models offer a dynamic codification scheme and, as such, form a key part of organizational learning.

The fundamental premise of system dynamics models is that the behavior of a system arises from its structure. This structure consists of feedback loops, stocks and flows, and non-linearities that are created by the interaction of the structure of the system with the decision-making processes of agents acting within it.(Sterman 2000) The dynamic behavior of any system can be modeled by combinations of three fundamental behavior modes – exponential-growth dynamics that arise through positive feedback, goal-seeking dynamics that arise through negative feedback, and oscillations that arise from negative feedback with time delays.(Sterman 2000) System dynamics models of organizational capability that mimic real performance thus provide powerful tools for organizational learning and testing the results of policy.

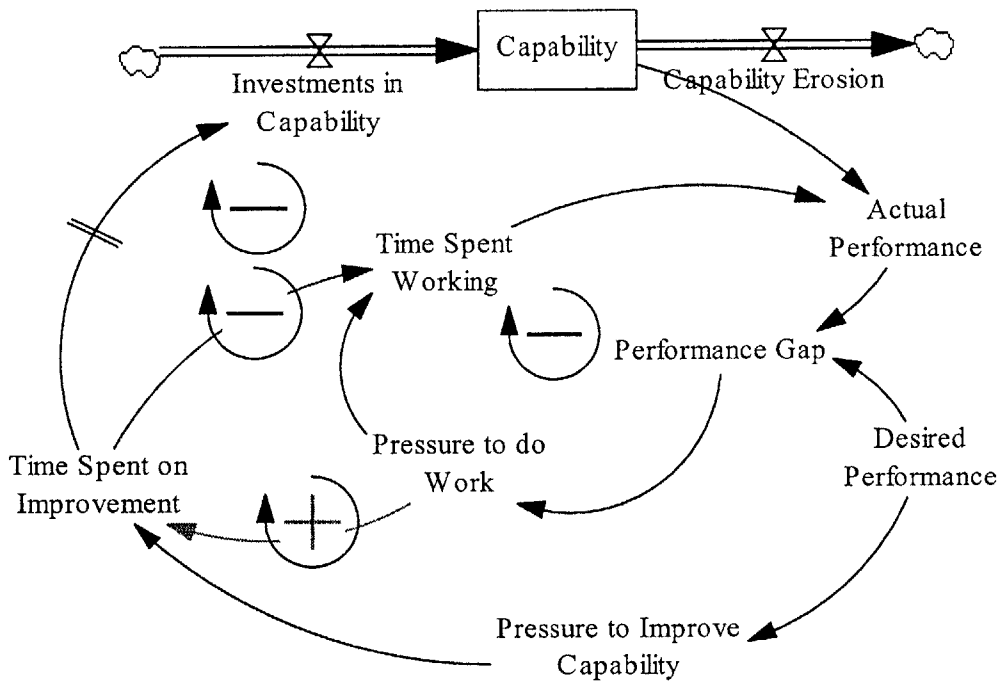
A.1.2: System Dynamics and Organizational Capability:

System Dynamics (SD) has been used to study research and development (R&D) processes and phenomena associated with R&D organizations, such as resource allocation among projects and the interrelation between R&D and the total corporation.(Roberts 1978) For example, Repenning and Sterman (Repenning and Sterman 2000) discuss the structure of process improvement initiatives within organizations. The causal loop diagram used in their study is shown below. The actual performance of any process depends upon the amount of Time Spent Working and the Capability of the process. Typically, time spent on improving process capability yields more enduring results than time spent working. However, there is usually a delay in uncovering root causes of problems and/or learning new capabilities and then going forward and implementing. The lag in enhancing capability depends on the technical and organizational complexity of the process with the delay for simpler processes such as yield of machines in a job shop of the order of months while the delay for more complex

processes such as product development processes can be several years. The Performance Gap is the difference between actual performance and performance expectations. Typically, expectations exceed performance. In order to close the performance gap, people need to work harder (increase the Time Spent Working) or work smarter (Time Spent on Improvement). The Pressure to do work and the Pressure to improve capability reflects the direct and indirect measures used by management to achieve improved results. Unfortunately, working smarter does have limitations (a) there is a delay in achieving results, and (b) there is a greater risk that the improvement efforts fail to hit the mark directly (particularly with increasing process complexity). Given increasing pressure for relatively short-term results, the Time Spent Working is increased at the expense of Time Spent on Improvement, resulting in two more loops. A positive feedback loop that reinforces the dominant behavior arises – with increasing performance gap, the pressure to do work increases, decreasing the Time Spent on Improvement, decreasing the Investments in Capability, decreasing Capability, decreasing Actual Performance, and further increasing the Performance Gap. There is also the increasing pressure to spend more time working and less time on improvements – the balancing loop shown in red below. With an increasing Performance Gap, pressure to do work increases, resulting in a decrease in Time Spent on Improvement and an increase in the Time Spent Working. Repenning and Sterman call the interaction between the above reinforcing and balancing loops the “capability trap.” In the short term, managers and workers can get an immediate performance boost by skimping on longer-term activities (for example, to offset efficiency losses, spend more time working than on preventative maintenance). Capability declines with time however, causing the eventual shift to a more and more short-term focus and poorer results (efficiency continues to take hits as the absence of preventative maintenance results in more and more breakdowns). The capability trap goes beyond low capability and high work pressure – eventually it gets embedded in the corporate culture and incentives as organizations that grow more dependent upon fire-fighting, reward, and promote “heroes,” To successfully navigate the capability trap, an organization needs to (a) recognize that performance typically may deteriorate over the short-term as a result of a longer-term focus on capability improvement, and (b) invest in additional resources, which may raise costs in the short term, pays off in the long term.

The reinforcing loop dynamics have to begin reinforcing virtuous capability improvement rather than the vicious working harder cycle for the organization to emerge from the Capability Trap.

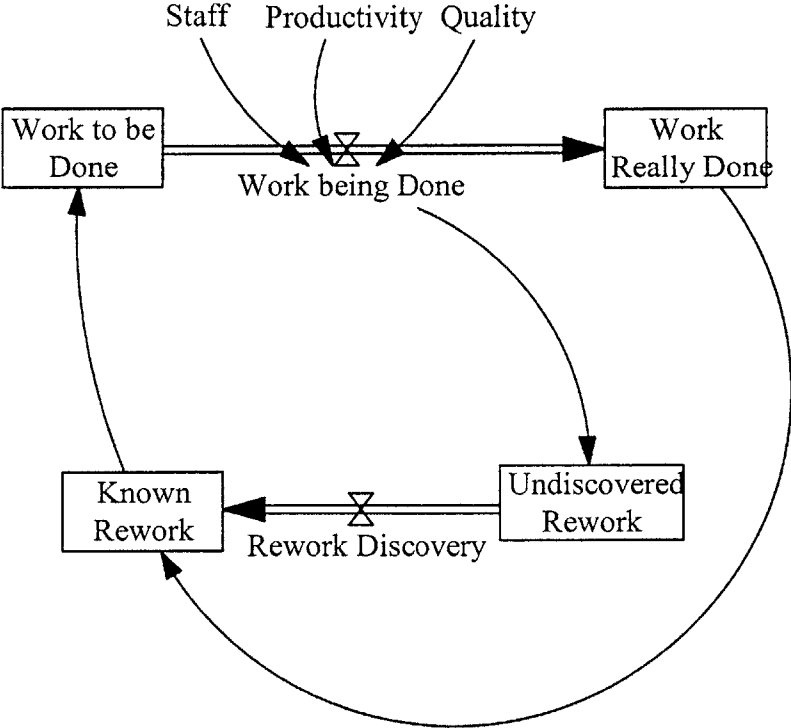
Fig A.2: Repenning Capability Trap



Recent literature in SD has focused on project dynamics. The focus on single project models has been attributed, at least partly, to their dramatic success in correlating the models to real world project performance.(Ford and Sterman 1998) The origin of the project model described below and modified later for use in this study was in the disputed claim between the Navy, and shipbuilding contractor, Ingalls of Pascagoula, Mississippi.

(Cooper 1980). The key element in the project model is the rework cycle, shown in the figure below.

Fig A.3: Key Elements of the Project Model



Initially, all tasks related to the project are in the stock entitled Work to be Done. Tasks are completed as a function of the staff available and the productivity and quality of their

work. Tasks may be completed correctly – resulting in Work Really Done, or incorrectly, resulting in Undiscovered Rework. Work quality is typically low for projects that involve high degrees of uncertainty. Cooper and Mullen (Cooper and Mullen 1993) found that the average fraction of work done correctly the first time in their sample to be 68% for commercial projects. As errors are discovered, typically later in the project cycle, tasks move from Undiscovered Rework to Known Rework. Additionally, changes in customer requirements (or changes that arise from improved understanding of customer requirements) result in tasks moving from the stock Work Really Done to the stock Known Rework. Known Rework now adds to Work to be Done, requiring additional resources to complete the project.

The ultimate effect of rework is to delay project completion. As the project falls behind schedule, however, several other harmful side effects begin to impact the project progress. The effect of prior work quality has an impact on the quality of current work in complex projects – poor early work quality results in poor current work quality. Schedule pressure can increase productivity through overtime work; however, work quality suffers as overtime results in fatigue and burnout. Additional staff can be (and is normally) added to the project staff but the dilution of the experience base that results affects both work productivity and quality adversely.

Single-project models do not effectively model the tradeoffs that are critical in multiple project environments. The dynamics of multiple project management has been the focus of some current literature. Repenning (Repenning 2000) presents a dynamic model of a multi-project product development system and, by capturing the dynamics of resource allocation among competing projects in different phases of development, shows the existence of a “tipping point” in an organization’s product development effectiveness. An increase in workload that exceeds capacity by as little as 25% is sufficient to push an otherwise robust organization into a vicious cycle of fire fighting. Once the system enters a fire-fighting mode, absent additional intervention, it never recovers. McQuarrie (McQuarrie 2002) uses the framework suggested by Repenning to discuss the impact of fire fighting in Aerospace Product Development. He suggests that the most important factors in improving an organization’s capacity to successfully execute projects is to improve project bids, proposals, and plans so they are consistent with the true scope and

available resources. The important levers that management has are (a) slipping projects earlier rather than later by recognizing execution issues early, and (b) provision of resource reserves that are beyond planned project levels.

