Project Management Institute

Project Portfolios in Dynamic Environments: Organizing for Uncertainty

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Library of Congress Cataloging-in-Publication Data

Petit, Yvan
Project portfolios in dynamic environments: organizing for uncertainty/Yvan Petit, Brian Hobbs.
p. cm.
Includes bibliographical references.
ISBN 978-1-935589-60-0 (alk. paper)
1. Project management. 2. Strategic Planning. I. Hobbs, Brian. II. Title.
HD69.P75P4753 2012
658.4'04—dc23

2012011087

ISBN: 978-1-935589-60-0

Published by: Project Management Institute, Inc.
14 Campus Boulevard
Newtown Square, Pennsylvania 19073-3299 USA
Phone: +610-356-4600
Fax: +610-356-4647
Email: customercare@pmi.org
Internet: www.PMI.org

10 9 8 7 6 5 4 3 2 1

Introduction

The Standard for Portfolio Management (Project Management Institute [PMI], 2008b) defines a project portfolio as: "a collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives" (p. 138). This standard proposes a process to manage project portfolios. This process, like a number of previous publications on this topic (Artto, 2004; Cooper, Edgett, & Kleinschmidt, 2001; Shenhar, Milosevic, Dvir, & Tamhain, 2007), stresses the importance of the alignment of the project portfolio to the firm's strategy, the identification, and prioritization of the projects being prime to ensure that firms execute the most beneficial projects.

The concept is analogous to financial portfolios where different factors are taken into consideration before investing: risks, returns, time-to-benefits, complexity, portfolio balance, and so forth. Similarly, the primary focus of project portfolio management (PPM) has been on how to select and prioritize projects to ensure that risks, complexity, potential returns, and resource allocations are balanced and aligned to the corporate strategy in order to provide optimal benefits to the enterprise.

The publications on PPM, including the normative body of knowledge, such as the PMI standards and the publications from the Office of Government Commerce (OGC), are fairly recent and most of them have attempted to address the most pressing needs rather than to cover all aspects in this field. For example, the PPM literature makes little mention of potential disturbances to the portfolio typically found in dynamic environments, such as new projects, terminated projects, delayed projects, incorrect planning due to high uncertainty, changing priorities, lack of resources on projects, changing business conditions, and new threats and opportunities, which might impact the successful implementation of the portfolio between portfolio planning cycles. It is not argued that the current processes and governance framework are incorrect or inadequate but just incomplete. It is therefore suggested to supplement the existing processes with additional empirical information.

The Standard for Portfolio Management (Project Management Institute, 2008b) does suggest that changes to the strategy might result in a realignment of the portfolio. However, ad hoc disturbances to the ongoing and approved project portfolios have been neglected. For example, the notion of new project requests to be included in an existing project portfolio is barely mentioned. This assumes an environment characterized by stability, predictability, and the ability to deploy a business strategy through a top-down cascading process. The study of the management of single projects has shown that organizations in dynamic environments face additional challenges: changing goals, continuous re-planning, shorter time for decisions, poorer quality of information, and constant reallocation of resources. Empirical evidence shows that organizations facing higher uncertainty

in dynamic environments put in place different approaches to maintain efficiency while keeping the organization flexible. The main assumption of this research is therefore that, for many firms, the environment is unstable, and that uncertainty must be managed to mitigate the impacts on project portfolios.

Preliminary research work performed at two firms during the summer of 2008 in addition to discussions with portfolio managers has indicated that firms in turbulent environments are indeed trying to put in place specific mechanisms to manage their project portfolios. Feedback received from academics and practitioners at the doctoral poster session at the PMI® Research Conference 2008, in Warsaw, Poland, confirmed a strong interest in this topic. Portfolio managers are looking for tools and concepts to assist them, but unfortunately, the mechanisms to adapt to changing environments have been neglected in the PPM literature. This is somewhat surprising considering that management in the face of uncertainty has been studied for a number of years in the fields of (1) change management of single projects, (2) organization theory, and (3) strategy theory.

The fact that this topic has been neglected in the area of PPM should not be seen as an indication of its lack of importance or relevance for the business community. The study of change management is covered in detail in normative bodies of knowledge in project management published by Project Management Institute, the Construction Industry Institute, and the Association for Project Management (APM). In this body of literature, changes are considered costly and something to be minimized. A number of techniques have been developed to control them.

Based on the observations that (1) the management of project portfolios once projects are selected and prioritized has been only superficially investigated, and (2) that many project portfolios face dynamic environments which results in a high level of uncertainty, this research proposes to address the following research question: *How is uncertainty affecting project portfolios managed in dynamic environments?* This includes the study of processes, procedures, tools, organizational structures, governance, and decision rules. The objectives of the research can be summarized as follows:

- to identify the *organizing mechanisms*[2] used to manage uncertainty affecting project portfolios in dynamic environments;
- to evaluate the use of the dynamic capability framework for the study of project portfolios;
- to study project portfolio management at the operational level using concepts borrowed from sensemaking (traditionally used to study the interpretative mechanism at individual level) and of dynamic capabilities (traditionally used to study strategic processes at corporate level); and
- to provide feedback to academicians, practitioners, and standard bodies on potentially useful practices in the field of project portfolio management.

Approaches developed to manage single projects in dynamic environments (such as different planning techniques, scope control, life cycle strategies, planned flexibility,

[2]See further discussion in section 2.2 about the concept of *organizing mechanisms* as the unit of analysis.

controlled experimentation, and time-based pacing) could be used as a starting point. Weick's Sensemaking Theory (1979, 1995a, 2001, 2003) also provides a good framework for studying the research topic. Weick suggests that rather than focusing on *organizations*, attention should be redirected to the process of organizing. In this theory, environments are not considered to exist but are scanned and interpreted. When changes occur in the environment, they must first be interpreted, and courses of action selected using a set of rules based on the retention of patterns and knowledge from previous experiences.

Another body of knowledge, which helps to answer the research question, comes from strategy theory. The publications on dynamic capabilities argue that it is no longer sufficient to develop unique resources or capabilities (as initially proposed in the *Resource-Based View*) to gain a strategic advantage but that resources and capabilities must be constantly reallocated and reoptimized to adapt to changing environments. PPM can be considered a good example of a dynamic capability but more importantly Teece (2009) proposes a dynamic capabilities framework that can be used in the study of PPM. The framework includes the following capabilities: *sensing*, *seizing*, and *transforming/ reconfiguring*. Teece includes knowledge management under the *transforming* dynamic capability, a concept analogous to Weick's retention in the sensemaking model. However, the activities related to the organizational memory (i.e., knowledge management and retention) are excluded from the study because this topic is very broad and would require a study in itself over a long period. In addition, it does not specifically address the research question.

Even though the concept of dynamic capabilities has been prevalent in the strategic management literature for at least 10 years, solutions are not readily available to portfolio managers. Only a few such capabilities have been investigated empirically, and unfortunately, there are very few descriptions of how firms can implement and maintain dynamic capabilities in practice. Describing and analyzing how portfolios are managed in dynamic environments has the potential to provide empirical evidence of a dynamic capability and to contribute to a better understanding of this phenomenon.

This report summarizes the results of research carried out between 2008 and 2010. Chapter 1 presents a literature review beginning with how PPM has evolved to become a set of governance processes documented in standards and other bodies of knowledge. The concept of uncertainty is then discussed and compared to other similar terms such as unexpected events, deviations, and risks. Different project management approaches, which have been developed to cope with dynamic environment, are then presented. These are then analyzed in relation to the goals of PPM to try to identify the current limitations in its use in dynamic environments, when uncertainty is high. Teece's dynamic capability is then presented. This theory is the foundation for the conceptual framework, described in Chapter 2. It is based primarily on Teece's dynamic capabilities and it is composed of three main levels: organizational context, dynamic capabilities, and *organizing mechanisms*. Chapter 3 describes the methodology. It summarizes the research strategy and provides the rationale for the use of multiple cases. The case study design and methods (including pilot cases, selecting the cases, collecting the evidence, analyzing the evidence, and reporting

the results) are then described. The chapter concludes with limitations and exclusions to the study and the ethical aspects which were taken into consideration during the research.

Chapter 4 provides a detailed description of the two firms and of the four portfolios that were studied. A detailed description of the type of uncertainty encountered during a period of at least one year appears in Chapter 5, and the different mechanisms identified in each of the components of the dynamic capabilities framework (*reconfiguring*, *seizing*, *sensing*, *transforming*, *second-order seizing*, and *second-order sensing*) are discussed for each firm in Chapters 6 and 7. These mechanisms are then analyzed within the context of the uncertainty they were put in place to manage. The results of a cross-case analysis are presented in Chapter 8.

Chapter 9 discusses the implications for theory and practice of the results presented in the previous chapter. It first provides a discussion of findings related to the use of dynamic capabilities as a conceptual framework. This is followed by some reflections on PPM in dynamic environments leading to a number of propositions that could be explored in future research. The conclusion summarizes the contributions of the research and its limitations.

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Chapter 1

Literature Review

This chapter reviews how project portfolio management (PPM) has evolved over time to become a set of governance processes documented in standards and other bodies of knowledge. The concept of uncertainty is then discussed and compared to other similar terms such as unexpected events, deviations, and risks. Different project management approaches, which have been developed to cope with dynamic environment, are then presented. These are analyzed in relation to the goals of PPM to try to identify the current limitations in its use in dynamic environments, when uncertainty is high. Finally, Teece's dynamic capability theory is presented to provide the theoretical base for the conceptual framework presented in Chapter 2.

1.1 Project Portfolio Management

This section describes how the empirical and theoretical foundations of project portfolio management (PPM) have developed to bring more focus on the selection and prioritization of projects to ensure value maximization and alignment to the strategy of firms managing multiple projects. PPM governance and processes are then briefly described to identify some of the latest understandings of the current limitations and unresolved issues related to the topic proposed in this research.

1.1.1 Origins of PPM

The concept of PPM is based on the earlier theories of portfolio selection in the field of finance. In 1952, Harry Markowitz published his seminal paper "Portfolio Selection," where he lays down the foundations for the modern portfolio theory based on the now well-established notion of *efficient frontier* between the expected return and the risk (Markowitz, 1952). Portfolio diversification existed well before 1952. Investors knew that they had to invest in a variety of securities to increase their revenue while minimizing risks. A subsequent publication by Markowitz (1999) actually dates the concept back to the 17th century. However, earlier investors focused on assessing the risks and benefits of individual securities; they would then select the opportunities for gain with the least amount of risk. Markowitz is considered the father of portfolio theory because he was the first to publish a theory taking into consideration the mathematical aspects of the risk-reward characteristics. Modern portfolio theory covers the effects of diversification when risks are correlated, distinguishes between efficient and inefficient portfolios, and calculates the risk-return of the portfolio as a whole.

Large industrial organizations face the same kind of challenges as financial investors. They have to select which product to invest in to maximize revenues while matching the level of risk and uncertainty that the firms are willing to take. Some of the diversification concepts from modern portfolio theory are therefore used in marketing and product management to optimize the balance of products. One of the most renowned techniques, the growth-share matrix, was developed by the Boston Consulting Group to identify where different products in a given portfolio lay over two scales: market growth rate and relative market share (Boston Consulting Group, 1970). The strategy was developed around the idea that *cash cows* (product with high market share and low growth) would generate sufficient profit to satisfy shareholders, and allow investments in *stars* (high growth and high market share) and *question marks* (high growth and low market share) to ensure revenues in the future. This introduced the concept of product portfolio management.

In the 1970s, research and development (R&D) enterprises slowly started to develop different quantitative decision models to support their project selection and resolve the resource allocation between projects to help them in reaching their strategic objectives. However, Baker and Freeland (1975) noted that many of these models were actually ignored in practice. The most prevalent method was still traditional capital budgeting thus ignoring the non-monetary aspects of the projects.

McFarlan (1981) introduced the concept of the selection of information technology (IT) projects and is now considered to be the author who provided some of the basis for the modern field of PPM. He proposes tools to assess the risks of individual projects and portfolios of projects. McFarlan suggested that the IT project risks are based on the "size and structure of the project and the company's experience with the technology involved" (p. 142). Risk-unbalanced portfolios might leave gaps for competition to step in and lead an organization to suffer operational disruptions (De Reyck et al., 2005).

In the mid-1980s and early 1990s, some researchers started to study the *project-oriented company*, defined by Gareis (1989; 2004) as a company that frequently applies projects and programs to perform relatively unique business processes. Some authors prefer to discuss *management by projects* or *multi-project management* (Anavi-Isakow & Golany, 2003; Blomquist & Wilson, 2004; Cooke-Davies, 2002; Engwall & Sjögren Källqvist, 2001; Fernez-Walch & Triomphe, 2004; Zika-Viktorsson, Sundstrom, & Engwall, 2006). The main idea is that enterprises not only have to manage single projects successfully to meet competition but also need to manage a large portion of their business through projects. This can easily be explained by the fact that according to Payne (1995) up to 90 percent of all projects, by value, occur in a multi-project context. Firms have to select and prioritize the *right projects* in addition to do the *projects right* (Dinsmore & Cooke-Davies, 2006b). This brought some consensus towards a common understanding and definitions of project portfolios and of the project portfolio management processes, which are presented in the upcoming sections.

1.1.2 Project Portfolio Definitions

A Guide to the Project Management Body of Knowledge (PMBOK® Guide) (Project Management Institute [PMI], 2008a) defines a project, as "a temporary endeavor undertaken to create a unique product, service or result" (p. 434) while the Association for Project

Management (APM) (2006) defines a project as "a unique, transient endeavor undertaken to achieve a desired outcome" (p. 150). Both of these definitions emphasize the temporary nature of the undertaking (meaning that every project has a definite beginning and end) and its non-repetitive nature (i.e., a project creates unique deliverables).

On the other hand, *programs* are defined by PMI as "a group of related projects managed in a coordinated way to obtain benefits and control not available from managing them individually. *Programs* may include elements of related work outside the scope of the discrete projects in the program" (2008c, p. 312). APM defines *programme*[1] as "a group of related projects, which may include related business-as-usual activities, that together achieve a beneficial change of a strategic nature for an organization" (2006, p. 149).

Earlier publications used the term *program* to also cover the notion of *portfolios*. For example, Pellegrinelli (1997) uses the expression *portfolio programme* to refer to a grouping of independent projects with a common theme. Office of Government Commerce (OGC) publications (2007) also use the term *programme* to mean almost the same thing as the previous definitions of *portfolios*. However, this confusion seems to have gradually disappeared.

The first definitions of *project portfolios* were fairly close to the financial portfolio definitions. For example, Archer and Ghasemzadeh (1999, 2004) proposed a definition of project *portfolio* as "a group of projects that are carried out under the sponsorship and/or management of a particular organization" (Archer & Ghasemzadeh, 1999, p. 208). Dye and Pennypacker (1999) included the notion of fit to organizational strategy in their definition of a project portfolio as "a collection of projects that, in aggregate, make up an organization's investment strategy" (p. 12). Githens (2002) added the notion of program and fit to organizational strategy in his definition: "a collection of projects or programs that fit into an organizational strategy. Portfolios include the dimensions of market newness and technical innovativeness" (p. 84).

The Standard for Portfolio Management (Project Management Institute, 2008b) keeps previous notions (e.g., inclusion of programs, alignment to strategy) in its definition but includes *other work* in the scope of project portfolio defined as "a collection of projects and programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives. The projects or programs of the portfolio may not necessarily be interdependent or directly related" (p. 138).

Project portfolios can also include other portfolios (sometimes called sub-portfolios or lower level portfolios). The hierarchy between portfolios, programs, and projects used by PMI is displayed in Figure 1-1. Programs are not always present in portfolios. They are created when a number of projects must be managed together, typically because they have very strong dependencies and that benefits are gained by managing a number of projects together.

In its definition of *project portfolio,* APM adds the notion of resource constraints and levels of management as: "a grouping of an organization's projects, programmes and related business-as-usual activities taking into account resource constraints. Portfolios can be managed at an organizational, programme or functional level" (2006, p. 146).

[1]APM uses the British spelling *programme* instead of *program*.

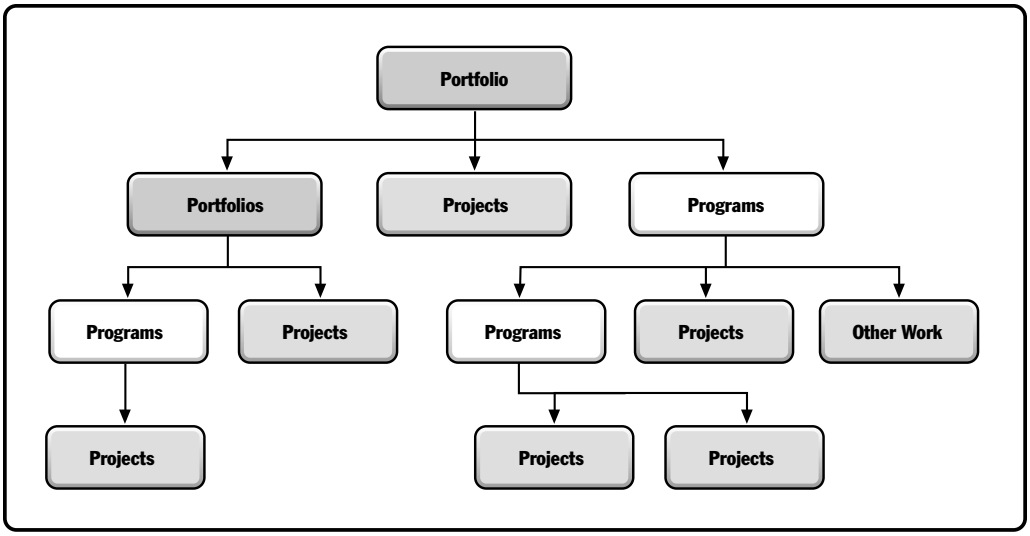

Figure 1-1. Portfolios, Programs and Projects—High Level View
(Source: Project Management Institute, 2008c, p.10)

On the other hand, OGC does not use the term *project portfolio* but rather the term *portfolio* to refer to the project and program investment. Their definition reflects this notion as the totality of an organization's investment (or segment thereof) in the changes required to achieve its strategic objectives (Jenner & Kilford, 2011, p. 131; Office of Government Commerce, 2008b, p. 5).

Finally, Turner and Müller (2003) took a different approach and build on the notion of projects as temporary organizations to define the portfolio as "an organization, (temporary or permanent) in which a group of projects are managed together to coordinate interfaces and prioritize resources between them and thereby reduce uncertainty" (p. 7). However, this definition of a project portfolio as an organization does not seem to have been widely accepted by the business and academic communities.

Table A-1, in Appendix A, compares the different notions included in the different definitions presented in this section. The definitions from PMI and APM, which are similar and have become the most prevalent, are adopted in this research.

1.1.3 Project Portfolio Management

Although there seems to be some uniformity in the recent definitions of a project portfolio, there is still much variety in the definitions of PPM. Authors focus on different aspects in their definitions and none of them seem complete. For example, PMI lists the PPM subprocesses and repeats its definition of portfolio in its definition of PPM as "the centralized management of one or more portfolios, which includes identifying, prioritizing, authorizing, managing, and controlling projects, programs, and other related work, to achieve specific strategic business objectives" (Project Management Institute, 2008b, p. 138).

On the other hand, Dye and Pennypacker (1999) focused on the term *management* and defined PPM as "the art and science of applying a set of knowledge, skills, tools, and techniques to a collection of projects in order to meet or exceed the needs and expectations of an organization's investment strategy" (p. xii).

Some recent definitions emphasize strategic alignment and define PPM as "the management of that collection of projects and programmes in which a company invests to implement its strategy" (Rajegopal, McGuin, & Waller, 2007, p. 11) and is very similar to Levine's (2005) definition as "the management of the project portfolio so as to maximize the contribution of projects to the overall welfare and success of the enterprise" (p. 22). APM excluded the notion of strategic alignment but included the idea of resource constraint in their definition as "the selection and management of all of an organization's projects, programmes and related operational activities taking into account resource constraints" (2006, p. 147).

Cooper, Edgett, and Kleinschmidt (2001) focused on the decision and revision processes in their definition of PPM as "a dynamic decision process wherein the list of active new products and R&D projects is constantly revised" (p. 3). This definition supports particularly well the standpoint taken in this research that project portfolios are dynamic entities that must be constantly monitored, controlled, and decided upon to ensure that they are kept in line with the organizational goals.

McDonough and Spital (2003) pointed out that PPM is more than just project selection. It includes "the day-to-day management of the portfolio including the policies, practices, procedures, tools, and actions that managers take to manage resources, make allocation decisions, and ensure that the portfolio is balanced in such a way as to ensure successful portfolio-wide new product performance" (p. 1864).

Table A-2, in Appendix A, compares the different definitions of PPM. What is fundamental and what should be remembered from all these definitions is that PPM is put in place to ensure that the right mix of projects is selected and managed in order to support the organization's strategy.

1.1.4 Recent Themes

Killen, Hunt, and Kleinschmidt (2007b) reviewed the literature and empirical evidence pertaining to PPM for new product development. They classified the main themes covered in this literature into four groups:

- goals of PPM;
- PPM as a decision-making process;
- methods for PPM; and
- organizational environment and effects.

Each of these groups is presented briefly in the following sub-sections. Although some authors have specifically studied the decision-making process in portfolio meetings (Christiansen & Varnes, 2008), the PPM as a decision-making process is covered under the subsection 1.1.6 within the broader theme of project portfolio governance. The fourth theme, organizational environment and effects, is described in the context of this research in section 1.2. In addition to the four themes listed previously, there have also been some publications

on implementing PPM in organizations (Pennypacker & Retna, 2009; Smogor, 2002) and on the value of PPM (Perry & Hatcher, 2008), two topics which are outside the scope of this literature review because they are not relevant for the research question.

1.1.5 Goals of Project Portfolio Management

According to Cooper, Edgett, and Kleinschmidt (1997b), which was later republished in (Cooper et al., 2001; Pennypacker & Dye, 2002), PPM has three main goals:

> **Goal 1—Value maximization:** To allocate resources so as to maximize the value of the portfolio in terms of some business objectives, such as profitability. . . . The values of projects to the business are determined, and projects are ranked according to this value until there are no more resources.
> **Goal 2—Balance:** To achieve a desired balance of projects in terms of a number of parameters: long-term projects versus short-term ones; high-risk versus sure bets; and across various markets, technologies, and project types.
> **Goal 3—Strategic direction:** To ensure that the final portfolio of projects reflects the business's strategy, that the breakdown of spending across projects, areas, markets, etc., mirrors the business's strategy, and that all projects are on strategy (Pennypacker & Dye, 2002, pp. 196–197).

In addition to these three goals, Kendall and Rollins (2003) added the following:

> **Goal 4:** Monitoring the planning and execution of the chosen projects.
> **Goal 5:** Evaluating new opportunities against the current portfolio and comparatively to each other, taking into account the organization's project execution capacity.
> **Goal 6:** Providing information and recommendations to decision makers at all levels.

There is unanimity in the literature on goal 3, which for some authors is the prime goal of PPM. Many authors, including PMI, use the term *alignment* or *alignment to strategy* to refer to this goal. The last 10 years have also seen an increase in the number of publications on alignment of projects with business strategy (Dinsmore & Cooke-Davies, 2006b; Garfein, 2005; Lan-ying & Yong-dong, 2007; Lanka, 2007; Milosevic & Srivannaboon, 2006; Shenhar et al., 2007).

On the other hand, there is no consensus on goal 4. According to APM (2006), it is the portfolio characteristics that should be monitored, not the projects themselves. Morris and Jamieson (2005) also observed that PPM is primarily to select and prioritize projects not to manage them.

In its process, *The Standard for Portfolio Management* (Project Management Institute, 2008b) supports five of the six goals. It focuses on the link between PPM and organizational strategy (goal 3) and includes evaluation (goal 1), portfolio balancing (goal 2), plus monitoring and control (goals 4 and 6). New opportunities (goal 5) are not explicitly covered in the standard.

The next section reviews the existing processes and governance rules that have been developed primarily by PMI, APM, and OGC. This will help to understand the existing frameworks in relation to PPM goals.

1.1.6 Project Portfolio Governance

Governance can be established at different levels in an organization and the use of the term can lead to some confusion. In a project management context, at least three levels can be defined:

- corporate (or organization) governance;
- portfolio governance; and
- project governance.

Corporate Governance

According to the Organization for Economic Co-Operation and Development (OECD),

> Corporate governance involves a set of relationships between a company's management, its board, its shareholders, and other stakeholders. Corporate governance also provides the structure through which the objectives of the company are set, and the means of attaining those objectives and monitoring performance are determined. (2004, p. 11)

Good corporate governance provides proper incentives for the board and management to pursue objectives that are in line with the interests of the company and its shareholders. It facilitates effective monitoring and control and ensures the board's accountability to the company and the shareholders. Codes of corporate governance have been developed primarily for companies listed on stock markets. They are often studied in terms of agency theory defining the relationships between the principal (i.e., the owners) and the agent (i.e., the managers) hired to undertake some action on behalf of the principal. "Governance provides a framework for ethical decision-making and managerial action within an organization that is based on transparency, accountability and defined roles" (Müller, 2009, p. 2).

According to *The Standard for Portfolio Management* (Project Management Institute, 2008b), *organizational governance* "establishes the limits of power, rules of conduct, and protocols that organizations use to manage progress towards the achievement of their strategic goals.. . .the process by which an organization directs and controls its operational and strategic activities, and by which the organization responds to the legitimate rights, expectations, and desires of its stakeholders" (p. 7). OGC specifies that *corporate governance* "encompasses the structures, accountabilities and policies, standards and process for decision-making within an organisation" (2008a, p. 78).

Project Portfolio Governance and Project Governance

Hazard and Crawford (2004) suggested using the term *project governance* regardless of whether the unit of discussion is a project, program, or portfolio. This is also the approach that Müller (2009) followed in defining the governance in the project management context:

> Governance, as it applies to portfolios, programs, projects and project management coexists within the corporate governance framework. It comprises the value system, responsibilities, processes, and policies that allow projects to achieve organizational objectives and fosters implementation that is in the best interests of all the stakeholders, internal or external, and the corporation itself. (p. 4)

More specifically, *The Standard for Portfolio Management* (Project Management Institute, 2008b) defines project portfolio governance as "a set of interrelated organizational processes by which an organization prioritizes, selects, and allocates limited internal resources to best accomplish organizational objectives" (p. 7). OGC considers that the main value of portfolio governance to decision makers is to put in place clearly defined management structures that align existing organizational governance meetings and decision-making to PPM.

The 2006 version of *The Standard for Portfolio Management* specifically shows *governance* as a process within the portfolio management activities. However, in the 2008 version of the PMI standard, *governance* is removed as a separate process in PPM but is now considered a knowledge area. The PMI standard splits the governance context into two: the management of operations and the management by projects. The latter can be further broken down into the project portfolio governance and the individual project governance.

Project Governance

According to PMI, project governance must provide a "comprehensive, consistent method of controlling the project and ensuring its success" (2008a, p. 20). Project governance is concerned with the steering of individual projects and ensuring that projects deliver what is expected for the sponsor. It supports the means by which the major project stakeholders (e.g., sponsors, customers, and investors) are provided with timely, relevant, and reliable information (Turner, 2006).

It should also describe how to monitor, coordinate, and control the resource allocation for the projects, and finally it should specify what happens to projects when changes occur:

> The governance of project management concerns those areas of corporate governance that are specifically related to project activities. Effective governance of project management ensures that an organisation's project portfolio is aligned to the organisation's objectives, is delivered efficiently, and is sustainable. Governance of project management also supports the means by which the board, and other major project stakeholders, are provided with timely, relevant, and reliable information. (Association for Project Management, 2004, p. 4)

Relationships Between Levels of Governance

The different levels of governance defined previously are interrelated in a hierarchy. Corporate governance defines the relationship between the management of the organization and external shareholders. The governance context can be split into two: the management of operations and the management by projects. PPM is a subset of corporate governance. When an organization manages a number of projects, portfolio governance is put in place through PPM to ensure that projects are selected, prioritized, and authorized. Finally, individual projects must be steered through project governance to ensure their alignment with the organization's strategy. It also describes how to monitor, coordinate, and control the projects.

This connection between project governance and corporate governance is most often provided by a project sponsor (Crawford & Cooke-Davies, 2005; Crawford, Cooke-Davies, Hobbs, Labuschagne, & Remington, 2008; Dinsmore & Cooke-Davies, 2006a) who ensures

that the project is kept in line with the corporate objective through some form of hierarchy of governance boards responsible for steering, supporting the projects, and deciding on key issues (Kendall & Rollins, 2003; Office of Government Commerce, 2008a). The relationship between the project manager and the sponsor has many similarities with the relationship between directors and the shareholders at the corporate level. This analogy is used by some authors to study project governance using transaction cost analysis and agency theory (Müller & Turner, 2005; Turner & Keegan, 2001). Finally, Müller (2009) found that there are different governance styles leading to the use of programs, portfolios, hybrid organizations and/or multi-project organizations depending on whether resources are shared between projects and whether the project objectives are related or not.

1.1.7 Methods for PPM

Project portfolio governance is normally described by a set of processes. While the early publications on PPM focus primarily on project selection and prioritization, the processes included in PPM are documented into more complete and integrated frameworks including decision-making, prioritization, review, realignment and reprioritization (Sommer, 2002).

PMI provides, by far, the most detailed PPM process description. PMI breaks down PPM into process groups and subprocesses with details on the activities along with their inputs and outputs. Figure 1-2 displays a flow chart of the PMI portfolio management process. It is composed of two process groups further decomposed into 14 portfolio management processes. The PMI process is rather linear with the exception of the feedback loops associated with a potential restart of the cycle due to significant business strategy change and a second loop-back that originates in the monitoring of portfolio performance.

Table A-3 in Appendix A compares the subprocesses proposed by PMI to other publications.[2] Most authors include the following subprocesses in their framework: evaluation, selection, prioritization, balancing, reporting, and review. Both the PMI standard and Rajegopal et al. (2007) add two subprocesses leading to project selection—identification and categorization—but Archer and Ghasemzadeh (1999, 2004) focused primarily on the project selection process.