There are relatively few studies of organizational growth and transformation using system dynamics. Weil and White (Weil and White 1994) present a system dynamics model of business transformation focused on the healthcare industry – specifically, how managed care will grow and replace the traditional health insurance business and the policies that a dominant company in the traditional health insurance business should adopt to emerge as a leader in a radically different business. They draw from their model several conclusions that are widely applicable. Substantial sacrifice in near-term profitability is required to launch the new business properly because of the need for aggressive investment in anticipation of volume growth. The vectors of differentiation in the new business should be based on product attractiveness and service quality, not price (to slow commoditization and enhance returns that are crucial for successful transformation). Last but not least, they emphasize the need to maintain product attractiveness in the core business through the transformation to maintain cross-subsidization through the transformation.

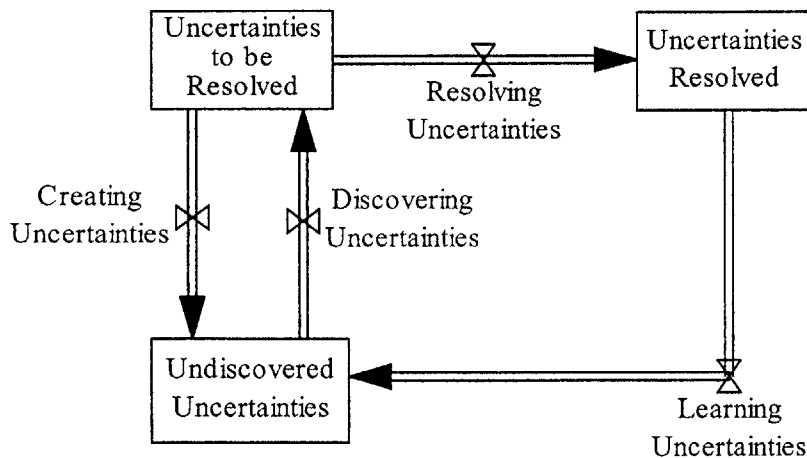
A.2: Objectives of SD Modeling in this Study:

In this study, I use a system dynamics model at the project level to investigate non-traditional growth in large firms. Specifically, in Table 3.1, I list the common causes of failure to achieve non-traditional growth in large firms at a system level and at a project level. In this section, I try to get a quantitative understanding of the relative impact of factors such as opportunity selection filters, resource availability, resource capability, decision-making structures, and expectations on project performance. Additionally, in the first section of this study, I presented a framework to characterize opportunities for growth based upon market, technology, and organizational uncertainty, and market, technology, and organizational interdependence. In this section, I use a system dynamics model to understand the relative impact of these factors on key project metrics such as total effort required for project completion, productivity and quality by explicitly modeling the opportunity assessment factors in a complex project model.

A.2.1: A Breakdown of Model Dynamics:

The central dynamics at the project level is analogous to the Rework Generation loop in the classic Project Dynamics model (Cooper 1980) (Lyneis 2002). At a project-level, there exist a set of uncertainties, classified separately in the earlier section of this study as technology, market, and organization, that need to be resolved (Uncertainties to be Resolved) in order to exploit the opportunity under consideration. Uncertainties are resolved through a Resolution process – the flow that connects the stocks from Uncertainties to be Resolved to Uncertainties Resolved. Uncertainties Resolved lead to the creation of new Undiscovered Uncertainties through the Learning process. Undiscovered Uncertainties are now added to the Uncertainties to be Resolved through the Discovery flow.

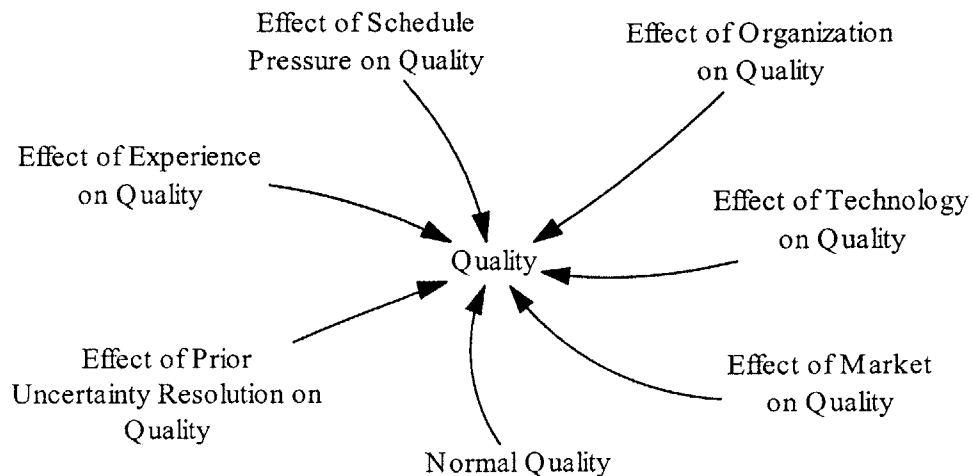
Fig A.4: Project Model Modified for Uncertainty Resolution



Additionally, the very process of defining the Uncertainties to be Resolved typically results in the Creation of Undiscovered Uncertainties as the early definition of an opportunity is subject to significant change as uncertainties are resolved.

Uncertainty resolution progress depends the *Quality and Productivity of the resolution process*. The Quality of resolution is a function of the factors shown in the figure below.

Fig A.5 Factors Affecting Quality of Uncertainty Resolution

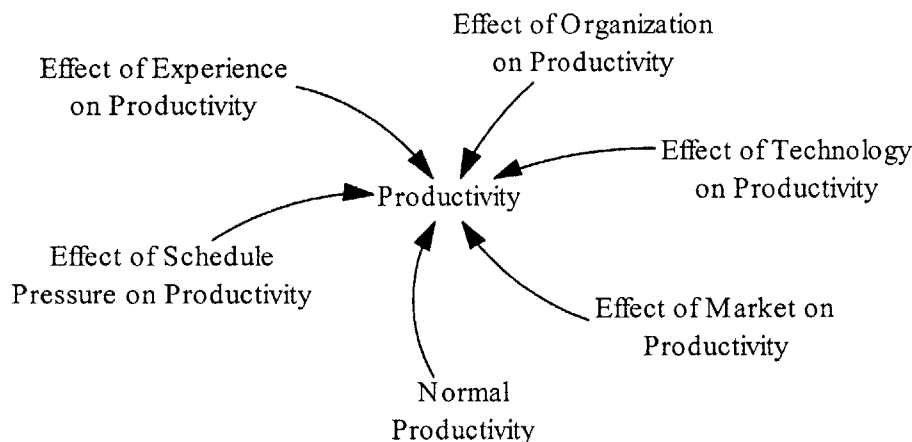


Normal quality (uncertainties/month) is the quality of uncertainty resolution under “normal” conditions where the interactions from other effects are negligible. However, there are numerous dynamic effects that have a substantial and ongoing effect on the quality of uncertainty resolution. These include (a) the effect of experience – the lower the experience of the project team, the poorer the quality of uncertainty resolution; (b) the effect of schedule pressure – the tighter the schedule constraints, the poorer the quality of uncertainty resolution; (c) the effect of prior uncertainty resolution – the poorer the quality of the early work, the slower the actual rate of uncertainty resolution because of the impact of the early work on the later efforts; (d) the effect of organizational factors

such as organizational receptivity to new ideas, decision-making processes, and project team influence – the higher the organizational uncertainty and lower the organizational independence, the higher the organizational complexity coefficient, the poorer the quality; (e) the effect of technology factors such as technology alignment with core capabilities, reliance on external resources etc. – the higher the technology uncertainty and lower the technology interdependence, the higher the technology complexity coefficient, the poorer the quality; and (f) the effect of market factors such as market overlap, sales and distribution channel familiarity, etc. – the higher the market uncertainty and lower the market interdependence, the higher the market complexity factor, the poorer the quality of uncertainty resolution.

The Productivity of Uncertainty Resolution is a function of the factors shown in the figure below.

Fig A.6 Factors Affecting Productivity of Uncertainty Resolution



Normal Productivity is the productivity of uncertainty resolution under “normal” conditions where the interactions from other effects are negligible. Uncertainty resolution productivity is however a function of several dynamic interaction effects. These include: (a) the effect of experience – the lower the experience of the project team, the poorer the productivity of uncertainty resolution; (b) the effect of schedule pressure – the tighter the schedule constraints, the higher the productivity of uncertainty resolution; (c) the effect of organizational factors such as organizational response speed and decision-making processes – the higher the organizational uncertainty and lower the organizational interdependence, the poorer the productivity; (d) the effect of technology factors such as

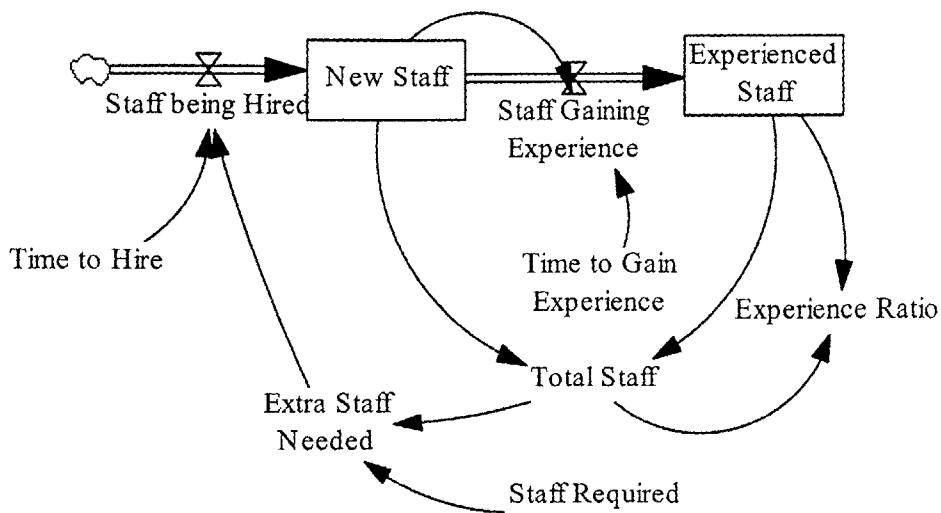
the availability of suitable equipment and relevant technical expertise, etc. – the higher the technology uncertainty and lower the technology interdependence, the poorer the productivity; and (e) the effect of market factors such as market overlap, sales and distribution channel familiarity etc. – the higher the market uncertainty and lower the market interdependence, the poorer the productivity of uncertainty resolution.