OGC (Jenner & Kilford, 2011; Office of Government Commerce, 2008a, 2008b) depicted the process as two interwoven cycles *portfolio definition* and *portfolio delivery,* which include a number of subprocesses. This is because they claim that both cycles are always in action at varying speeds, "as such the portfolio management model does not have a mandated starting point, middle, or end" (Office of Government Commerce, 2008a, p. 36).

The two circles resemble PMI's process groups: *aligning* and *monitoring and controlling.* Table A-4, in Appendix A, compares the groupings from PMI and OGC. It can be observed that PMI does not include any *planning* or *benefit management* processes while OGC is less specific when it comes to *categorization, evaluations,* and *selection.* OGC prefers to lump these activities under the more generic group *understand.*

[2]See also Sanchez, Robert, and Pellerin (2009) who compared the processes included in six references (Callahan & Brooks, 2004; Cooper, et al., 2001; Kendall & Rollins, 2003; Levine, 2005; Martinsuo & Lehtonen, 2007; Miller, 2002).

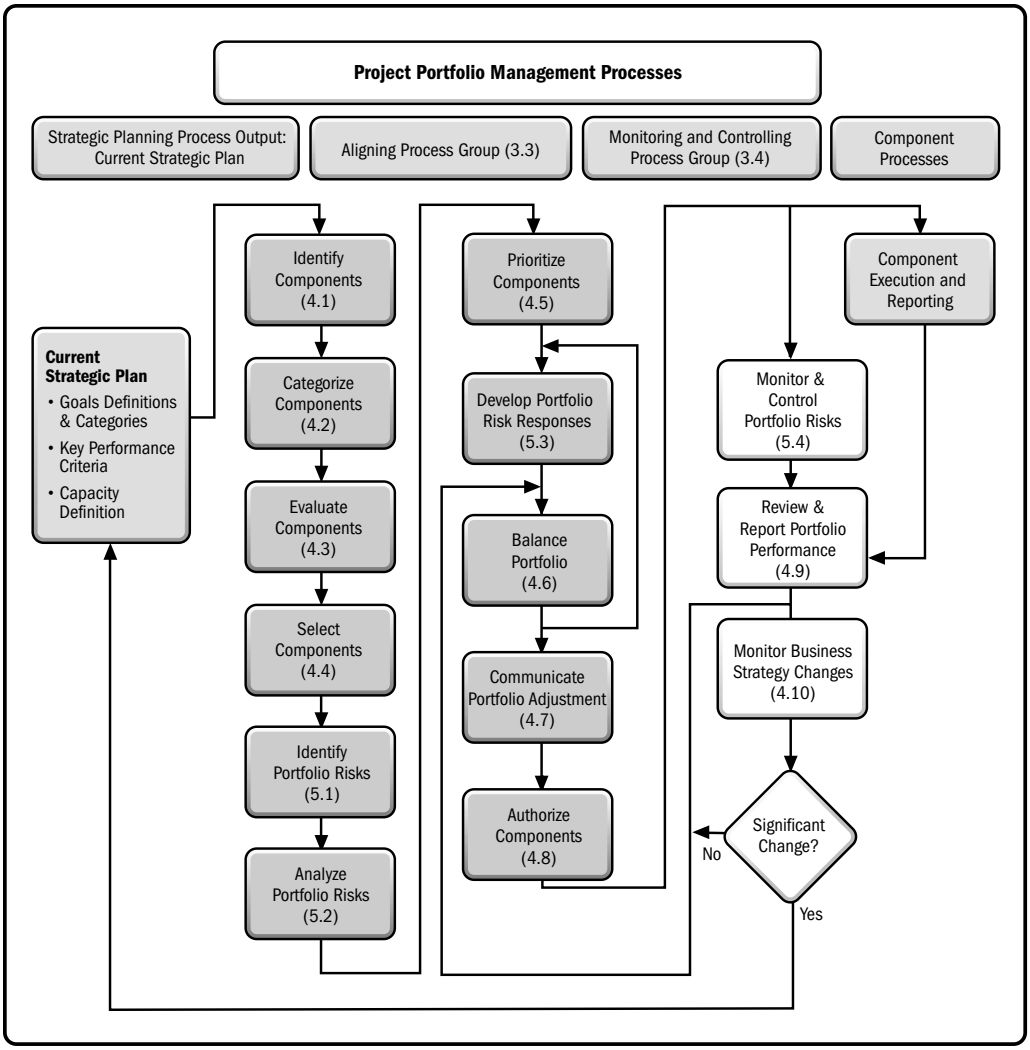

Figure 1-2. Portfolio Management Processes—High Level Illustration

(Source: Project Management Institute, 2008b, p. 36)

Neither of these processes includes the management of changes. The aim of the present research is to supplement the existing processes with additional empirical information to identify new perspectives in this area. It is not argued that the current processes and governance frameworks are incorrect but just incomplete. The following sections use the structure provided by PMI PPM framework to summarize the related contributions from the literature in this area.

Aligning

PMI groups all the processes leading to the project and portfolio authorization under the process group *aligning*. Shenhar et al. (2007) viewed alignment of project management

and business strategy as "an internal collaborative state where project activities continually support the achievement of enterprise strategic goals" (p. 7). This includes seven of the PMI standard processes described briefly in this sub-section.

Identification and Categorization: Identification is the starting point of any PPM process. Although the process of creating a complete list of all ongoing and proposed projects in an organization sounds simple, this is the first important challenge in large corporations implementing PPM. De Reyck et al. (2005) discussed getting a centralized view of the project portfolio while Rajegopal et al. (2007) used the term *project registry* to refer to a list of projects including characteristics such as length, type, product, or service supported, return on investment, and customer. Project categorization was among the first tools used in PPM. Crawford, Hobbs, and Turner (2005), in research on project classification and categorization, identified two main reasons to classify projects: the tailoring of project management resources to the project type and the categorization of projects to prioritize and select them.

Evaluation and Selection: There is extensive literature on project selection, much of which is based on mathematical programming and models. De Piante Henriksen and Jensen Traynor (1999) and Linton, Walsh, and Morabito (2002) provided a comprehensive overview of this literature, which includes hundreds of publications. However, most empirical research fails to demonstrate application of these models in practice (Cooper et al., 2001; De Piante Henriksen & Jensen Traynor, 1999; Hall & Nauda, 1990; Liberatore & Titus, 1983; Linton et al., 2002). Some of the reasons for the lack of use of optimization models by managers include these:

- the diversity of project types, resources, and criteria (Liberatore & Titus, 1983);
- inability to incorporate interrelationships between projects and criteria (Linton et al., 2002);
- perceptions that the models are difficult to use (Chien, 2002);
- the lack of available data and uncertainty in future projections (Martino, 1995); and
- management's preference for simple tools that are not so mathematically elaborate and do not require expert assistance (De Piante Henriksen & Jensen Traynor, 1999).

Cooper et al. (1997a; 1997b; 1998; 2001) have published a number of articles and books based on the results of their survey of the project portfolio selection tools used by 205 large corporations. The research was done with the support of the Industrial Research Institute and covered mainly new product development projects. Their main objective was to identify the tools and techniques that distinguished high performing organizations from low performing organizations to identify best practices. They then developed some of the earlier forms of PPM processes and connected them to the stage-gate, a decision process for individual projects (Cooper, 2008; Cooper, Edgett, & Kleinschmidt, 2002a, 2002b).

A number of scoring models and financial techniques such as net present value, dynamic rank ordered list, expected commercial value, real options, checklists and productivity index have been used in the industry and surveyed by Cooper et al. (1997a, 1997b) and Rad and Levin (2007). The survey performed by Cooper et al. indicates that the financial techniques are still the most common but that the enterprises with the best performance focus on aligning projects to strategy instead of evaluating projects individually; a concept reminiscent of Markowitz's financial portfolio technique. Additional techniques include scenario planning

(Dye, 2002), *what-if* analysis (Benko & McFarlan, 2003), decision trees (Gustafsson & Salo, 2005), scoring techniques (De Piante Henriksen & Jensen Traynor, 1999), and portfolio management indices (Rad & Levin, 2005).

Identify Risks, Analyze Risks, and Develop Portfolio Risk Responses: Risk management is not covered in the first edition of *The Standard for Portfolio Management* (Project Management Institute, 2006). Three subprocesses related to risks are added in the 2008 edition: identify risks, analyze risks, and develop portfolio risk responses. Risks are decomposed into structural risks, component risks, and overall risks. The subprocesses build on knowledge and techniques, which have been developed for project management, such as probability/impact assessment and the development of risk response plans. Similar models have also been proposed by Sanchez, Robert, and Pellerin (2008).

The literature specializing in the field of project, programs, and portfolios was recently reviewed to assess how risk management is addressed at these three levels (Sanchez et al., 2009). It was found that

> project risk management is a well developed domain in comparison to the program risk management and portfolio risk management fields, for which specifically written methodologies are difficult to find. The review also demonstrates the need to include better tools to perform a continuous control and monitoring process. (p. 14)

Prioritization: Prioritization is the process of "ranking the selected components based on their evaluation scores and other management considerations" (Project Management Institute, 2008b, p. 139). This is a process that has received little attention in the literature in comparison to the selection and balancing techniques. The prioritization techniques are often simple; for example, weighted ranking, scoring techniques, or expert judgment.

Balancing: The purpose of the *balancing* process is

> to develop the portfolio components mix with the greatest potential to support the organization's strategic initiatives and achieve strategic objectives. Portfolio balancing supports the primary benefits of portfolio management and the ability to plan and allocate resources (such as financial, physical assets, IT assets, and human resources) according to strategic direction and the ability to maximize portfolio return within the organization's desired risk profile. (Project Management Institute, 2008b, p. 41)

One of the first tools developed for *project balancing* was a project categorizing framework proposed by Wheelwright and Clark (1992) called *aggregate project plan.* This plan allowed for an overview of the project portfolio along two dimensions—the extent of changes made to the product and the degree of process change—leading to four categories of projects (in increasing order of change): derivative projects, platform projects, breakthrough projects, and R&D projects. This framework could be used to identify gaps in the firms' capabilities.

Different graphical representations of the projects, using bubble charts are now used. This modern adaptation of the Boston Consulting Group matrix maps the different projects according to two axes. It uses the size of a circle to represent the cost of the projects, the color of the circle to represent another variable, such as the timing, and shading to represent yet another variable such as the product line.

Cooper et al. (1998) surveyed these different techniques and found that the axes most frequently used by practitioners are *risk* vs. *reward* (based on net present value or internal rate of return). Rather than balancing projects individually, strategic buckets (i.e., envelope of money) can be assigned to subsets of the portfolio (sometimes called subportfolios). Executives ensure that the right level of spending is assigned to the right groups of projects.

Projects can then be ranked, selected, and balanced within the bucket (Cooper et al., 1997b, 2001). The partitioning of projects into groups can also be done according to the level of technical and market uncertainty using the concept of *real options* borrowed from the financial domain (Better & Glover, 2006; Lint & Pennings, 2001; MacMillan & McGrath, 2002; MacMillan, van Putten, McGrath, & Thompson, 2006; McGrath & MacMillan, 2000).

Balancing processes ensure that the organizations' constraints are taken into consideration and according to Kendall and Rollins (2003):

> Every organization has two constraints that limit how many projects can be active at any point in time. One is the amount of money the organization has or is willing to invest in change. The other is the organization's strategic resources—the one most in demand across many projects or the most heavily loaded resource across most projects. This determines how many projects can be active at any point in time (p. 211).

Resource balancing is a very complex operation that might take into consideration a large number of variables. This constitutes one of the main challenges of PPM, which is described further in section 1.3.6.

Portfolio balancing provides the greatest potential to support the organization in achieving strategic objectives. It is in line with goal 2 presented in section 1.1.5. This is the process in which the best mix of projects is identified to achieve the organization's strategic goals. The best mix might actually not only include the projects with the highest values or lowest risks. Unbalanced portfolios might result in too many projects of a certain type at the expense of another type resulting in increasing risk exposure.

Communicate Portfolio Adjustment: This process addresses the need to communicate changes on the project portfolio to stakeholders once they are decided within the *aligning* process group. This strictly focuses on the communication aspects once the changes have been identified and approved. The adjustments mentioned by PMI might be due to previous processes such as *prioritize components, balance portfolio,* and *authorize components.*

This process is also part of the feedback loop when the portfolio performance is reviewed and the portfolios need to be adjusted. Although this introduces the notion of adjustments to portfolios, it does not cover how changes to portfolios should be identified, analyzed, and planned.

Authorization: This process formalizes the decision made by the executives regarding the spending, priorities, and resource allocation. This decision process must be clearly aligned with the individual project decision process (for example, the gates or go decisions) and includes communicating the information about the portfolio to the organization.

Monitoring and Controlling

Portfolio Reporting and Review: This is the periodic assessment of the portfolio to determine its performance along key indicators and metrics such as evolution toward results, spending, risks, dependencies. This is management's opportunity to gather the necessary information about the portfolio to be able to re-align the projects, if necessary.

The Standard for Portfolio Management (Project Management Institute, 2008b) includes the subprocess *review and report portfolio performance* under the *monitoring and controlling* process group in the standard. This is not performed at the individual project level but rather at the portfolio level

> to gather and report performance indicators and review the portfolio at an appropriate predetermined frequency. This ensures both alignment with the organizational strategy and effective resource utilization. . . . Ultimately, the purpose of the review process is to ensure that the portfolio contains only components that support achievement of the strategic goals. (p. 43)

This might result in the addition, reprioritization, or exclusion of some projects in addition to new directives and rebalancing of the portfolio. The introduction of new projects to the portfolio is mentioned by Kendall and Rollins (2003) and Dye and Pennypacker (1999), but it is not covered explicitly in the PMI standard.

McDonough and Spital (2003) found that portfolios being reviewed quarterly performed better than those reviewed semi-annually. Although they hypothesize that the optimal frequency of review might depend upon the type of projects and the dynamism of the industry, they did not have sufficient data to test these relationships. They also observe that project termination is often a more difficult managerial decision than project approval, which corroborates similar findings by Cooper et al. (2001) and Royer (2003).

Monitor Business Strategy Changes: According to the PMI standard, the only significant changes to the portfolio are strategic changes (i.e., major changes affecting the strategy that has a cascading effect on the portfolio). The process *monitor business strategy changes* is based on the output of the process *review and report portfolio performance* and

> enables the portfolio management process to respond to changes in business strategy. Incremental changes to the strategic plan generally do not require changes to the portfolio. However, significant changes in the business environment often result in a new strategic direction, thereby impacting the portfolio. A significant change in the strategic direction will impact component categorization or prioritization and this will require rebalancing the portfolio. (Project Management Institute, 2008b, p. 43)

If changes in business strategy were to occur, the normal *aligning* cycle described in section 1.1.7 would be followed, in other words, *identification*, *categorization*, *evaluation*, *selection*, etc. This is a first feedback loop. Another feedback loop occurs when the *review and report portfolio performance* process identifies some deviations with respect to progress against plan, budget, expected return on investment, and priority.

An important assumption, by PMI, is that changes other than *business strategy changes* are considered insignificant for the portfolio. This assumption can be challenged in the light of other PMI and project management publications. For example, APM mentions that portfolios might have to be adjusted due to changes in the risks, state of the projects, external forces, or changes in the constraints (i.e., financial or key resources). APM (2006) states that this type of change in terms of "adjustments of the portfolio with regard to the constraints, risks and returns anticipated, and in the light of developing circumstances around the portfolio" (p. 8).

In addition, many organizations are faced with continuous change that might not always translate to business strategy change. This is particularly true in the project management context. *The Standard for Portfolio Management* (Project Management Institute, 2008b) acknowledges that change must be monitored at the project portfolio level and compares the management of change in projects, programs, and portfolios as follows:

> **Projects:** project managers expect change and implement processes to keep change managed and controlled.
> **Programs:** the program manager must expect change from both inside and outside the program and be prepared to manage it.
> **Portfolios:** portfolio managers continually monitor changes in the broad environment (p. 6).

In addition, rather than going through complete portfolio planning cycles, they might make *adjustments* to their ongoing portfolios, an activity briefly mentioned in the PMI standard in the section called *communicate portfolio adjustment*. The assumption for this research is that portfolio managers might not only monitor changes but might also implement processes to keep change managed and controlled, which is an aspect not well covered in the PPM literature.

1.1.8 Limitations of Current PPM Literature

The main priority of PPM publications and research was initially to improve organizational performance by introducing good practices to select and prioritize projects (i.e., to ensure that the right mix of projects was executed) (Cauchick, 2008). There is also extensive literature on project selection, much of which is based on mathematical programming and models. However, most empirical research fails to demonstrate much application of these models in practice. Another recurring theme is the alignment of the projects with the organization's strategy and PPM is most commonly implemented through a number of processes related to project governance.

It is not argued that the current processes and governance framework are incorrect but just incomplete. The purpose of the present research is to supplement the existing processes with additional empirical information and conceptualization to supplement them with information on how project portfolios are managed when there is a high level of uncertainty. There are a number of similar concepts related to uncertainty: risks, unexpected events, and deviations. These notions and their link to dynamic environments are reviewed in the following section.

1.2 Dynamic Environments and Uncertainty

1.2.1 Dynamic Environments

Organizations do not live in a vacuum. They are surrounded by an environment that Fitzroy and Hulbert (2004) classified into three levels:

- The remote environment refers to the broad social/technical/economic environment in which the firms compete. The remote environment level is the most global and affects the largest number of organizations simultaneously. This environment is typically slow moving and is characterized by trends such as population growth, population aging, and cultural trends.
- The industry environment (sometimes called meso-system [Floricel & Ibanescu, 2008)]) includes any factor affecting all competitors in a specific industry. This includes entry barriers, specific market regulations, common resources, and technologies used to trade or produce the products or services.
- The competitive environment covers the relationships with direct or indirect competitors and collaborators (such as suppliers and partners), the channels of distribution and the customers themselves.

The notion that organizations have to face changing environments is not new and is now commonly accepted especially in sectors dealing with new technologies. The concept was already identified, at least 50 years ago, when proponents of the structural contingency theory (Burns & Stalker, 1961; Lawrence & Lorsch, 1967) theorized that the rate of environmental change and the level of uncertainty affected organizations. Their initial research focused on the impact on structures and management techniques while subsequent authors broadened the impact of the changing environments to the decision process (Child, 1972; Grandori, 1984; Howell, Windahl, & Seidel, 2010). However, the environment and the boundaries between the organization and the environment are not always easy to identify and Duncan (1972) prefers to redefine the environment as "the totality of physical and social factors that are taken directly into consideration in the decision-making behavior of individuals in the organization" (p. 314).

The term *dynamic* is taken to mean *characterised by constant change*. Collyer and Warren (2009) considered the dynamism of the environment as a nondichotomic dimension that applies in varying degrees to all projects. Any given project is neither "dynamic" nor "not dynamic" but evolves in an environment with different rates of change. "In the project management context, dynamism is taken to be a dimension of a project that represents the extent to which a project is influenced by changes in the environment in which it is conducted" (p. 355). Extremes (i.e., very dynamic or very stable environments) are easy to identify. For example, an environment could be considered stable if it remains the same over a period of months or years, or if changes are readily predictable. Today, some organizations have evolved from considering changes as rare, episodic and risky (punctuated equilibrium) to being frequent, relentless, and even endemic (Brown & Eisenhardt, 1997).

According to Lauer (1981), the temporal pattern of any social phenomenon can be characterized by one of these elements: periodicity (i.e., various rhythms of

social life), tempo (i.e., rates or frequencies of activities), timing or synchronization (involving the adjustment of various social units and processes with each other), duration (measured or perceived) and sequence (when activities must be executed in a certain order). In a special issue of the *Academy of Management Review* devoted entirely to time, Ancona, Okhuysen, and Perlow (2001) proposed five conceptions of time that are useful in assessing and classifying how different activities are conceived and implemented:

> **Linear (or clock time):** Depicts the continuum as linear—infinitely divisible into objective, quantifiable units such that the units are homogeneous, uniform, regular, precise, deterministic, and measurable.
> **Cyclical:** Events repeat over and over. Farmers are used to the cyclical patterns of days and seasons.
> **Unpredictable event time:** A reference point used to indicate an irregularity. For example, an earthquake can be used as a reference point for things that happened before or after.
> **Predictable event time:** This is related to the previous notion but is based on predictable events such as Passover or Easter.
> **Life cycle:** This is time conceived as a sequence of phases in a predictable pattern (for example, childhood followed by adolescence followed by adulthood).

Another aspect is that the rate of change is not always continuous. While Fitzroy and Hulbert (2004) distinguished two types of change: incremental and revolutionary, Floricel and Ibanescu (2008) classified the environmental change patterns into four groups: *velocity, turbulence, growth,* and *instability.*

These elements might be useful to assess how organizations react to different types of changes in the environment. For example, if organizations have to control certain activities based on events from the environment, it must determine the frequency at which this must be performed. Should they monitor continuously or wait for events to occur? This decision might be influenced by the time it takes (duration) to react and the sequence of activities. All these might have to be synchronized with cyclical patterns such as annual budgets or cyclical market patterns.

Different conceptions of time are therefore present in the way PPM processes are described. It can be observed that project managers typically conceive time as linear (with specific start and end dates). The PMI PPM process depicted in Figure 1-2, also conceives time as linear but allows feedback loops based on events (changes in strategy and project performance). This is one example of the conception of unpredictable event time. On the other hand, OGC uses a cyclical conception of time in their model.

Daft and Armstrong (2009) and Duncan (1972) showed that, although a dynamic environment is not the only source of uncertainty, changes in the environment combined with high complexity always lead to increased uncertainty. This has led to a very extensive literature which is reviewed in the following sections. This includes a discussion on the terminology, which includes: risks, risk management, changes, deviations, unexpected events, uncertainty, and uncertainty management.

1.2.2 Risks and Risk Management

Risks

Risk management has been one of the core knowledge areas in project management for many decades. Literature abounds in this field (Chapman & Ward, 1997; Jaafari, 2001; Kendrick, 2009; Persson, Mathiassen, Boeg, Madsen, & Steinson, 2009; Project Management Institute, 2009; Raz, Shenhar, & Dvir, 2002) and most general books on project management include at least a section on risk management (Andersen, 2008; Dinsmore & Cabanis-Brewin, 2006; Gray & Larson, 2008; Kerzner, 2006; Nicholas, 2004).

Risk management is also covered in the *PMBOK® Guide* (Project Management Institute, 2008a), which defines a *project risk* as an uncertain event or condition that, if it occurs, has a positive or negative effect on a portfolio objective (p. 127).

PMI uses the same definition for *portfolio risks* in which case the effects would be on the portfolio rather than the project objective: an uncertain event, set of events or conditions that, if they occur, have one or more effects, either positive or negative on at least one strategic business objective of the portfolio (Project Management Institute, 2008b, p.139).

The APM has a similar definition of *project risk event*: an uncertain event or set of circumstances that, should it or they occur would have an effect on the achievement of one or more of the project objectives (Association for Project Management, 2006, p. 156).

Both PMI and APM define a risk as an uncertain *event* which might have positive effects (opportunities) or negative effects (threats) although project managers and the literature in general tend to focus on threats rather than on opportunities. A number of techniques have been developed to assess the probability of occurrence and the potential impacts to projects. A typical classification of risks is based on the level of knowledge about the possibility for the risk to take place (known or unknown) and the level of knowledge about the impact (known or unknown). This leads to four possibilities (Cleden, 2009, p. 13):

> **Known-Knowns (Knowledge):** Refers to project data, predictable future states, and verifiable evidence. This is what we know that we know.
> **Unknown-Knowns (Untapped knowledge):** Includes untapped resources or unshared skills and information. This is sometimes called "reinventing the wheel" if we don't know that we know and miss opportunities to benefit from existing knowledge.
> **Known-Unknowns (Risks):** These are identified risks which we know might occur but without knowing when they will occur or what their impact will be. A possible delay of a piece of equipment is an example of something that we know we don't know.
> **Unknown-Unknowns: (Unfathomable uncertainty):** Covers all the events that are impossible to predict or that we are unaware of. This includes gap in the knowledge, hidden knowledge, unpredictable events and all the events that we don't even know that we don't know.

In addition to the known-unknown classification, Kendrick (2009) proposed to distinguish between *controllable known* risks and *uncontrollable known* risks. It is possible for a project team to deal with causes of *controllable* risks. For *uncontrollable* risks, it is not possible to deal with the causes, but techniques, such as contingency plans, have been developed to deal with their effects once they occur (for example, replacement strategy in the case of the loss of key project members).

Risk Management

Processes have been developed to deal with risks, mainly in the category of the *known-unknowns*. Risk management includes the different techniques to either reduce the probability of occurrence of an event or reduce its impact on the project (or inversely for positive risks). This can be seen in the definitions provided by PMI and APM:

> Project risk management includes the processes of conducting risk management planning, identification, analysis, response planning, and monitoring and control on a project. The objectives of project risk management are to increase the probability and impact of positive events, and decrease the probability and impact of negative events in the project. (Project Management Institute, 2008a, p. 273)

> Project risk management is a structured process that allows individual risk events and overall project risk to be understood and managed proactively, optimizing project success by minimizing threats and maximizing opportunities. (Association for Project Management, 2006, p. 26)

The risk management processes include activities to identify, assess, plan a response, and implement a response. It mainly uses proactive management actions although it might involve reactive action in the case of uncontrollable unknowns or in cases when risks become reality (Pavlak, 2004; Power, 2007).

Once risks have been identified through brainstorming techniques or expert judgment, they are typically assessed using a probability and impact assessment to determine the overall potential impact on the project (Association for Project Management, 2006; Project Management Institute, 2008a). The risk management response planning techniques include these:

- **Risk avoidance:** The project plan can be changed in order to avoid a given risk entirely. The focus is then on reducing its probability of occurring or its impact to null. This can be done by changing strategy, clarifying scope, and seeking specific expertise, reducing the number of critical paths, increasing lead-time, etc.
- **Risk mitigation:** Implies the reduction of the probability and/or the impact of the project risk under an acceptable threshold. The techniques include improved communication, stronger sponsor support, and special attention to specific activities.
- **Risk transfer:** Requires the shift of ownership of the risk impact to a third party. When the impact of risk is primarily financial, it is sometimes possible to use *insurance* thus protecting the project for a fee. An alternative is to subcontract certain *risky* activities to a third party.
- **Risk acceptance:** Used when it is too costly or impossible to avoid, mitigate or transfer the risk. The consequence might be that the sponsor stops a project if unwilling to accept the risk. Alternatively, contingency plans might be prepared in the event that the risk might occur (i.e., dealing with the effect rather than the cause).

PMI does not mention risk management in the first version of *The Standard for Portfolio Management* (2006), but it includes the following subprocesses in the second edition (2008b):

- identify portfolio risks;
- analyze portfolio risks;

- develop portfolio risk responses; and
- monitor and control portfolio risks.

The techniques proposed to analyze and develop risk responses at project portfolio level are similar to the techniques identified in the *PMBOK® Guide* (Project Management Institute, 2008a) for single projects (i.e., avoidance, mitigation, transfer, and acceptance). Additional risk management processes, at project portfolio level, have also been explored by Olsson (2008).

1.2.3 Changes, Deviations, and Unexpected Events

Instead of studying risks, some authors studied the different types of changes and deviations affecting projects and the techniques used to handle them once they occur. For example, Hällgren and Maaninen-Olsson (2005, 2009) distinguished between risks, deviations, and changes based on the type of management action (i.e., proactive or reactive) and their impact. A *risk* is a known, yet unrealized situation. *Changes*, sometimes called *variances*, refer to "realized situations with a significant divergence to the project plan. In contrast to risks, changes are not addressed in advance (Nicholas, 2004, p. 341), meaning that changes are managed when a situation has materialized, being reactive in nature" (Hällgren & Maaninen-Olsson, 2005, p. 18).

A *deviation* is defined as "a situation, regardless of consequence-positive or negative, large or small, that deviates from any plan in the project" (Hällgren & Maaninen-Olsson, 2005, p. 18). Changes and deviations are both identified in relation to a plan. While *changes* focus on major project plans, *deviations* might be related to any level and any portion of the plans including operational day-to-day plans. *Changes* are *deviations* but not all *deviations* are due to *changes*.

Söderholm (2008) investigated the term unexpected events. He identifies three categories of *unexpected events* appearing in projects: reopenings caused by stakeholders redefining some of the project parameters, revisions to plan to improve its accuracy and adapt to events, and finally daily fine-tuning (i.e., adapting the day-to-day work to changing environments). These three categories are based on level of impact and how they are dealt with. *Unexpected events* include both *deviations* and *changes*.

Unexpected events can have minor or major impacts and might be caused by internal or external sources. *Unexpected events* are also studied in the context of high-resilience organizations by Weick and Sutcliffe (2007) in which they suggested different techniques to ensure that organizations are still highly reliable when *unexpected events* occur. According to these authors, *unexpected events* can take three forms:

- An event that was expected to happen fails to occur;
- An event that was not supposed to happen does happen; and
- An event that was simply unthought-of happens (pp. 27–29).

There are different rules used to determine which tactics to use depending on the type of unexpected events, changes, or deviations. In a project context, Geraldi, Lee-Kelley, and Kutsch (2010) studied how project respond to unexpected events and compare such reactions in successful and unsuccessful projects. Steffens, Martinsuo, and Artto (2007) studied the change management system, the criteria for change decisions, and the way of making change decisions.

They observe differences in the treatment of operational and strategic changes to projects. The results report multiple parallel change management approaches depending on the business context maturity, type of change, and the IT system used. Based on observations of how project managers handle deviations, Hällgren and Maaninen-Olsson (2005) found four types of tactics to address them based on the knowledge need (exploitative or explorative) and previous experience with the type of deviation.

1.2.4 Uncertainty Management versus Risk Management

The term *risk* is defined as an *event* rather than being associated to more general sources of uncertainty. In projects undertaken in rapidly changing environments where uncertainty may be unavoidable, "managers need to go beyond traditional risk management; adopting roles and techniques oriented less toward planning and more toward flexibility and learning" (De Meyer, Loch, & Pich, 2002, p. 61). Some authors have therefore advocated starting using the broader concept of *uncertainty management* instead of *risk management* (Cleden, 2009; Perminova, Gustafsson, & Wikström, 2007, 2008; Ward & Chapman, 2003). "Uncertainty management is not just about managing perceived threats, opportunities and their implications. . . . It implies exploring and understanding the origins of project uncertainty before seeking to manage it, with no preconceptions about what is desirable or undesirable" (Ward & Chapman, 2003, pp. 98–99).