Model dynamics affect the *Quality* and *Productivity* of uncertainty resolution. I assume here that superior uncertainty resolution is a necessary but not a sufficient condition for successful new growth.

A.2.2: Resource Allocation Dynamics:

In addition to the above dynamics, the model also uses a simple resource allocation system. The figure below summarizes the staffing model used – a linear first-order, negative-feedback system that exhibits goal-seeking behavior. Total staff is the sum of new staff and experienced staff. An estimate of the staff required is provided at the beginning of the project. The difference between the staff required and the total staff on the project causes staff to be hired. There are two key time delays in the system – a delay to hire new staff and a delay for new staff to become experienced staff. The hiring delay corresponds to the average time an organization takes to identify staffing needs, determine required skills, and execute the hiring process. The experience delay corresponds to the average time that it takes for new project team members to become familiar with their roles, responsibilities, and team processes that are necessary for them to contribute fully.

Fig A.7 Resource Allocation Dynamics



The two time delays in the system result in staffing fulfillment that is significantly longer than intuitively expected. Whereas the time delays are each set at 3 months, the time to get to the full staffing complement per the requirements, set initially at 20, is much longer. As shown below, it takes over 12 months to reach the staff level required. Additionally, because experienced staff has higher quality and productivity than new staff, it is desirable to increase the experience ratio (ratio of experienced staff to total project staff) of the project team. As shown below, it takes over 18 months for the experience ratio to approach 1. The result of these two delays is significant under resourcing of projects, particularly in the early days of the project. Under resourcing, in turn, results in a slower rate of progress than desired, increasing the impact of schedule pressure on quality and productivity.

Fig A.8 Total Staff as a Function of Time

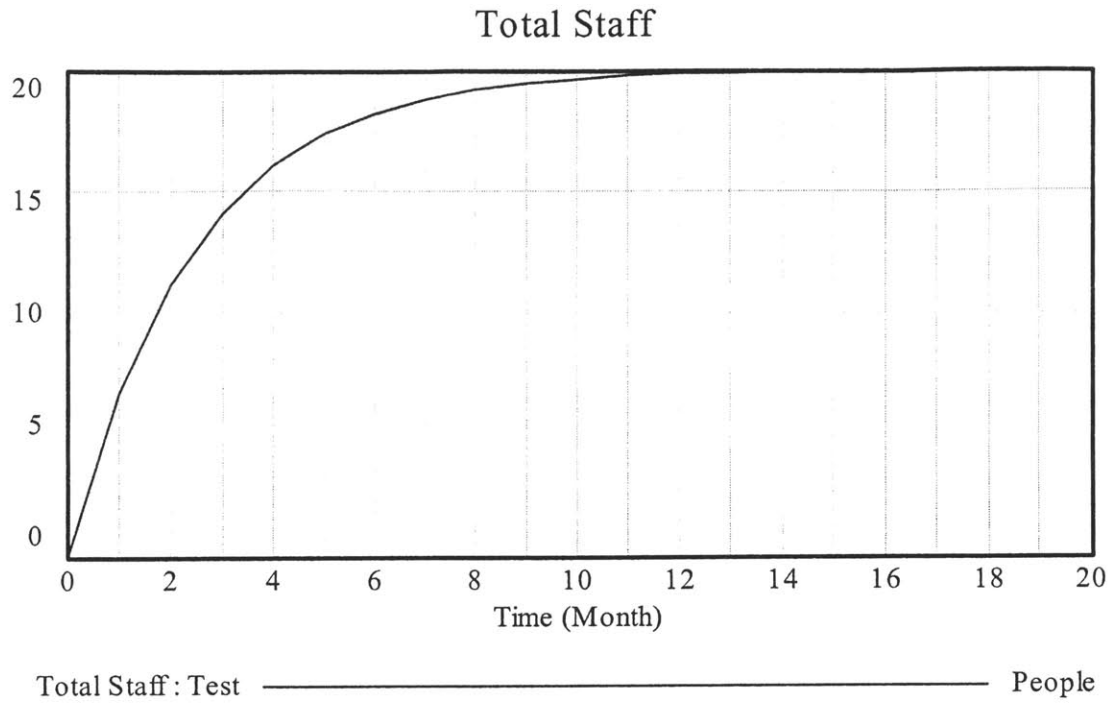
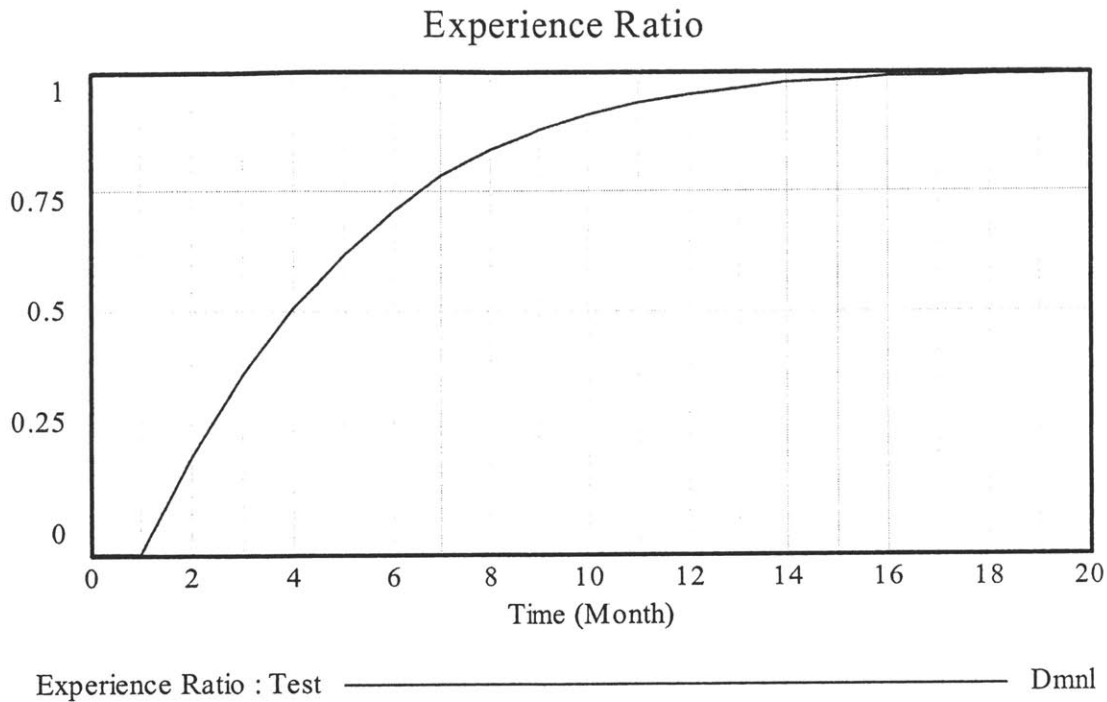


Fig A.9 Experience Ratio as a Function of Time



A. 2.3: Model Calibration:

Model inputs were calibrated to firm-specific values that were determined empirically. Interviews were conducted of ten project leaders/managers of new business development projects in a single, large, established firm and the average of their responses used for key model parameters. It is emphasized that the model parameters are based upon guesstimates based upon the experience of those interviewed (and can be tuned for a specific project with project-specific inputs), however, the model results are sufficiently general in a relative sense to be meaningful.

A.3: Model Results:

I explicitly model the effects of market, technology, and organizational complexity, where the complexity factor is a combination of uncertainty and interdependence defined in Chapter 3 of this study. Several combinations of market, technology, and organizational complexity are modeled – the table below provides a summary of the scenarios simulated. It is reasonable to expect that non-traditional growth opportunities in large firms be characterized by at least one high complexity factor amongst market, technology, and organization. The scenarios considered compare the impact of complexity on project metrics including Productivity, Quality, Uncertainty Resolution, and Cumulative Effort Expended.

Table A.1: Market, Technology and Organization Complexity

Factor	Market	Technology	Organization
Low Complexity – M, T, O	0.1	0.1	0.1
Medium Complexity – M, T, O	0.5	0.5	0.5
High Complexity – M Medium Complexity – T, O	0.9	0.5	0.5
High Complexity – M, T Medium Complexity - O	0.9	0.9	0.5
High Complexity – M, T, O	0.9	0.9	0.9

The figures below show, respectively, productivity, quality, cumulative effort expended, and uncertainties resolved, for each of the scenarios above. The effect on productivity and quality as a function of complexity has a significant effect on the cumulative effort expended and the uncertainties resolved. Increasing the complexity from low to high changes the uncertainty resolution time from less than 21 months to over 204 months. The complexity factor has a compounding effect on the cumulative effort expended to

resolve the initial uncertainties, changing the cumulative effort required from *1314 person*months for a single high-complexity factor (market only) to 1622 person*months for two high-complexity factors (market and technology – an increase of 23% in the effort necessary) to 2704 person*months for all three high-complexity factors (an increase of ~106% in the effort necessary)*. From the perspective that non-traditional growth projects are typically under considerable schedule pressure as well as budget pressure to deliver revenues, this translates into decisions that are typically made with more unresolved uncertainties for projects that deal with multiple high complexities simultaneously. In turn, this reduces an already low probability of success for such projects.

Fig A.10: Productivity as a Function of Time for Different Project Complexities

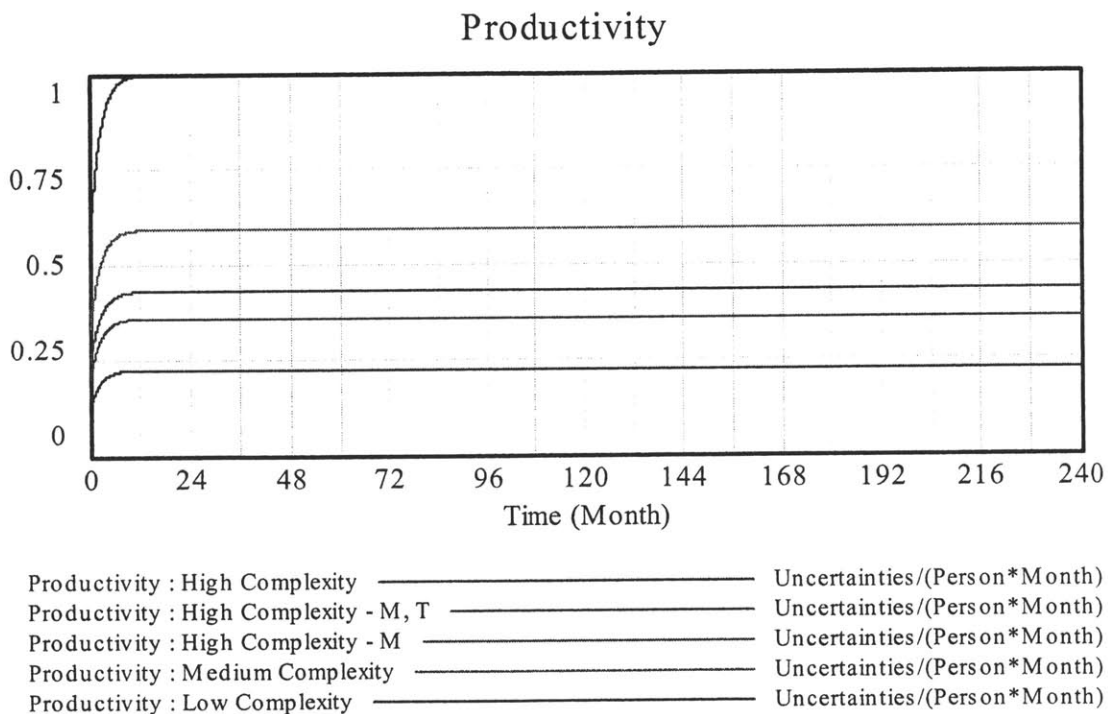


Fig A.11: Quality as a Function of Time for Different Project Complexities

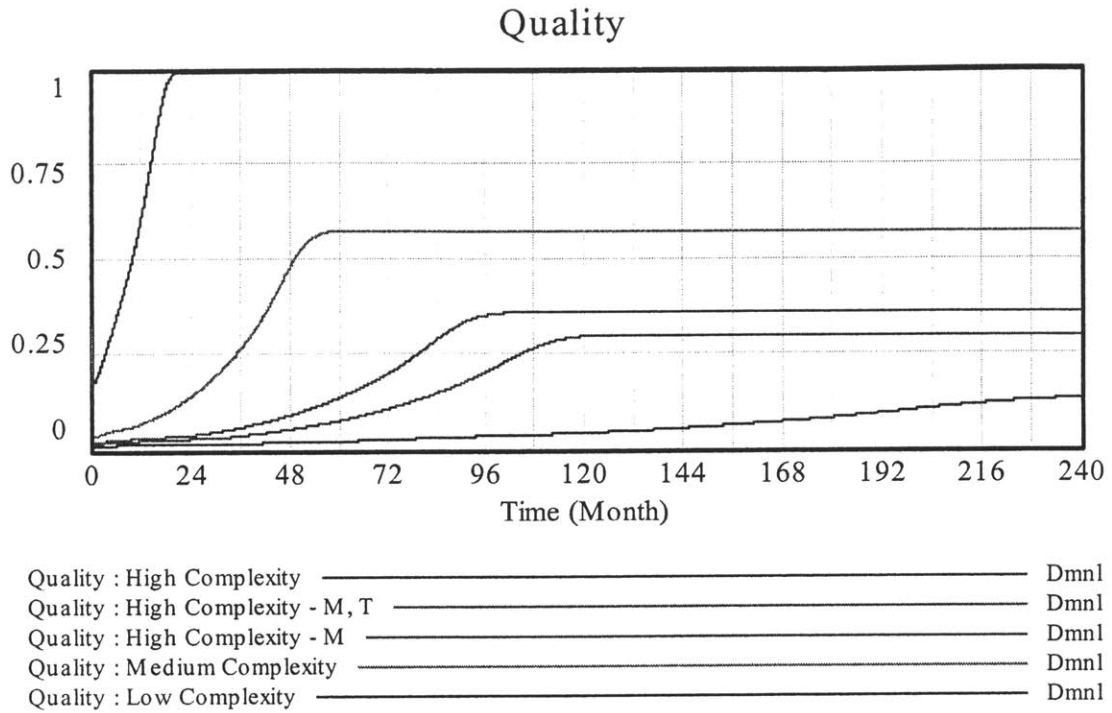


Fig A.12: Uncertainties Resolved as a Function of Time

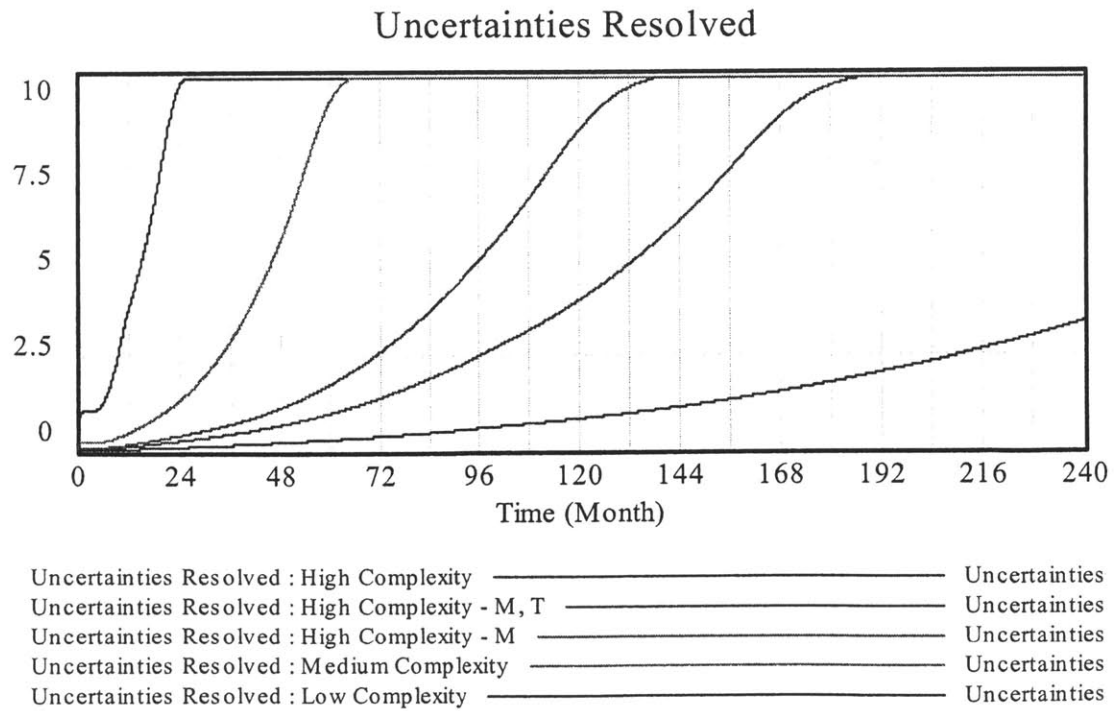
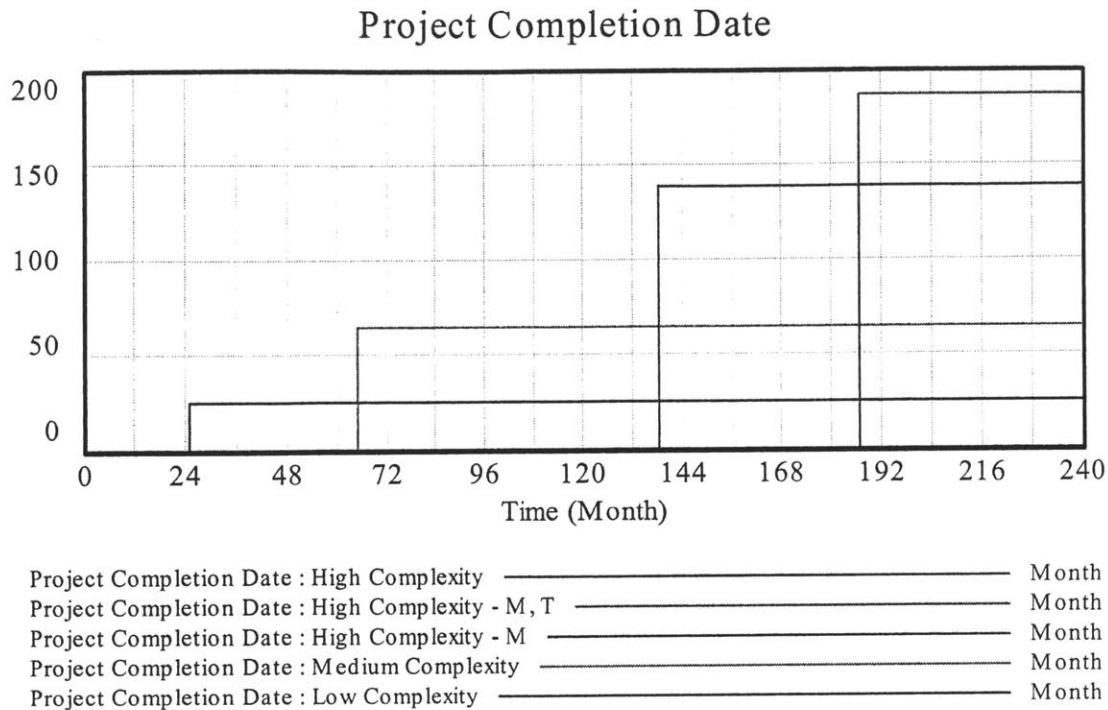


Fig A.13: Project Completion Date as a Function of Time



This highlights the importance of careful selection of growth opportunities and the importance of selecting within a portfolio of projects those project that provide maximum probability of success through (a) organizational uncertainty reduction, (b) appropriate resourcing, and (c) portfolio planning in keeping with resourcing needs.