Ward and Chapman (2003) bring attention to some important areas of uncertainty related to projects:

- variability associated with estimates of project parameters;
- uncertainty about the basis of estimates of project parameters;
- uncertainty in the process and logistics;
- uncertainty about objectives and priorities; and
- uncertainty about fundamental relationships between project parties.

An *uncertainty management* perspective draws attention to the need to understand and manage variability in organizational activities that have impacts on a number of projects. This perspective highlights the need to put in place different approaches and techniques to address some aspects of project related uncertainty outside individual project contexts.

The concept of *uncertainty* facing organizations is not recent and has frequently been studied in organization theory, psychology, and economics. The term *environmental uncertainty* has been used both as a descriptor of the state of organizational environments and as a descriptor of the state of a person who perceives himself/herself to be lacking critical information about the environment. Scott (1998) provided an example of the first type of definition of *environment uncertainty* as follows

> The variability of the items or elements upon which work is performed or to the extent to which it is possible to predict their behavior in advance. Specific measures of *uncertainty* include uniformity or variability of inputs, the number of exceptions encountered in the work process, and the number of major product changes (p. 233).

or in the project context:

> The uncertainty of projects is the degree of precision with which the variation in outcome, resources, and work processes of projects can be forecasted (Dahlgren & Söderlund, 2010, p.16).
>
> Project uncertainty is the variation of items or elements upon which work is performed and the unpredictable behavior of people. Some measures of uncertainty are based on variability of inputs, the number of exceptions encountered in the work process, and the number of major product changes experienced. [. . .] Risk is actually a measure of uncertainty (Danilovic & Sandkull, 2005, p.195).

An example of the second type of definition is

> the individual's inability to assign probabilities to events . . . ; the inability to predict accurately what the outcomes of a decision might be (Duncan, 1972, p. 317)

The first type of definition implies that it is possible to characterize environments in terms of how objectively uncertain they are; the second type implies that environmental uncertainty ought to be studied as a perceptual phenomenon (Milliken, 1987).

Lawrence (1981) tried to characterize uncertainty as a combination of unpredictability (which in turn is a combination of instability and ignorance of data) and complexity (a combination of a number of variables and interdependence of variables). The combination of uncertainty and complexity is also used to characterize projects into typologies to assess different project management tools and techniques (Olausson & Berggren, 2010; Sicotte & Bourgault, 2008; Windischhofer, Perminova, & Gustafsson, 2009).

Leifer et al. (2000) suggested that the sources of project uncertainties can generally be classified under the following four broad categories:

- **Technical uncertainties** includes issues related to the completeness and correctness of the underlying scientific knowledge, the technical specifications of the product, manufacturing, maintainability, and so forth.
- **Market uncertainties** include issues related to customer needs and wants—either existing or latent forms of interactions between the customer and the product, methods of sales and distributions, the relationship to competitors' products, and so forth.
- **Organizational uncertainties** refer to the capabilities required from the project team, their relationship with the rest of the organization, the level of support from management.
- **Financial uncertainties** include access to funding for the projects including partnerships.

Instead of focusing on the sources of uncertainties (technical issues, market, people, cost, schedule and quality) or their potential impact, De Meyer, Loch, and Pich (2002) and Loch, De Meyer, and Pich (2006) proposed a typology of uncertainty as it relates to project-management techniques (see Appendix B). They propose the following typology:

- **Variation:** It comes from many small influences and yields a range of values on a particular activity. Project managers can still plan a complete project based on the

sequence of tasks but the duration estimates might vary. Scheduling techniques such as PERT and Monte Carlo are used to plan for variations.

- **Foreseen uncertainties:** These are identifiable and understood influences. This is analogous to risks, which can be identified and might lead to contingent actions.
- **Unforeseen uncertainties:** This is analogous to the unknown-unknowns. However, "it can also arise from the unanticipated interaction of many events each of which might, in principle, be foreseeable" (p. 62).
- **Chaos:** "Whereas projects subject to unforeseen uncertainty start out with reasonably stable assumptions and goals, projects subject to chaos do not. Even the basic structure of the project plan is uncertain, as is the case when technology is in upheaval or when research, not development, is the main goal. Often the project ends up with final results that are completely different from the project's original intent" (p. 62).

1.2.5 Managing Uncertainty in Project Portfolios

Dynamic environments lead to *uncertainty* which make it difficult (and often impossible) for project managers and portfolio managers to plan projects very far in advance with a high degree of precision. The scope of this research covers what is put in place to prepare for *foreseen uncertainty* and investigates how organizations manage their portfolios when *unforeseen uncertainties* do occur.

The Standard for Portfolio Management (Project Management Institute, 2008b) mentions that, in projects, the project manager tries to keep change to a minimum while the "portfolio manager continually monitors changes in the broad environment" (p. 6). Although PMI has introduced the notions of risk management in the recent version of the standard, there is little additional guidance or empirical evidence on how portfolio managers should handle uncertainty and changes affecting their project portfolio. The PPM literature makes little mention of potential disturbances to the portfolio, which might impact the successful implementation of the portfolio during or between portfolio planning cycles. Ad hoc disturbances to the ongoing and approved project portfolios are almost completely neglected.

This can probably be explained by the fact that the topic of PPM is young and that researchers and academics preferred to focus on more pressing issues in this area. This oversight is not because the topic lacks interest because for many firms, the environment is unstable and the high level of uncertainty due to dynamic environments leads to a number of challenges to organizations. These challenges are reviewed in the next section. In these firms, managers are looking for tools and techniques to help them manage their portfolio knowing that the environment is continuously changing.

1.3 PPM Challenges in Dynamic Environments

Organizations having to manage project portfolios in dynamic environments not only have to face a higher level of uncertainty when planning their individual projects but must also

deal with a number of additional organizational challenges, which are presented in this section. This includes:

- changing and uncertain goals;
- detailed planning and continuous replanning; balancing decision quality against decision speed;
- imaginary precision—poor quality of information;
- race to resolve project unknowns;
- resource reallocation and redistribution; and
- managing the stream of new projects to the portfolio.

1.3.1 Changing and Uncertain Goals

The portfolio management literature stresses the importance of setting a clear vision and goal followed by a clear strategy. In dynamic environments, the portfolio goals might have to be revisited on a regular basis. These changing goals must then be translated down into updated project goals within the portfolio.

However, goals might be influenced by external forces out of the project's control (Collyer & Warren, 2009). For example, in dynamic environments customers might also be operating in an environment of uncertainty and change, their requirements might also change rapidly. In converging industries (for example, internet, cable TV, and mobile telephony using similar services), it might not even be clear who the customers are.

1.3.2 Detailed Planning and Continuous Re-planning

Many planning techniques, based on high levels of details, have been developed within the different project management bodies of knowledge. However, the amount of change during the lifetime of projects makes detailed plans difficult to maintain at least for a period far into the future. This is a challenge to projects for which planning becomes more difficult. In a project portfolio, this challenge is aggravated especially if there is a large amount of dependency between projects. In the time it takes to update plans, additional changes occur, a challenge that Collyer and Warren (2009) summarized it as follows:

> Analysis and decision-making had to be conducted more rapidly than the emergence of new changes. Plans with excessive detail were found to be misleading and abandoned in favour of a higher level or rolling wave approach. Even in the static environment, there could be too many unknowns at the start to be resolved by the deadline, so the rapid introduction of new unknowns in the dynamic environment was doubly challenging . . . High levels of details in a plan may in fact discourage adjustments to a changing environment. (pp. 357–358)

1.3.3 Balancing Decision Quality Against Decision Speed

Projects conducted in highly uncertain environments must balance decision quality against decision speed (Gray & Larson, 2008). Eisenhardt (1989b) investigated this particular issue in the high-velocity environment of the personal computer industry. She found that high performers were the fast decision makers. However, some of her conclusions challenged traditional

views of strategic decision-making: fast decision-makers used more information not less than slow decision makers did; they considered more alternatives and developed more sophisticated advice processes. Consequently, organizations have to put in place elaborate information collecting and processing systems to support their decision processes. However, this high level of information is rarely reliable, which brings another challenge: poor quality of information.

1.3.4 Imaginary Precision—Poor Quality of Information

PPM models require precision in the information to a degree that far exceeds the ability of the organization to produce it. Cooper et al. (2001) "saw this time and again: portfolio task forces designing and trying to implement very exotic portfolio methods, only to be thwarted by the very poor quality of the data inputs" (p. 191).

Elonen and Artto (2002, 2003) identified the "information overflow and lacking quality of information" among the key challenges facing IT project portfolio managers. Regardless of the level of sophistication of the portfolio selection and decision tools, the decision-making process will be as good as the quality of the information. This is particularly challenging in the front-end activities where projects and product outcomes have to be defined and integrated with the ongoing project activities (Khurana & Rosenthal, 1997).

1.3.5 Race to Resolve Project Unknowns

The planning technique called *progressive elaboration* is mostly applicable when the levels of change are fairly low. However, rapid changes in the environment increase unknowns, Collyer and Warren (2009) summarizes this as follows:

> The challenge is to conduct exploration at a greater rate than the emergence of environmental change. . . . The effort to resolve unknowns at the start of the project is severely challenged by the introduction of additional unknowns along the way, because what is learned can become obsolete in less time than it takes to learn. Materials, methods and goals are always moving, making projects more akin to stacking worms than stacking bricks. (p. 356)

1.3.6 Resource Reallocation and Redistribution

In the PPM context, the word *resource* is taken in its broad sense as "skilled human resources [. . .], equipment, services, supplies, commodities, material, budgets or funds" (Project Management Institute, 2008a, p. 446). The optimal allocation of resources to maximize value corresponds to goal 1 of PPM (see section 1.1.5). However, this can rarely be done completely at the time of deciding the composition of the project portfolio. Firms reallocate resources over time as indicated by the feedback loop from the portfolio performance analysis to the balancing process in the PMI flow. The literature abounds with anecdotes of enterprises facing a project demand much higher than their resource availability.

For example, Cooper et al. (2001) suggested:

> Too many projects and not enough resources is the number one challenge. Pipeline gridlocks plague many business portfolios. A lack of resources (and related problems of resource allocation) is likely the most serious problem that firms face in implementing effective portfolio management. (p. 185)

Resource balancing is mentioned as a critical challenge in many publications (Blichfeldt & Eskerod, 2008; Elonen & Artto, 2003; Kavadias, 2001) but only a few of them actually researched the problem directly. For example, based on a qualitative survey in two Swedish firms, Engwall and Jerbrant (2003) identified that the *resource allocation syndrome* might be one of the operational problems that is general to multi-project management. They suggest that the *resource allocation syndrome* might be "an effect of management accounting systems that are dysfunctional for multi-project management [. . .] and secondly an effect of opportunistic project management behaviour within the organization" (p. 408). They observed that the primary lever for portfolio management to affect an ongoing project in trouble is resource reallocation however:

> portfolio management was overwhelmed with issues concerning prioritization of projects and, distribution of personnel from one project to the other, and the search for slack resources. . . . when resources were redistributed it often produced negative effects on other projects of the portfolio. (p. 407)

This constant reallocation of resources was also observed by Cooper et al. (2001) who distinguished two very different philosophies: flexible reallocation to highest priority regardless of prior commitments versus fairly firm commitments. According to Cooper and Edgett (2003) and Seider (2006), the recommended solution to solving the resource allocation problem is the implementation of portfolio management which would provide greater visibility and focus of the resource capacity analysis and allocation. However, McCauley, Bundy, and Seidman (2002) claimed that the traditional methods to resolve the resource allocation problem (i.e., hiring additional personnel, using portfolio management to identify most important projects and to work on them, leveling of project plans by resource profiles) do not work in practice and propose instead an alternative technique called *resource bottleneck analysis*. This technique is based on the analysis of the flow and bottlenecks in the project stream, a method reminiscent of Ford's assembly line analysis.

1.3.7 Managing the Stream of New Projects to the Portfolio

The introduction of a new project can be a very significant change to portfolios that might have multiple consequences including the previously mentioned reallocation of resources. Dye and Pennypacker (1999) compare the entry of new ideas into the portfolio to a *stream of projects*. Githens (2002) refers to *pipeline management* when it comes to the process by which individual ideas are developed into workable projects.

Anavi-Isakow and Golany (2003) proposed new project control mechanisms that limit the number of active projects in multi-project environments. They suggest that incoming projects should first enter a backlog list and be staggered into a network of interrelated resources. The proposed mechanisms adapt the concept of constant work-in-process that was used earlier in the context of production management.

In dynamic environments, requests to add a new project to the portfolio might occur at any time. As is mentioned in section 1.1.5, Goal 5 of PPM is the evaluation of new opportunities against the current portfolio and the stage at which projects should enter the PPM process. The link to the process evaluating new product opportunities is considered by

Cooper et al. (2001) as one of the key unresolved issues. However, this connection to the process leading to project set-up is excluded from the *PMBOK® Guide* (Project Management Institute, 2008a), *The Standard for Portfolio Management* (Project Management Institute, 2008b), and *The Standard for Program Management* (Project Management Institute, 2008c). It is unclear from these three documents what is supposed to happen when a new project request occurs between portfolio planning cycles.

1.3.8 Summary

Organizations managing project portfolios face a number of challenges that are summarized in this section. This includes uncertain goals, continuous replanning, continuous reallocation of resources, and managing the stream of new projects. Because of these challenges, project portfolios must put in place tools and processes to assist them. The objective of the research question is to investigate those mechanisms.

It is understood that such mechanisms might not be applicable to all environments. Some distinction must be made between the needs of organizations' very turbulent environments and those operating in more stable environments. Such concerns have been investigated for many years in the *structural contingency theory* covered in the following section.

1.4 PPM Processes Contingent on Environment

1.4.1 Early Foundations

Early theories of organizations attempted to identify the *one best way*. In opposition to this widespread idea, Burns and Stalker (1961) published a qualitative study of the electronics industry in England and Scotland where they found that some organizations had different management systems depending on their environment. This idea became the basis for the *structural contingency theory*. They suggest that

> A *mechanistic* management system is appropriate to stable conditions. It is characterized by the specialized differentiation of functional tasks . . . hierarchic structure of control, authority, and communication . . . a tendency for interaction between members of the concern to be vertical
>
> The *organic* form is appropriate to changing conditions, which give rise constantly to fresh problems and unforeseen requirements for action . . . and is characterized by: the contributive nature of special knowledge and experience to the common task of the concern . . . a network structure of control, authority, and communication . . . a lateral rather than vertical direction of communication through the organization (Burns & Stalker, 1961).

In parallel, Woodward (1965) conducted a comparative survey study of one hundred manufacturing organizations. She examined their organizational structures and found them to be unrelated to the size of organizations but more to the type of manufacturing activities. She focused mainly on the production systems involved in the organization and distinguished three main types of production process: unit and small batch, large batch and mass, and process (e.g., oil refinery).

These two studies established the main concepts of the *structural contingency theory,* which introduced the notion of fit where *contingency* is defined as "any variable that moderates the effect of an organizational characteristic on organizational performance" (Donaldson, 2001).