Given the reality that non-traditional growth opportunities are typically characterized by high complexities on at least one of the three factors, it is important to consider the options available to firms that need to work with such projects. The following options are available:

- a) minimizing the impact of schedule pressure by increasing the willingness to slip schedule,
- b) decreasing the time taken for new hires to gain experience,
- c) reducing staff turnover,
- d) increasing the availability of project staff through hiring,
- e) decreasing the time taken to discover uncertainties, and

f) changing decision-making efficiency through reduced organizational complexity.

The impact of each of the above factors and the cumulative impact of all of these factors on key project metrics is presented below for a single scenario where the market complexity factor is high (0.9) and the technology and organizational factors are medium (0.5, 0.5). Subsequently, I discuss how each of these may be accomplished in conjunction with the existing new business development processes in a large firm.

Table A.2: Scenario Analysis

Factor	Base Case	Scenarios	Project Completion Date – months (Effect on Cumulative Effort Expended – person*months)
Base Case			138 (230)
Willingness to Slip Schedule	Willingness to Slip = 0	Willingness to Slip = 1	122 (205)
Time to Gain Experience	Time to Gain Experience = 2.5 months	Time to Gain Experience = 1.0 months	123 (230)
Turnover	Staff Leaving Delay = 1 Months	Staff Leaving Delay = 4 Month	109 (576)
Exp. Staff	Willingness to Hire Exp. Staff = 0; Exp. Staff Hired = 0	Willingness to Hire Exp. Staff = 1; Exp. Staff Hired = 0.2* Extra Staff	110 (2474)

		Needed	
Uncertainty Discovery	Maximum Time to Discover Uncertainties = 8 months; Minimum Time to Discover Uncertainties = 1 month	Maximum Time to Discover Uncertainties = 4 months; Minimum Time to Discover Uncertainties = 0.5 month	53 (298)
Organizational Complexity	Organizational Complexity = 0.5	Organizational Complexity = 0.1	81 (433)
Cumulative	All of the above	All of the above	49 (895)
Cumulative (No Hiring)	All of the above	All of the above except Willingness to Hire = 0	50 (208)

The table above summarizes the results of 8 scenarios that reduce the project completion date starting with a base case completion date of 138 months. In each of the scenarios considered, all of the uncertainties are resolved over the duration of the simulation run. The improvements in order of increasing effectiveness by shortening the time for project completion are:

- a) reducing the time for new project staff to gain experience,
- b) increasing the willingness to slip schedule early,
- c) being willing to hire staff as needed,
- d) reducing staff turnover,
- e) reducing organizational complexity, and
- f) reducing the time to discover uncertainties.

In addition to the above, two scenarios include a combination of the above individual effects. In one case, the cumulative scenario includes all of the above and in the other, it includes all of the above but the willingness to hire staff as needed. The project completion date is the shortest for the former.

In addition to the project completion date, the other key metric is the cumulative effort expended. Clearly, from the results in the table above and the figures below, the willingness to hire results in a significant increase in the number of new hires and in the number of person months of cumulative effort necessary to complete the project. Reducing staff turnover also has the impact of increasing the cumulative effort while reducing the project completion time.

Fig A.14: Cumulative Effort Expended – Scenario Analysis

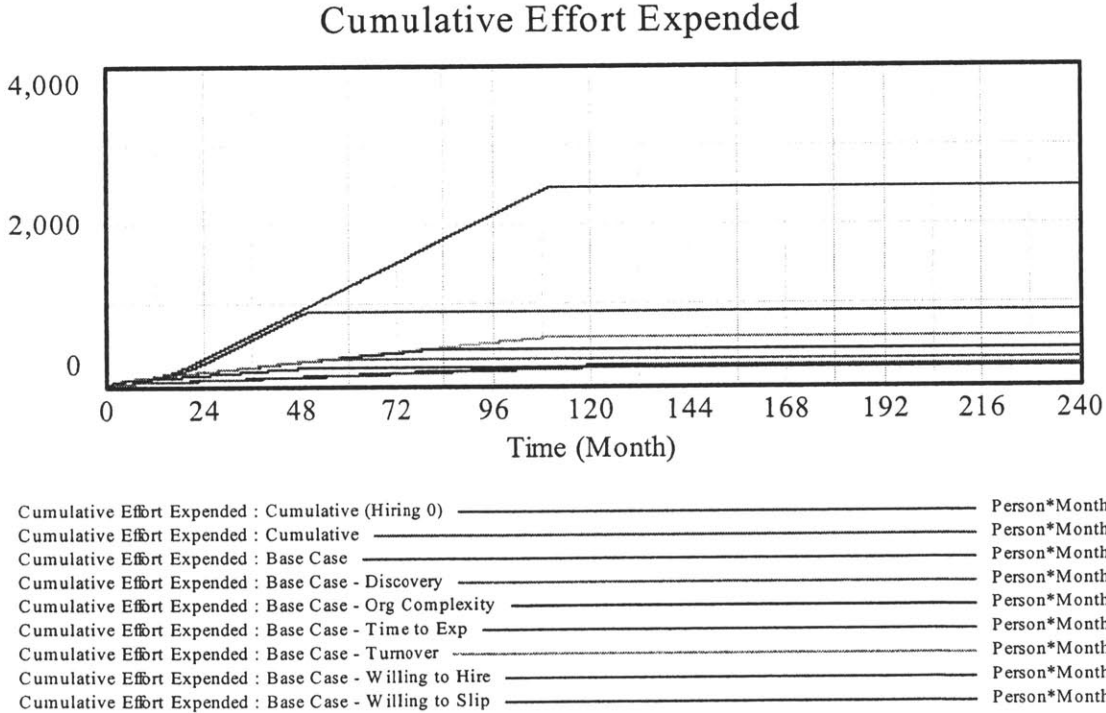


Fig A.15: Uncertainties Resolved – Scenario Analysis

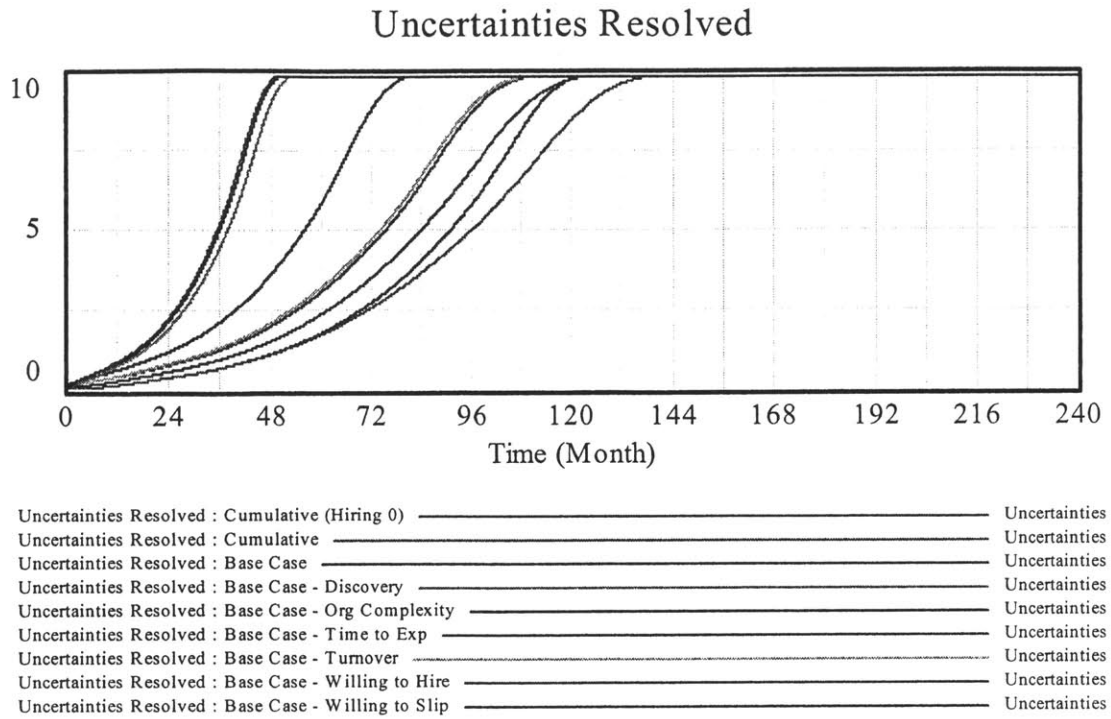


Fig A.16: Project Completion Date – Scenario Analysis

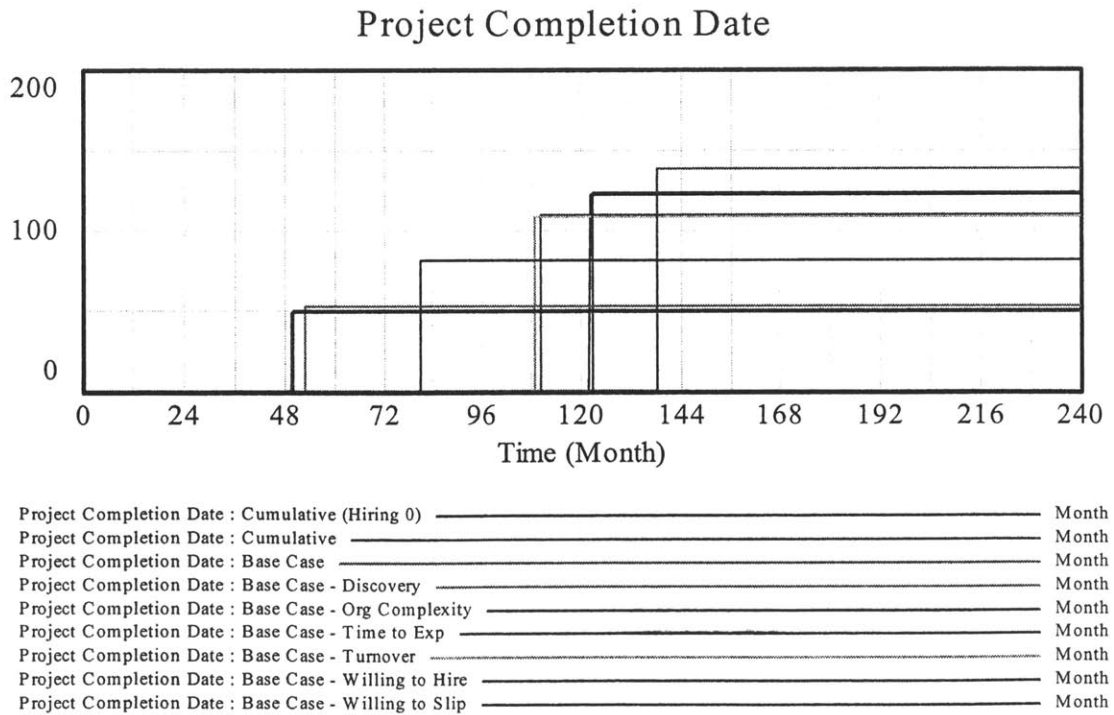
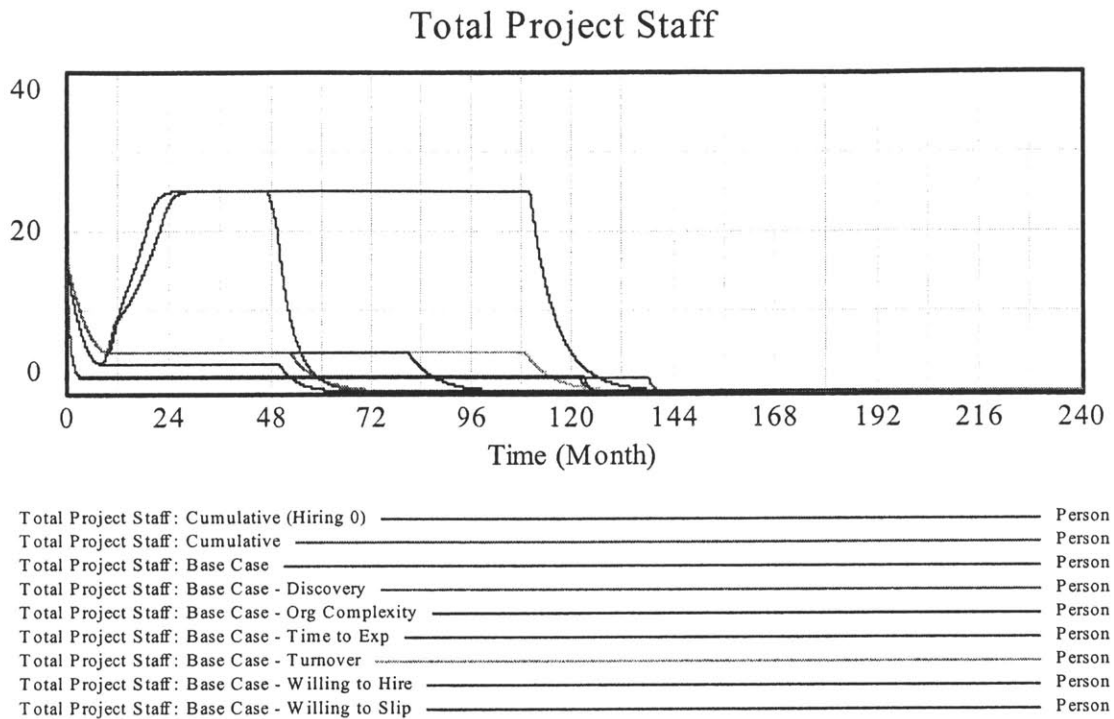


Fig A.17: Total Project Staff – Scenario Analysis



A.4 Discussion:

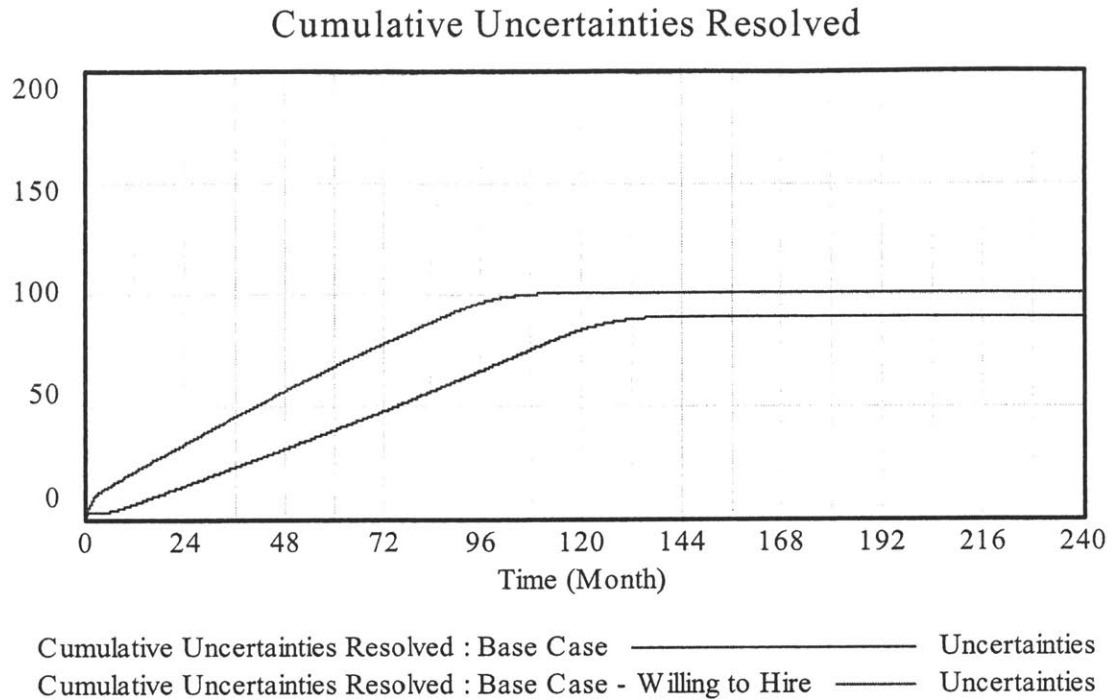
The simulation results suggest the following impacts on policy:

- a) Clearly the largest impact on project completion date is from the time to discover uncertainties. Reducing the time to discover uncertainties by a factor of 2 decreases the project completion time from 138 months to 53 months, a factor of 2.6, while increasing cumulative effort by only 30%. Uncertainty discovery can be accelerated using such product-development best practices such as rapid prototyping and concurrent engineering. Several books and articles on product development processes affirm the benefits of such practices.(Smith and Reinertsen 1991) (Ulrich and Eppinger 2000) (Wheelwright and Clark)
- b) The next largest impact on the project completion date is from reducing the organizational complexity. The first section of this study is focused on this variable. Matching the project complexity, factored into uncertainty and interdependence, with organizational structures that are best aligned with

complexity resolution has the effect of reducing organizational complexity, which, in turn, reduces the time to completion. The simulation results suggest that for the scenario considered, reducing organizational complexity from 0.5 to 0.1 reduces the time to project completion by over 40%.

- c) Reducing staff turnover, which increases the number of experienced staff working on the project, reduces the project completion time. Particularly for complex projects, which last for multiple years, staff turnover has a very significant effect on knowledge loss and subsequent re-work ultimately results in project delays and over-stretched budgets. Clear commitment to goals by staff and by management, appropriate reward structures, and well-defined milestones and project objectives, have a significant impact on reducing staff turnover.
- d) Willingness to hire staff, both new staff and experienced staff, also has a significant impact on reducing project completion time. Willingness to hire results in a significant difference in the total number of project staff. Whereas in the base case, total project staff equilibrates at a fairly low level, as shown in the figure below, in the scenario wherein we're willing to hire, it equilibrates at the maximum allowable level for much of the duration of the project. Continuous hiring results in a much higher cumulative effort because a lot of the effort is related to newly hired staff climbing a learning curve, over which time their work productivity and work quality is low. Poor work quality, in turn, generates more rework – increasing the cumulative number of uncertainties resolved over the project duration, shown in the figure below. The simulation results suggest that hiring practices for projects need to be carefully examined to understand the productivity versus quality tradeoffs. For complex projects, early hiring to fill anticipated needs concomitant with low staff turnover provide for the soonest completion dates. These need to be managed, however, with conflicting budget-related issues, learning curve navigation, and communication overhead.

Fig A.18: Cumulative Uncertainties Resolved – Willingness to Hire



- e) Increasing the willingness to slip schedule early, decreases schedule pressure effects on productivity and quality. Increasing schedule pressure has a short-term effect on increasing productivity. However, staff fatigue and burnout become issues if schedule pressure is maintained for a significant period. This results in poorer quality, which ultimately increases the amount of rework that is needed. The figures below show schedule pressure effects on productivity, quality, and cumulative uncertainties resolved. The higher productivity but lower quality of uncertainty resolution results in a higher number of cumulative uncertainties resolved and significantly delayed project completion. Realistic schedules that have some flexibility to them are an answer to schedule pressure-related effects.