Lawrence and Lorsch, first used the term *contingency theory* in their book "Organization and Environment" (1967). They theorized that the rate of environmental change affected the differentiation and integration of organizations where:

> *Differentiation* refers concretely to differences between departments in goal orientation, time orientations, formality of structures, and interpersonal orientations. *Differentiation* between departments arises because departments differ in their task. Task certainty is related to formality of structure. Moreover, performance was higher where greater task uncertainty was associated with less structural formality and with less centralization. (pp. 30–38)
>
> *Integration* is achieved by using integrative devices, with higher levels of integration being achieved by the more sophisticated devices, which in order of increasing sophistication are: hierarchy, rules, integrating individuals, and integrating departments. (p. 138)

Further publications identified a number of contingency variables to be correlated to structure and management models. The most important conclusions are that: different management techniques must be used depending on environmental variables, that there is no one best way, and that organizations and management techniques vary according to contingencies.

While the supporters of the *structural contingency theory* advocated for the adaptation of the organizations according to external parameters, Hannan and Freeman (1977) confirmed that organizations facing uncertain environments put in place different mechanisms to react and be flexible. If they do not adapt, they tend to disappear.

1.4.2 Empirical Evidence of Different PPM Methods Under High Uncertainty

Some researchers applied the contingency theory concepts in their research on PPM; for example, the assertion that no single PPM method is appropriate for all situations and that organizations need to customize their process to suit their environment is reinforced by findings throughout the empirical literature dedicated to PPM (Floricel & Miller, 2003; Killen et al., 2007b).

Dahlgren and Söderlund (2002, 2010) researched the project portfolio control mechanisms in four Swedish enterprises and found that different types of firms have different control mechanisms depending on the level of uncertainty and the level of dependencies between projects. Based on initial findings from a qualitative investigation in four firms (Saab Aerospace Future Products, Ericsson BSC, Ericsson SRF, and Telia Mobile) and using a model which had been developed by Thompson (1967). Depending on the level of uncertainty and the level of dependencies between projects, they propose four types of control mechanisms:

- routine-based control,
- resource-based control,
- planning-based control, and
- program-based control.

They found that, in contexts with high uncertainty, plans can no longer be relied upon as the main control mechanism since plans require a certain level of stability. If projects are rather independent from each other, controlling at portfolio level is based on the control of autonomous projects, each with a high degree of uncertainty. *Resource-based control* is centered on the choice of the project managers (plus delegation of authority) and the allocation of resources to projects. When dependencies are high and uncertainty great, some means of coordinating these dependencies must be found in addition to the resource-based controls. Progress meetings are arranged on a frequent basis to solve dependencies and detect coordination errors in the project portfolio.

Bengtsson, Müllern, Söderholm, and Wåhlin (2007) studied coordination mechanisms (instead of the control mechanisms studied by Dahlgren and Söderlund) in relation to the activity context (complex or simple) and the ambiguity of the tasks (clear or ambiguous). Although more sophisticated, Bengtsson et al.'s findings contained many similarities with those of Dahlgren and Söderlund.

Danilovic (2002) and Danilovic and Sandkull (2005) also studied the relationship between uncertainty and dependencies in multiple project situations. They claim that the sources of uncertainty in new product development are the organizational settings, the product architecture, and the project management. In a similar study of 29 Internet software development projects MacCormack and Verganti (2003) also found that projects carried out in different environments are likely to require quite different development processes if they are to be successful. "Stated more formally, a contingent view implies that the performance impact of different development practices is likely to be mediated by the context in which those practices operate" (p. 217).

Blomquist and Müller (2006) found that there is a relationship between an organization's environment and its governance style especially in complex environments. The governance structure and rules put in place by organizations to manage their project portfolios and their projects vary greatly between organizations. High performing organizations show more flexibility in adapting their governance to the requirements of their environment. A more recent study by Müller, Martinsuo, and Blomquist (2008) showed the relationship of the project portfolio control techniques and portfolio management performance in different contexts.

1.4.3 Consequences for PPM in Dynamic Environments

The standards on PPM that have emerged in recent years tend to propose a *one best way* regardless of the type of environment. Standards attempt to support most portfolios, most of the time. However, according to the *contingency theory* enterprises tend to get better results and performance if they adapt their procedures to the characteristics of their environment. New ideas and new projects must be included all the time in existing portfolios; resources must be constantly reallocated due to constant re-planning of projects; the amount of information required is higher although its quality might be poorer.

Even though there appears to be clear indications that organizations try to identify different approaches to manage project portfolios in dynamic environments, there has been little research to assess what they are. The focus of the present research is to document some

of the approaches that are used by organizations managing project portfolios in dynamic environments. The ambition is not to identify new contingency variables or to demonstrate that specific approaches under given contingencies lead to higher performance. The level of dynamism was used instead to specify the specific type of firms that would be investigated in this research.

1.5 Different Project Management Approaches for Dynamic Environments

Section 1.3 summarizes the challenges that organizations face when confronted with dynamic environments. When managing their project portfolios, organizations facing higher levels of uncertainty tend to put in place specific mechanisms not always present in static environments (Buganza, Dell'Era, & Verganti, 2009). At portfolio level, organizations might try to implement the same tools and techniques that are used to manage single projects in dynamic environments.

Collyer and Warren (2009) surveyed the literature to identify approaches that might be used to deal with dynamic environments. This classification was used to study the project management approaches in rapidly changing environments (Collyer, Warren, Hemsley, & Stevens, 2010). The classification that they propose is used to structure this section:

1. Environment manipulation: making dynamic static
2. Emergent planning approaches
3. Scope control
4. Controlled experimentation—probing the future
5. Life cycle strategies
6. Management coordination and control
7. Soft approaches

Two additional mechanisms are added:

8. Planned flexibility: Flexibility in product and in process (from the project management literature)
9. Boundary-spanning activities (from organization theory literature).

1.5.1 Environment Manipulation: Making Dynamic Static

The simplest approach to deal with the challenges of a dynamic environment is to attempt to make it more static by resisting change. This could be achieved by rejecting change requests, delaying adoption of new technologies and processes, and extending the life of existing systems. These approaches have very severe limitations in highly dynamic environments and competitive markets. Collyer and Warren (2009) summarized these limitations as follows:

- lost opportunity and productivity through delayed implementation of new approaches, materials or business objectives, that provide significant benefits, despite the challenges;
- reduced business competitiveness, especially when competing organizations offer, or make use of, new systems which are often more effective; and
- reduced business compatibility when an organization falls too far behind best practice.

1.5.2 Emergent Planning Approaches

Section 1.3.2, identifies some of the challenges encountered with established project planning techniques when activities cannot be planned in detail very far into the future. In contrast with *management by planning,* commonly proposed in the project management literature, Lewis, Welsh, Dehler, and Green (2002) describe an *emergent planning* style sometimes called *progressive elaboration* (Project Management Institute, 2008a) or *adaptive project framework* (Wysocki, 2007) where planning is developed in greater detail as the project progresses throughout the project life cycle.

Turner and Cochrane (1993) categorized projects according to two parameters: how well defined the goals are, and how well defined the methods of achieving them are. This leads to four types of projects. Payne and Turner (1999) found that for projects with unknown goals and unknown methods, planning should be based on:

- milestone plans and project responsibility chart, where the milestones represent completion of the life cycle stages; and
- lower level activities being planned on a rolling wave basis.

According to Laufer (1997), traditional project planning focuses on reducing the project content (i.e., "what") first and then determine the means by which the project deliverables will be reached thus reducing the uncertainty around the "how". However, he suggests that, in dynamic environments, these two levels of uncertainty would instead be reduced gradually and simultaneously.

Another common planning approach to deal with risks and uncertainty is called *contingency planning* where *flexible* actions are predetermined and then are either triggered by signals or used up as slack in the budget or in the schedule.

1.5.3 Scope Control

The notion of change management in the management of single projects is thoroughly studied and documented (Nicholas, 2004). Its initial focus has been on scope change control but more recent publications have started to look at other types of changes. Generally, changes to projects must be controlled and their impacts minimized with change control boards.

Projects are rarely executed exactly according to the initial plan and the project organization gains efficiency by controlling and ultimately minimizing changes to the projects. One of the reasons that the project management discipline focuses on the control of changes is based on empirical studies showing that changes can negatively impact project costs, delay, and ultimately project failures regardless of the quality of the project plans (Construction Industry Institute, 1995, 2004; Dvir & Lechler, 2004; Midler, 1995; Williams, Eden, Ackermann, & Tait, 1995). The software product development literature also covers change management as a component to improve efficiency (McGrath, 1996, 2004; White, 2006).

PMI (2008a) has therefore included a section called *perform integrated change control* in the *PMBOK® Guide* under the knowledge area *project integration management*. It is defined as "identifying, documenting, approving or rejecting, and controlling changes to the project baselines" (p. 420). Changes to projects typically either affect the scope (in which case the configuration management process might be triggered) or goal changes (for which

the steering process might be involved). The Association for Project Management (APM) also includes change control in their body of knowledge. They focus on the impacts of baselined scope, time, cost, and quality objectives and address the process to handle them professionally in the project.

Construction Industry Institute (2004) proposed a number of principles of effective change management, for example: to promote a balanced change culture, to recognize change, to evaluate change, to implement change and to continuously improve from lessons learned. These principles translate into different good practices depending on the phase of the project. This goes beyond simple change control and attempts to implement some form of flexibility and allowance for changes. Change management in single projects focuses on the control of scope change through different forms of configuration management techniques such as change control boards. Construction Industry Institute includes four additional types of change: organizational changes, changes in work execution methods, changes in control methods, and changes in contracts and risk allocation. This classification draws attention to the fact that sources of change are not only external to the organization but also internal (i.e., methods, organizational structure).

In dynamic environments, changes are not only unavoidable but may be required for successful results best suited to the receiver's needs. This has led to the study of different mechanisms to monitor, coordinate, and control projects in dynamic environments in order to gain flexibility, while maintaining efficiency.

1.5.4 Monitoring and Control Mechanisms of Projects

Monitoring and control are typical processes encountered in project management. "*Project monitoring* is the gathering of information to determine the current state and progress of the project in relation to its expected state and progress" (McBride, 2008, p.2386). McBride classified the monitoring mechanisms into four groupings:

> **Automatic monitoring:** Information that can be gathered automatically from software development or project management tools and systems.
> **Formal monitoring:** Information that is gathered through a formal administrative system.
> **Ad hoc monitoring**: Information gathered through irregular enquiry such as audits and reviews.
> **Informal monitoring**: Information gathered informally through conversations or their equivalent (p. 2387).

Project control is often used in combination with *project monitoring* and is a well-documented practice in project management. It is defined, by PMI (2008a), as "comparing actual performance with planned performance, analyzing variances, assessing trends to effect process improvements, evaluating possible alternatives, and recommending appropriate corrective action as needed" (p. 422). Control mechanisms in the face of changes in external environment are primarily studied using the principles of *cybernetics* derived from system theory (Ashby, 1956; Beer, 1959; Kuhn, 1986; Wiener, 1948). In *cybernetics*, the feedback loops are most often negative (in the case of a thermostat, this would correspond

to turning off the heating system if the temperature is too high) but might be positive (this is called an explosion or run-away system) or might include shutdown processes (i.e., terminating the process completely).

Collyer and Warren (2009) distinguished between three levels of control: input control (based on recruitment, training, and induction), process control (based on plans, procedures, and check-lists), and output control (based on rewards and recognition).

Mélèse (1979), used his systems modular analysis, distinguishes between the *search for equilibrium, adaptation, evolution* and *safeguard*[3]:

> The search for equilibrium describes the short-term regulation mechanisms put in place to reduce the detrimental oscillations. This includes the use of targets and control loops. These can be based on real-time values or trends.
>
> The adaptation corresponds to the responses to specific variables from the environment.
>
> The evolution corresponds to the expected nature of the internal or external context. The mechanisms would include anticipation and feed-forward loops.
>
> Finally, the safeguards are mechanisms put in place to protect the organization from certain dangers. These would include sensors connected to diagnostics, alerts, and other safeguards.

Regulating mechanisms can include what is sometimes called *second-order controls* or *double-loop learning* (Argyris, 1976, 1977). The goals themselves can be modified based on information collected. This distinction between first-order and second-order controls in the multi-project context is summarized, as follows, by Dinsmore and Cooke-Davies (2006b):

> The basic philosophy underlying this first-order control is to be clear about goals—which tend to be set in concrete—and to take whatever action is necessary to meet them. Multi-project management, by contrast, requires a more sophisticated control system involving second-order control. In this system, the goals themselves may be adjusted in light of changing external circumstances and in view of mutating internal perceptions of what is possible or desirable to be achieved. (pp. 46–47)

1.5.5 Buffering and Boundary-Spanning Activities

Organizations are connected to, and interact with their environments and as such can be conceived as *open systems* (Beishon, 1972, p. 18) "capable of self-maintenance on the basis of throughput of resources from the environment" (Scott, 1998, p. 89). Since the *open-system* is defined as a system in interaction with its environment, the boundaries around the system must be determined. However, the position of this boundary is somewhat arbitrary and can be difficult to delineate exactly, especially in socio-technical systems.

[3]Mélèse uses the French terms: *analyse modulaire des systèmes*, *sauvegarde*, *évolution*, *adaptation* and *équilibration*.

Katz and Kahn (1969) used the notion of *interface* (defined as the area of contact between one system and another) to understand the boundary relationships:

> A primary role of management is serving as a linking pin or boundary agent between the various subsystems to ensure integration and cooperation. Furthermore, an important managerial function is that of serving as boundary agent between the organization and environmental systems. (p. 50)

Within organizations, certain members will be more closely involved and linked to the environments than others and certain roles related to these boundary-spanning functions might be defined (Aldrich, 1979; Daft & Armstrong, 2009). Thompson (1967) used the notion of domain to determine the points at which the organization is dependent on external events. Organizations would try to place a buffer between the external environment and the technical core (i.e., the key activities for the organization) and seek to place their boundaries around those activities that, if left to the task environment, would be crucial contingencies. They would try to smooth out the transactions, anticipate, and adapt.

While striving for rationality, complex organizations are faced with the impossible task to acknowledge and analyze all options in the optimal manner. Thompson (1967) summarized this contradiction as follows: "We will conceive of complex organizations as open systems, hence indeterminate and faced with uncertainty, but at the same time as subject to criteria of rationality and hence needing determinateness and certainty" (p. 10).

To face this uncertainty, Thompson suggests that organizations striving under norms of rationality, might take a number of actions to buffer their core technologies from environmental influences, to smooth out input and output transactions, and to anticipate and adapt to environmental changes, which cannot be buffered or leveled.

1.5.6 Life Cycle Strategies

The early product development life cycles were based on the *waterfall* model. This is based on consecutive (and sometimes slightly overlapping) phases such as concept, analysis, design, build and test, deploy and operations. This model is based on the construction industry and was implemented in many software development methodologies. It relies heavily on the planning and control mechanisms of each phase (White, 2006). In the *waterfall* model, a large amount of time is spent planning upfront with the intention of reducing risk and increasing delivery precision. However, it can actually increase the risk of failure because of the time it takes to get results while the project scope requirements evolve.

A good way to reveal unknowns as they occur is the *rolling wave* approach where the plan for each phase is completed at the end of the preceding phase. This is also known as a *spiral* (Boehm, 1988), *iterative* approach (Hughes & Chafin, 1996) and *incremental* approach. Depending on the frequency of the iterations, feedback can be obtained more rapidly than in the *waterfall* model.