Fig A.19: Effect of Schedule Pressure on Productivity

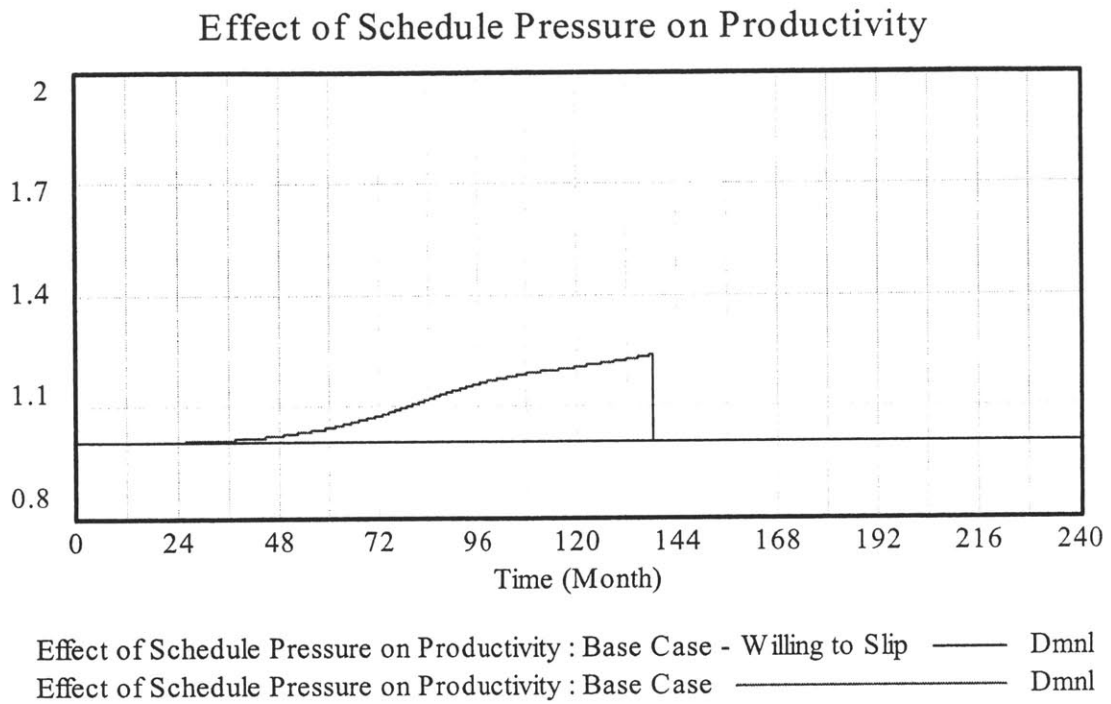


Fig A.20: Effect of Schedule Pressure on Quality

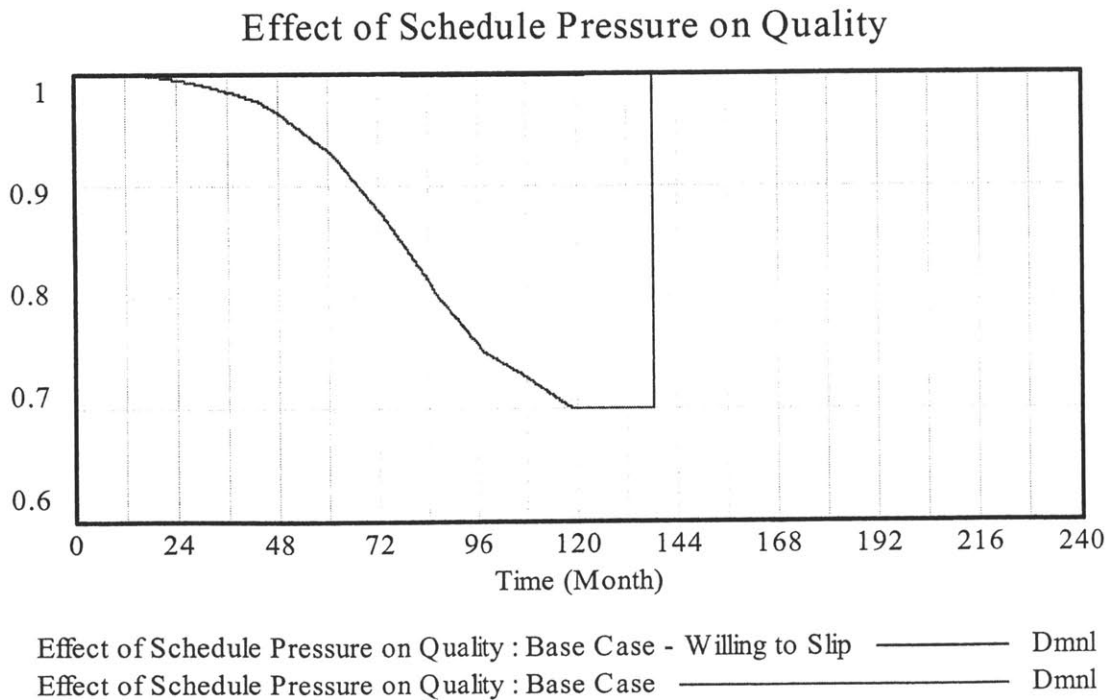
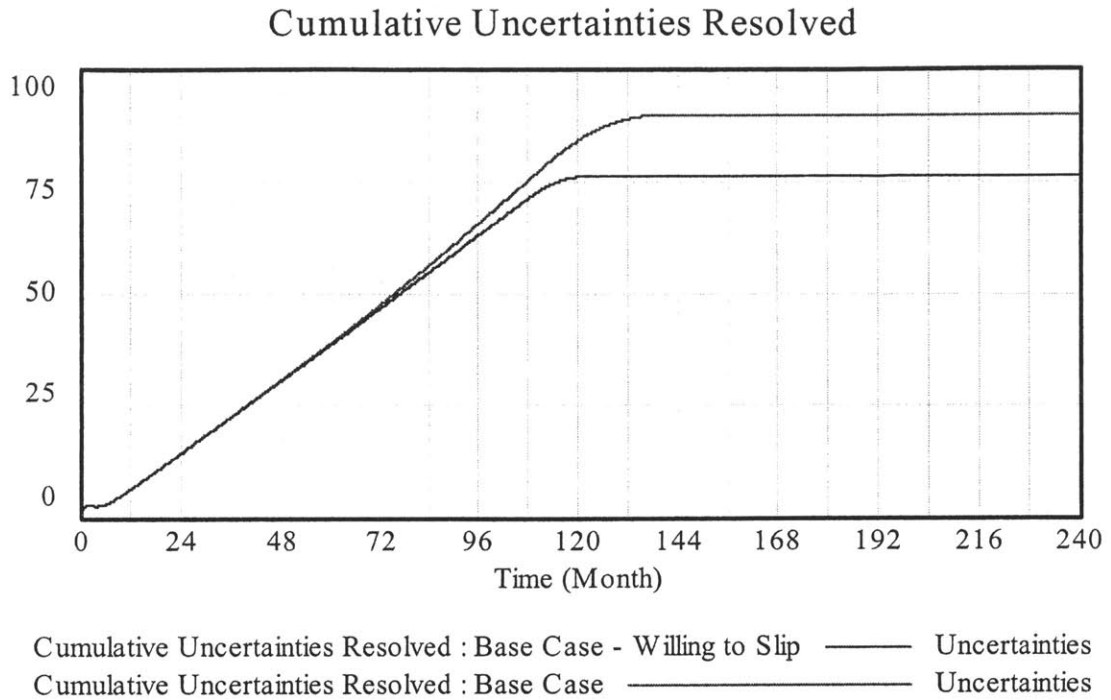


Fig A.21: Cumulative Uncertainties Resolved – Willingness to Slip Schedule



- f) Reducing the time taken for staff to gain experience is another lever for reducing total project completion time. A focus on proper documentation that can be reviewed by new project staff and devoting the requisite time with new project staff to bring them up-to-speed is critical to reducing the learning curve effects that hurt both work productivity and quality.

Appendix B

The following questionnaire was used to survey 24 project leaders/managers of new business development projects in a single, large, established firm.

Introduction provided to interviewees: *I am working on a Master's thesis (as part of the SDM program at MIT/Sloan) that is looking at the reason's why large, established firms find it difficult to pursue non-traditional business opportunities for revenue growth. I request your help with filling out the following questionnaire based upon your experience with any specific project that you managed/led that was pursuing revenue growth through a non-traditional (outside the direction of a Business Unit) business opportunity.*

1. Could you please provide an approximate time frame of the last (or most relevant) growth-related project that you led or managed?
 - (a) Project is currently active
 - (b) Project was concluded in the last year
 - (c) Project was concluded over a year ago but less than 3 years ago
 - (d) Project was concluded over 3 years ago

2. Could you please list the project name (to ensure that this analysis is not biased by multiple survey results for the same project)?

Project Name:

3. Could you please provide a summary of the outcome?
 - (a) Project resulted in a commercial launch
 - (b) Project entered commercialization but was halted prior to launch
 - (c) Project was halted prior to the beginning of a commercialization process
 - (d) Project is in progress

4. What is/was the technical uncertainty in the project?
 - (a) Inventions are/were required
 - (b) Inventions are/were not required

- 4a. Does/Did the project require capital expenditure of greater than \$10 Million to enable commercial launch?
- (a) Yes
 - (b) No
5. What is/was the alignment with the firm's technical core competencies?
- (a) Good alignment (or leverage) with technical core competencies
 - (b) Some alignment with technical core competencies
 - (c) Poor alignment with technical core competencies
6. What is/was the market uncertainty in the project?
- (a) Customer needs are/were known, distribution and sales channels is/were known, segmentation is/was possible
 - (b) Customer needs are/were known, distribution and sales channels are/were unknown or segmentation is/was not possible
 - (c) Customer needs are/were unknown, distribution and sales channels are/were unknown, segmentation is/was not possible
7. What is/was the alignment with the firm's existing markets, sales, and distribution?
- (a) Good alignment with existing markets, sales, and distribution
 - (b) Some alignment (or leverage) with existing markets, sales, and distribution
 - (c) Poor alignment with existing markets, sales, and distribution
8. What is/was the organizational uncertainty in the project (part 1)?
- (a) Decisions are/were needed from Senior management more than 2 levels over your level in the organization hierarchy
 - (b) Decisions are/were made by the team, by you, or your immediate management, at the time.

9. What is/was the organizational uncertainty in the project (part 2)?

Are you familiar with previous projects **similar** to yours that had succeeded in getting to commercial product launch?

(a) Yes

(b) No

10. What is/was the alignment with the firm's organizational resources?

(a) Resources (people, money, equipment) are/were made available without significant difficulty

(b) Resources (people, money, equipment) are/were available but only after some difficulty

(c) Resources (people, money, equipment) are/were practically unavailable

11. What representation of project team (from the four pictures below) is closest to the organizational structure you have/had for your project?

Figure key:

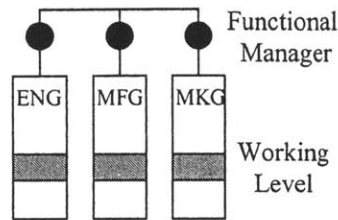
Functional Teams: Led by functional managers (no assigned project leader)

Lightweight Teams: Led by Project Manager. Project Team members report to Functional Managers, not to the Project Manager. Project Team focused primarily on the Technology.

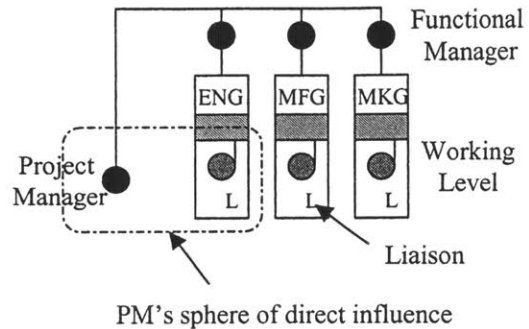
Heavyweight Teams: Led by Project Manager. Project Team members report to Project Manager for the duration of the Project. After completion of project, team members return to Functional Organization. Project Team focused on Technology and Market (Development through Commercialization).

Autonomous Teams: Led by Project Manager. Project Team members report to Project Manager and are no longer linked with their prior Functional Organization. Project Team focused on Technology and Market (Development, Commercialization through New Business Growth).

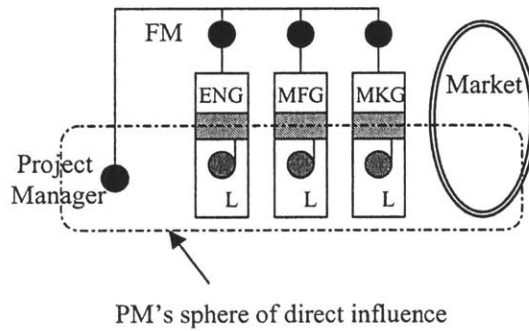
Functional Team Structure



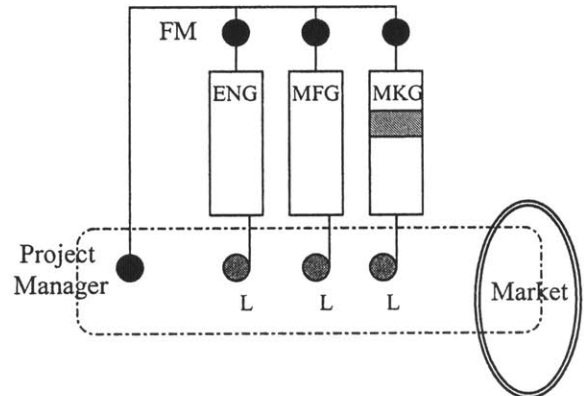
Lightweight Team Structure



Heavyweight Team Structure



Autonomous Team Structure



12. Given the opportunity, would you have preferred a different organizational structure?

- (a) Yes (If Yes, which one – please circle – F, L, H, A)
- (b) No

13. Did you work closely (from a technical or market perspective) with external resources, such as a joint development partner firm, the governmental agency, a university/academic institution, acquisition, corporate venture funding, etc.?

- (a) Yes
- (b) No

14. Did you follow (at a reasonable approximation) one of the Kodak standard development/commercialization processes (KECP, KMCP, RTDP, iPDP)?

(a) Yes

(b) No

Please answer **one** of the following open-ended questions, based upon your answer to Q2 in this questionnaire:

15. If you answered (b) or (c) to Q2 (i.e., the project was halted before commercial launch), what do you think was (were) the main cause(s) of project cancellation?

16. If you answered (d) to Q2 (i.e., the project is ongoing), what do you think are the main inhibitors to project success (i.e., technical challenges, market-related issues, organizational issues – a specific answer is highly appreciated)?

17. If you answered (a) to Q2 (i.e., the project went to commercial launch), what do you think was (were) the main cause(s) of project's success?

Fig B.1: Survey Results

Project	Outcome	Inventions		Tech. Align	Market Uncer	Market Overlap	Org. Dec.	Fam.	Resources	Structure	Pref.	Extn.	KxCP	
1 Active	Launch	Yes	Yes	Good	Good	Good	>=2 levels	Yes	Easy	F	F	Yes	Yes	
2 1 Year	>Comm.	No	No	Some	Some	Some	<=1 level	No	Some	L	L	No	No	
3 1-3Years	<Comm.			Poor	Poor	Poor			Difficult	H	H			
4 >3 Years	In prog.									A	A			
	Name													
	4 PPS	1	2	2	1	1	3	2	2	1	2	2	1	1
	3 IEB	1	2	2	2	1	2	2	2	1	2	2	1	1
	2 SD	1	2	2	2	1	1	2	2	2	2	2	2	1
	4 Mblmg	1	2	1	1	2	1	1	1	1	3	3	1	2
	3 A	1	1	1	1	1	1	1	2	2	3	3	1	1
	3 H	1	2	2	1	1	2	2	2	1	3	3	1	1
	3 3Dlmg	2	1	2	2	1	3	1	2	2	3	4	1	1
	2 Okr	2	2	2	2	2	3	1	1	2	2	3	1	1
	4 MCF	3	1	1	3	3	2	1	2	1	4	4	1	2
	4 F&W	3	1	2	1	1	1	1	1	2	2	2	2	1
	1 Ene	3	1	2	1	3	3	1	2	3	2	4	2	1
	2 lmg	3	1	1	1	2	3	1	2	2	2	4	2	1
	3 Spr	3	1	1	2	3	2	1	2	2	2	3	2	1
	1 B	4	1	1	1	2	3	1	1	2	2	3	2	2
	1 Timg	4	1	2	2	2	2	1	1	1	3	3	1	1
	1 R2R	4	1	1	2	3	2	1	2	1	2	2	1	2
	1 3DC	4	1	2	2	1	1	2	1	3	2	2	1	1
	1 DFD	4	1	1	2	1	2	1	2	1	2	3	1	1
	1 K	4	1	2	1	3	3	1	1	2	2	3	2	1
	1 M	4	1	1	2	3	3	1	2	3	2	4	2	2
	1 OF	4	1	1	2	2	2	1	1	2	2	3	1	1
	1 DB	4	1	1	2	2	2	1	1	1	2	3	1	1
	1 Pas	4	1	2	2	3	1	1	2	1	2	2	2	1
	1 Pac	4	1	2	1	2	2	1	2	2	3	3	1	1

Fig B.2: Survey Results – Technology

Name	Technology			Uncertainty	Interdependence	Tech Factor
	Inventions	Capital				
PPS	2	2	1	1	1	3
IEB	2	2	1	1	1	6
SD	2	2	1	1	1	6
Mpc	2	1	1	10	3	3
A	1	1	10	10	10	3
H	2	2	1	1	1	3
3DIimg	1	2	10	1	7	6
Okr	2	2	1	1	1	6
MCF	1	1	10	10	10	9
F&W	1	2	10	1	7	3
Ene	1	2	10	1	7	3
Img	1	1	10	10	10	3
Spr	1	1	10	10	10	6
B	1	1	10	10	10	3
Timg	1	2	10	1	7	6
R2R	1	1	10	10	10	6
3DC	1	2	10	1	7	6
DFD	1	1	10	10	10	6
K	1	2	10	1	7	3
M	1	1	10	10	10	6
OF	1	1	10	10	10	6
DB	1	1	10	10	10	6
Pas	1	2	10	1	7	6
Pac	1	2	10	1	7	3

Fig B.3: Survey Results – Market

Market Name	Uncertainty	Interdependence	Market Factor
PPS	1	3	30
IEB	1	2	20
SD	1	1	10
Mpc	2	1	20
A	1	1	10
H	1	2	20
3DImg	1	3	30
Okr	2	3	60
MCF	3	2	60
F&W	1	1	10
Ene	3	3	90
Img	2	3	60
Spr	3	2	60
B	2	3	60
Timg	2	2	40
R2R	3	2	60
3DC	1	1	10
DFD	1	2	20
K	3	3	90
M	3	3	90
OF	2	2	40
DB	2	2	40
Pas	3	1	30
Pac	2	2	40

Fig B.5: Survey Results – Cumulative

Name	Tech Factor	Market Factor	Org. Factor	
PPS	3	30	33	1
IEB	6	20	33	1
SD	6	10	67	1
Mpc	9	20	17	1
A	30	10	50	1
H	3	20	33	1
3DImg	42	30	50	2
Okr	6	60	33	2
MCF	90	60	25	3
F&W	21	10	33	3
Ene	21	90	75	3
Img	30	60	50	3
Spr	60	60	50	3
B	30	60	33	4
Timg	42	40	17	4
R2R	60	60	25	4
3DC	42	10	75	4
DFD	60	20	25	4
K	21	90	33	4
M	60	90	75	4
OF	60	40	33	4
DB	60	40	17	4
Pas	42	30	25	4
Pac	21	40	50	4

Fig B.4: Survey Results – Organization

Org. Name	Uncertainty	Interdependence	Org. Factor	
PPS	2	2	1	33
IEB	2	2	1	33
SD	2	2	2	67
Mpc	1	1	1	17
A	1	2	2	50
H	2	2	1	33
3DIimg	1	2	2	50
Okr	1	1	2	33
MCF	1	2	1	25
F&W	1	1	2	33
Ene	1	2	3	75
Img	1	2	2	50
Spr	1	2	2	50
B	1	1	2	33
Timg	1	1	1	17
R2R	1	2	1	25
3DC	2	1	3	75
DFD	1	2	1	25
K	1	1	2	33
M	1	2	3	75
OF	1	1	2	33
DB	1	1	1	17
Pas	1	2	1	25
Pac	1	2	2	50