The advent of the agile methodology pushes this concept even further. It is proposed for the development of software in rapidly changing and uncertain markets where early scope freeze is detrimental to project success (Bhattacharya, Krishnan, & Mahajan, 1998). The ideas from agile methodology have drastically challenged the more traditional development

life cycles (David & Strang, 2006; Fernandez & Fernandez, 2008; Smith, 2007; S. Thomke & Reinertsen, 1998). The main principles have been documented into a manifesto (Fowler & Highsmith, 2001) and can be summarized as follows:

- deliver working software frequently, preferably using a shorter timescale ranging from a couple of weeks to a couple of months;
- use feedback as the primary control mechanism rather than planning. The feedback is driven by regular tests and releases of the evolving product;
- proceed first with components least subject to change;
- welcome changing requirements, even late in development; and
- focus on communication more than on processes.

1.5.7 Flexibility in Process and in Product

The project management community is faced with the dual need for stability and flexibility. According to Andersen (2008), on one hand firms seek *stability* because the costs of changing are too high while, on the other hand, they require *flexibility* in order to adapt to the world outside, seek opportunities, and beat the competition. Thomke and Reinertsen (1998) claimed that development flexibility provides a powerful alternative to accurate forecasting and is a good method for reducing development risk. Thomke (1997) suggests that projects using flexible design technologies outperform projects using inflexible technologies by a factor of 2.2 (in person-months). High flexibility enables designers to tolerate high levels of risk, whereas low flexibility results in significantly higher resource investments that are aimed at minimizing the risk of design changes. However, Pagell and Krause (2004) did not corroborate this finding and find no support for the proposition that firms that respond to increased uncertainty with increased flexibility will experience increased performance.

Bettis and Hitt (1995) distinguished between *robustness* which is the potential for success under varying future circumstances or scenarios and the flexibility provided by the *strategic response capability* which incorporates the abilities to rapidly sense change in the environment, conceptualize a response to that change and reconfigure resources to execute response. The flexibility provided by the *sensing-seizing-reconfiguring* approach is further discussed in the section 1.6, on dynamic capabilities. The distinction between *robustness* and *flexibility* is employed in the project management context by Floricel and Miller (2001) who find high project performance requires strategic systems that are both robust with respect to anticipated risks and governable in the face of disruptive events.

Olsson (2006) studied the management of *flexibility* in project management, which he defined as "the capability to adjust the project to prospective consequences of uncertain circumstances within the context of the project" (p. 67). Olsson saw *flexibility* as a way of making irreversible decisions more reversible or postponing irreversible decisions until more information is available. He distinguished two broad categories of approach to build flexibility into projects: *flexibility in the process* (e.g., late locking, successive commitments, contingency planning) and *flexibility in the products* (e.g., ability to meet alternative demands with the same product). A further distinction can also be made between internal and external project flexibility where internal project flexibility relates to flexibility within a defined scope

(i.e., how requirements are to be met) and external project flexibility refers to the adjustments in the project scope (i.e., what requirements are to be met) (Olsson, 2008).

Verganti (1999) studied more specifically the *flexibility in the process* in an empirical study of 18 Italian and Swedish firms. He presents mechanisms called *planned flexibility* based on a balance of reactive and anticipation capabilities, each of these capabilities being most efficient at different phases of the project.

These conflicting needs for efficiency and flexibility are also very present at the project portfolio level and this raises two questions. Are the tools and techniques employed for single projects in the face of uncertainty directly applicable at the portfolio level? Is it sufficient to develop *planned flexibility* at the project level only or should there also be some *planned flexibility* put in place at the portfolio level? According to Raynor and Leroux (2004), this could indeed be achieved through project selection not only focusing on the traditional rank-ordering heuristics but using scenario planning to prepare for the unpredictable future.

1.5.8 Controlled Experimentation—Probing the Future

A common approach in the management of innovation and of research initiatives is the use of experimentation and selection processes. In some cases, this might mean pursuing different solutions for the same problem and retaining the best outcome.

This approach, called *selectionism*, was employed by NASA, in the 1960s, for the development of the lunar module and is employed by car manufacturers to develop prototypes (Pich, Loch, & Meyer, 2002). A perpetual portfolio of initiatives can test ideas and resources can quickly be reassigned to the most promising projects.

Rather than balancing between the rigidity of planning and the chaos of reacting, Brown and Eisenhardt (1997) observed that successful organizations facing constant change use a variety of future probing techniques. This includes four specific tactics:

- **Experimental products:** Creating prototypes in order to get early customer feedback before the product is completed.
- **Futurists:** Creating possible future scenarios trying to envisage how the future might look (instead of betting the future products on a single future scenario).
- **Strategic partnerships:** Using alliances with key customers or suppliers to get leading edge views in specific areas.
- **Frequent meetings:** Involving different departments and brainstorming sessions to think about the future.

1.5.9 Time-Based Pacing

Brown and Eisenhardt (1997) and Eisenhardt and Brown (1998) studied new product development in fast-paced industries. They found that successful enterprises often used what they call *time-based* pacing. In comparison to the more common *event-based* pacing, which is based on the outcome of specific events regardless of the exact date (e.g., delivery of a new micro-chip), *time-based* pacing is based on predictable time intervals between successive projects. New generations of products are planned at fixed intervals (e.g., one per year). This becomes the main driver over and above cost and content. This might have

impacts on the way project portfolios are managed. If projects are delayed, organizations might prefer to maintain the date at the expense of removing content or additional cost. What is most important is to determine the right rhythm that suits both the organization's ability to deliver and the customer willingness to buy these products or services. "For most companies, getting in step with the market means moving faster. Sometimes however, finding the right rhythm means slowing down" (Eisenhardt & Brown, 1998, p. 65).

1.5.10 Using the Project Management Techniques at PPM Level

At portfolio level, organizations might try to implement the same tools and techniques that are used to manage single projects in dynamic environments. The techniques and approaches presented in this section provide a good starting point to study and investigate similar techniques used when project portfolios are managed. It is not clear that all these approaches are applicable to portfolios or whether new approaches are developed to support this level.

The topic of organizations having to cope with uncertain environments has been studied from many points of view in the organization theory and strategy literatures. The following chapter presents two theories which have been developed in these two management literature traditions and which could be used as theoretical frameworks for this research: Weick's (1969, 1979) interpretation system view and Teece's (2007, 2009) dynamic capabilities' framework.

1.6 Dynamic Capabilities

The field of strategy theory has generated a vast number of publications addressing one of the most fundamental question in this field: "How do firms achieve and sustain competitive advantage?" (Rumelt, Schendel, & Teece, 1994). This includes the perspective of how organizations gain a strategic advantage through adaptation to fast changing environments (Eisenhardt, 1989b; Teece, Pisano, & Shuen, 1997).

The early strategic models from the 1960s were based on the SWOT (strengths-weaknesses-opportunities-threats) analysis. This framework suggests that "firms obtain sustained competitive advantages by implementing strategies that exploit their internal strengths, through responding to environmental opportunities, while neutralizing external threats and avoiding internal weaknesses" (Barney, 1991, p. 99).

During the 1980s, the dominant strategic paradigm was Porter's competitive forces approach. Porter (1980) defined five forces that determine the competitive intensity and therefore attractiveness of a market (defined by its profitability) assuming that an industry in which competition is fierce will drive down overall profitability. This theory focuses on the environment at the industry level. Porter's five forces model includes the *threat of substitute products* (i.e., the propensity of customers to switch to alternatives), the *threat of new entrants* (with the notion of *barriers to entry*), the *intensity of competitive rivalry*, the *bargaining power of customers*, and the *bargaining power of suppliers*. Porter's model focuses on factors outside the firms. However, some authors take the perspective that advantages could be gained not only by deterring entry and price controls (like Porter is suggesting) or by tactical manoeuvring (as proposed by Shapiro [1989]), but

rather by improving internal efficiency to lower cost, and/or to improve product quality and performance.

Wernerfelt (1984, 1995) studied the firms from the resource perspective, the so-called resource-based view (RBV). He treats the unique resources developed by firms as a form of entry barrier and defined *resources* as follows:

> Anything which could be thought of as a strength or weakness of a given firm. More formally, a firm's resources at a given time could be defined as those (tangible and intangible) assets that are tied semi-permanently to the firm. . . . Examples of resources are brand names, in-house knowledge of technology, employment of skilled personnel, trade contacts, machinery, efficient procedures, capital, etc. (p. 172)

Barney (1991, 1996, 2001) observed that the RBV is based on two basic assumptions: strategic resources are heterogeneously distributed across firms and resources are not perfectly mobile across firms. Barney further characterizes the firm resources in terms of their *sustained competitive advantage* (i.e., advantages that other firms are unable to duplicate) as value, rareness, imperfect imitability, and substitutability.

The RBV is criticized by Priem and Butler (2001) mainly for the fact that RBV tends to be all inclusive (i.e., anything can become a strategic asset) and that the theory does not propose *how* to achieve a competitive advantage out of resources. They also observe that merely possessing rare or valuable resource does not guarantee the development of competitive advantages or the creation of value.

Leonard-Barton (1992) studied *core capabilities* in the context of product development projects. She observes that *core capabilities* also have the drawback of inhibiting innovation (i.e., *core rigidities*), paving the way for the more recent theory of dynamic capabilities discussed in the next section.

1.6.1 Dynamic Capabilities

Following the criticisms and the limitations of the RBV in environments of rapid technological change, Teece et al. (1997) published their seminal article where they define dynamic capabilities as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (p. 516). This expression emphasizes two main aspects: the capacity to renew competence in the face of changing business environments, and the key role of strategic management in adapting, integrating, and *reconfiguring* internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment. Teece et al. argued that the competitive advantage of firms is based on *organizational processes* shaped by *asset position* and the *paths* available to it where the term *organizational process* refers to: coordination/integration, learning, reconfiguration, and transformation processes. The *asset position* refers to the resources typically covered by RBV: technological assets, innovation capabilities, financial assets, reputational assets, structural assets, institutional assets, and market assets. *Path dependencies* add the idea that the possible paths a firm can take are dependent on its history. The history is sometimes hard if not impossible to imitate by competitors. For example, technological opportunities depend on knowledge and competence already built by the firms.

However, this definition does not address the questions of what constitutes such abilities, what their attributes are, and how they can be recognized (Arend & Bromiley, 2010). In 2009, a special issue of the *British Journal of Management* was published on dynamic capabilities. According to the editors of the issue, most of the debates have focused on two critical issues. The first concerns the nature of dynamic capabilities and the definition of the term; the second concerns their effects and consequences (Easterby-Smith, Lyles, & Peteraf, 2009). The slowness to converge on a common definition might be because scholars come from different research traditions and have viewed dynamic capabilities with different perspectives. This has brought about countless debates in the literature.

Teece et al.'s definition was criticized for being vague and tautological. Helfat (2007) points out that a direct association between competitive advantage and dynamic capabilities is tautological, in the same way that it is for the resource-based view. In other words, defining dynamic capabilities as those capabilities that distinguished a posteriori high performing firms from low performing firms does not help to identify and define them. They argued that whether dynamic capabilities contribute to competitive advantage depends on the same sort of factors identified for the resource-based view.

For the last 10 years, authors have proposed improved definitions (see Appendix C for a comparison of a number of definitions) and this area of strategic management is still emerging.[4] The most recent definition proposed by Teece (2009) is adopted in this research because it allows a clear distinction between the different processes:

> Dynamic capabilities refer to the particular (nonimitability) capacity business enterprises possess to shape, reshape, configure, and reconfigure assets so as to respond to changing technologies and markets and escape the zero-profit condition. Dynamic capabilities relate to the enterprise's ability to sense, seize, and adapt in order to generate and exploit internal and external enterprise-specific competences, and to address the enterprise's changing environment. (pp. 87–88)

Despite a lack of consensus in the literature concerning the definition of dynamic capabilities, some common themes emerge:

- to define and describe what are *capabilities;*
- to assess what makes them *dynamic;*
- to find how they relate to changing environments; and
- to identify what firms have to do to develop those capabilities.

The first three themes are explored in the following sections.

1.6.2 Capabilities

In order to understand the concept of dynamic capabilities, the term *capabilities* must first be reviewed and defined. In most definitions, *capabilities* refer to routines. For example, Collis (1994) defined organizational capabilities as "the socially complex routines that determine

[4]See, for example, (Di Stefano, Peteraf, & Verona, 2009, 2010) for an extensive literature analysis and (Ambrosini & Bowman, 2009) for a review of the definitions and concepts.

the efficiency with which firms physically transform inputs into outputs" (p. 145). In a similar vein, Winter (2003) defined an organizational capability as "a high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type." Amit and Shoemaker (1993) defined *capabilities* as "a firm's capacity to deploy resources, using organizational processes, to effect a desired end. They are information-based, tangible, or intangible processes that are firm specific and are developed over time through complex interactions among the firm's resources" (p. 35). Other definitions assume that *capabilities* are not related to specific resources or competences (sometimes referred to as assets) but are collective and socially embedded and relate to the way complex problems are solved over time (Dosi, Nelson, & Winter, 2000; Schreyögg & Kliesch-Eberl, 2007). Examples of *capabilities* include product development processes, strategic decision making, and alliance and acquisition routines (Eisenhardt & Martin, 2000).

Capabilities have sometimes been categorized as substantive capabilities, absorptive capabilities, adaptive capabilities, and innovative capabilities. Each of these categories is discussed in more details in the following subsections.

Substantive Capabilities

Substantive capabilities refer to the ability to perform the basic functional activities of a firm. They are what Schreyögg and Kliesch-Eberl (2007) called the "patterned and replicable activities oriented toward specific tasks," and Winter (2003), "the organization's ability to produce a desired output."

The paradox of substantive capabilities (sometimes called operating or core capabilities) is that to qualify as capabilities a certain amount of routinization is required (Dosi et al., 2000). Firms want to develop and maintain substantive capabilities to produce outputs with the highest efficiency and effectiveness possible. This is achieved through routines that are path-dependent and involve some form of commitment through investment by the firms. At the same time, due to structural inertia, these routines might become maladapted to the environment and might have a tendency to persist despite external threats (Becker, 2004; Schreyögg & Kliesch-Eberl, 2007). This dilemma is summarized as follows:

> On one side, they have to develop reliable patterns of selecting and linking resources in order to attain superior performance and competitive advantages and on the other side this endeavour constitutes—at least in volatile markets—a considerable risk of becoming locked into exactly these capabilities (Schreyögg & Kliesch-Eberl, 2007, p. 919).

Teece (2007, 2009) conceives the concept of dynamic capabilities as the ability to respond to this dilemma by adapting, integrating, and reconfiguring clusters of resources to match the requirements of a changing environment. He added the term *dynamic* to refer to the renewal mechanisms involved to adapt to continuously changing business environments. In practice, this involves changing the routines of the enterprise.

> Routines help sustain continuity until there is a shift in the environment. Changing routines is costly, so change will not be (and should not be) embraced instantaneously. Departure from routines will lead to heightened anxiety within the organization, unless the culture is shaped to accept high levels of internal change. (Teece, 2009, p. 34)

Adaptive Capabilities

Chakravarthy (1982) distinguishes between the state of *adaptation* (i.e., the state in which a firm can survive the conditions of its environment) and the *adaptive capability* defined as a firm's process to identify and capitalize on emerging market opportunities. Accordingly, adaptation describes an end state while adaptive capability focuses on the process of continuous learning and adjustment.

Adaptive capabilities are also sometimes associated with the effective balancing between exploration and exploitation strategies (Staber & Sydow, 2002; Wang & Ahmed, 2007). This balance, called ambidexterity, has led to a large number of publications and is defined as the ability of a firm to adapt over time and to simultaneously explore and exploit (Benner & Tushman, 2003; O'Reilly, Harreld, & Tushman, 2009; O'Reilly & Tushman, 2004, 2008).

Miles and Snow (1978) propose four types of organizational adaptation: defenders, prospectors, analyzers, and reactors. According to their model, adaptive cycles link the entrepreneurial problem (choice of product-market domain), the engineering problem (choice of technologies for production and distribution), and the administrative problem (rationalization of structure and process).

Absorptive Capacities

The term *absorptive capacities* was coined by Cohen and Levinthal (1989, 1990) who found that it was critical for the innovative firms to recognize the value of new, external information, assimilate it, and apply it to commercial ends. This capacity to acquire and incorporate knowledge was observed both at individual and organizational levels and was found to be dependent on prior acquired knowledge.

Zahra and George (2002) described the *absorptive capacity* as the processes by which firms acquire, assimilate, transform, and exploit knowledge. The *acquisition* refers to the ability to identify external knowledge that would be useful to the enterprise's operations. The *assimilation* includes the routines and processes to translate and interpret the acquired knowledge to make it useable to the firm. These routines can sometimes be *transformed* to make them compatible with the existing routines. This might involve the combination of multiple sets of knowledge that must be combined and developed into a new type of knowledge. Finally, the transformed knowledge must be *exploited* in new routines.

Easterby-Smith, Graça, Antonacopoulou, and Ferdinand (2008) used the concept of *absorptive capacity* in a qualitative study of three cases and found demonstrates the need for further development of a process approach and the potential value of conducting more longitudinal qualitative studies to understand the inner processes of absorptive capacity. They also found that absorptive capacity theory needs to take conscious note of boundaries, which are difficult to define and can evolve significantly over time.

Some attempts were made to equate the knowledge exploration, retention, and exploitation of absorptive capacities to dynamic capabilities (Lichtenthaler & Lichtenthaler, 2009). This direct connection between dynamic capabilities and knowledge management has brought some confusion in the concepts that are discussed further in section 2.3.

Innovative Capabilities

Wang and Ahmed (2007) include *innovative capabilities* as a common feature of dynamic capabilities. It refers to a firm's "ability to develop new products and/or markets, through aligning strategic innovative orientation with innovative behaviours and processes" (p. 38). While *absorptive capacities* refer to the identification and integration of external knowledge, the innovative capacity describes the possibility to develop the knowledge (and capability) internally.

Higher Order (Meta) Capabilities

Section 1.5.4 reviews some of the monitoring and control mechanisms of projects. It is mentioned that regulating mechanisms can include *second-order controls*. Collis (1994) and Winter (2003) applied this idea to organizational capabilities and claim that dynamic capabilities govern the rate of change of ordinary capabilities. If this is the case then, a first-order capability includes skills at performing a particular task (i.e., the basic functional activities of the firm (or *substantive capability* as defined above). A second-order (or meta-capability) is defined as the competence to build new first-order competences or to improve the activities of the firm. The third-order capability would include improvements to the second-order capabilities. It would be possible to conceive innovations "to innovate the innovation that innovates the innovation that innovates . . . and so on *ad infinitum*" (Collis, 1994, p. 148). Collis's higher-order capabilities can be considered dynamic capabilities. They relate to the modification and the creation and extension of the resource base. Third- and fourth-order capabilities (or meta-capabilities) are related to the learning-to-learn capabilities.

In a similar vein, Schreyögg and Kliesch-Eberl (2007) proposed a separate management activity and the concept of capability monitoring as "a dual-process model of capability dynamization." Danneels (2008) also used the idea of second-order competence to study how firms explore new markets and new technologies in order to develop new competences which could be added to their resource-base. Zahra, Sapienza, and Davidson (2006) use similar topologies to study the key differences in the dynamic capabilities between new ventures and established companies. Ambrosini, Bowman, and Collier (2009) also propose a hierarchy of capabilities with different typologies of dynamic capabilities (incremental, renewing, and regenerative capabilities) depending on the perceived environmental state (stable, dynamic, or hyper).

1.6.3 What Is Dynamic in Dynamic Capabilities?

Various authors offer different interpretations of the term *dynamic* in the expression dynamic capabilities. Some authors refer to the environmental dynamism. This is probably not in the spirit of the definition of dynamic capabilities. Although, dynamic capabilities are commonly found in dynamic environments it can also be observed in other types of environments. For example, Eisenhardt and Martin (2000) found that in moderately dynamic markets emphasis is on variation and the more traditional incremental continuous improvements while in high-velocity markets the dynamization approaches are more radical but also more experiential and improvisational.

Dynamic can also relate to the capabilities themselves, i.e., they are capabilities that are dynamic, capabilities that change themselves over time. Stoelhorst and Liu (2009) mentioned that definitions of dynamic capabilities seem to have evolved from a concern with the environment as the main sources of dynamics to a concern with higher order

capabilities and managerial action. The *dynamism* relates to how the resource base is changed in a dynamic environment by the use of dynamic capabilities. *Dynamic* refers to change in the resource base, to the renewal or reallocation of resources. Put differently, it means that the dynamism consists in the interaction of the dynamic capability and resource base, allowing the modification of this resource base.

1.6.4 Dynamic Capabilities as a Framework

In this research, Teece's framework (2007, 2009) is used to structure the micro-foundations of the dynamic capabilities used when managing project portfolios under high levels of uncertainty (see a more detailed description of the conceptual framework in Chapter 2). Teece (2007, 2009) proposes a dynamic capabilities framework that identifies classes of relevant variables and their interrelationships. Figure 1-3 shows these capabilities and their relationships to a number of micro-foundations (i.e., distinct skills, processes, procedures, organizational structures, decision rules, and disciplines). It is made of three main capabilities:

- to *sense* and shape opportunities and threats;
- to *seize* opportunities; and
- to maintain competitiveness through enhancing, combining, protecting, and when necessary, *reconfiguring* the business enterprise's intangible and tangible assets.

According to Teece (2009), *sensing* might include, but is not limited to the following:

- to identify target market segment, changing customer needs;
- to tap into in exogenous technology;
- to tap into innovation (from suppliers and complementors); and
- to direct internal R&D and select new technologies.

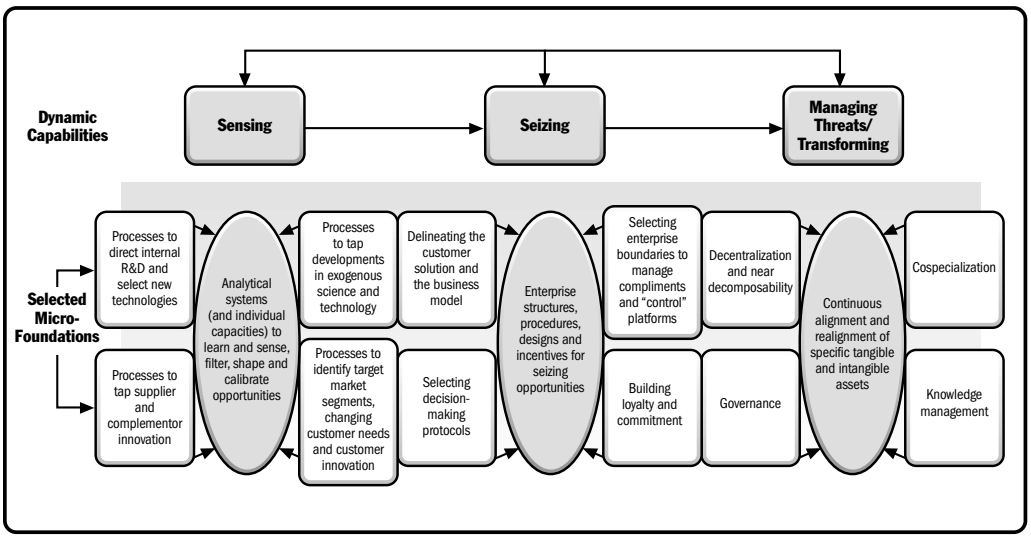

Figure 1-3. Foundations of Dynamic Capabilities and Business Performance

(Source: Teece, 2009, p. 49 - By permission of Oxford University Press)

Seizing is defined as the structures, procedures, designs, and incentives for identifying that changes are required once a new technological or market opportunity is sensed. This includes four micro-foundations:

- selecting the decision-making protocols;
- delineating the customer solution and the business model;
- selecting the enterprise boundaries to manage complements and control platforms; and
- building loyalty and commitment.

The third and last capability in Teece's framework is called *managing threats and transforming* and is defined as "the continuous alignment and realignment of specific tangible and intangible assets" (Teece, 2009, p. 49). In the face of changing environments, the enterprise might have to reconfigure and reassign existing capabilities and potentially develop new ones. The micro-foundations in this capability include:

- **Decentralization and near decomposability:** adopting loosely coupled structures, embracing open innovation, developing integration and coordination skills.
- **Governance:** achieving incentive alignment, and minimizing agency issues.
- **Cospecialization:** managing strategic fit so that asset combinations are value enhancing.
- **Knowledge management:** learning, knowledge transfer, achieving know-how and intellectual property protection.

As is discussed in this chapter, the recent publications on dynamic capabilities theory argue that it is no longer sufficient to develop unique resources or capabilities (as initially proposed in the RBV) to gain a strategic advantage but that these resources and capabilities must be constantly reallocated and re-optimized to adapt to changing environments. This is precisely what the management of project portfolios in dynamic environments is about. Even though the concept of dynamic capabilities has been prevalent in the strategic management literature for at least 10 years, only a few such capabilities have been investigated empirically and unfortunately there are very few descriptions of *how* firms can implement and maintain dynamic capabilities in practice. The study of dynamic capabilities in a multi-project context should therefore contribute additional empirical evidences. A conceptual framework based on dynamic capability is described in the next chapter.

1.7 Concluding Remarks on Literature Review

The focus of PPM publications and research has been, up until now, to improve organizational performance by introducing practices to select and prioritize projects. Section 1.1 shows that there has been little research on the management of project portfolios once they have been decided upon. The purpose of the present research is to supplement the existing processes with additional empirical information and conceptualization to supplement them with information on how project portfolios are managed when there is a high level of uncertainty.

In the research question "*How is uncertainty affecting project portfolios managed in dynamic environments?*" the concept of uncertainty was preferred over other concepts

such as unexpected events, risks, or deviations, which are presented briefly in section 1.2. Dynamic environments lead to uncertainty that makes it difficult for portfolio managers to plan projects very far in advance with a high degree of precision. Mechanisms are put in place to manage *foreseen uncertainty* and to manage portfolios when *unforeseen uncertainties* occur.

For many firms, the environment is unstable and the high level of uncertainty due to dynamic environments leads to a number of challenges to organizations, which are summarized in section 1.3. The focus of the present research is to document some of the approaches that are used by organizations to alleviate those challenges when managing project portfolios in dynamic environments. Based on the contingency theory, described in section 1.4, the assumption of this research is that the management of project portfolio in highly dynamic environments will differ from the management in more static environments.

A number of techniques to manage uncertainty at project level are summarized in section 1.5. These techniques are presented assuming that it is likely that similar techniques are used when managing project portfolios. This provides a good starting point to evaluate if all these approaches are applicable to portfolios or whether new approaches are developed to support this level.

The topic of organizations having to cope with changing and uncertain environments has been studied from many points of view in the organization theory and strategy literatures. The concept of dynamic capabilities has been developed to conceptualize the strategic level of organizations. This theory is presented briefly in section 1.6 and is then used to produce a conceptual framework that is most appropriate to study the adaptation processes at operational levels. As is discussed in this chapter, the recent publications on dynamic capabilities theory argue that it is no longer sufficient to develop unique resources or capabilities to gain a strategic advantage but that these resources and capabilities must be constantly reallocated and reoptimized to adapt to changing environments. This is precisely what the management of project portfolios in dynamic environments is about. Even though the concept of dynamic capabilities has been prevalent in the strategic management literature for at least 10 years, only a few such capabilities have been investigated empirically and unfortunately, there are very few descriptions of *how* firms can implement and maintain dynamic capabilities in practice. The study of dynamic capabilities in a multi-project context should therefore contribute additional empirical evidences. A conceptual framework, based on dynamic capability, is described in the next chapter.

Chapter 2

Conceptual Framework

This chapter describes the conceptual framework that was used for this research. It is based primarily on Teece's dynamic capabilities, discussed in section 1.6.4, and it is composed of three main levels: organizational context, dynamic capabilities, and *organizing mechanisms*. It provides the basis for the research methodology described in Chapter 3. The dynamic capability level is further decomposed into three elements:

- **Sensing:** processes to sense, filter, and interpret events and uncertainty;
- **Seizing:** business model used, selection rules, and decision-making protocols; and
- **Transforming/Reconfiguring:** characterization of changes to project portfolios and of other changes with impacts on portfolio.

2.1 Organizational Context

The top part of the conceptual framework, the organizational context, is studied to provide background data to understand why the project portfolio is put in place and under which organizational constraints it must operate. It includes the following elements:

- **Environment**: The type of industry, the market, the competition, the legal aspects, the political aspects and how dynamic the environment is. This was used to assess and select the case studies to be investigated.
- **Strategy**: It is assumed that a strategy for the project portfolio is already decided. Attempts were made to understand the vision, the mission, and the strategy to assess how the uncertainty is managed.
- **Organizational structure:** This organizational structure was assessed to understand how the projects are structured. This included the functional organization, the utilization of external resources, and the alliances with external firms.
- **Constraints:** includes the financial budget for the project portfolio but also access to resources and schedule constraints.
- **Corporate governance:** includes the decision bodies at corporate level, directives, rules and guidelines to control the organization.
- **Project portfolio characteristics**: the structure of the project portfolio, the history of the portfolio, the characteristics of the projects, and the dependencies between the projects and toward the resources was assessed. Dahlgren and Söderlund (2010) suggested that the project portfolio coordination and control mechanisms depend on characteristics of the projects such as uncertainty and level of dependencies.

A number of project characteristics are therefore analyzed: (1) level of dependencies between subportfolios; (2) level of dependencies between projects; (3) level of dependencies with respect to resources; (4) coupling and autonomy of projects with respect to portfolios; (5) size of project in portfolios; (6) phase of each project in the portfolio; and (7) whether resources are internal or external.

2.2 *Organizing Mechanisms* as the Unit of Analysis

This research investigates the elements that constitutes *sensing – seizing - reconfiguring/ transforming*. The lowest elements, in Figure 2-1, are called micro-foundations, by Teece (2009) and include: distinct skills, processes, procedures, organizational structures, decision rules, and disciplines. Dawidson (2006) studied the *organizing mechanisms* for project portfolio management. She proposes a framework that classifies these *organizing mechanisms* in three areas:

- the *organizational processes*, i.e., how the portfolio management activities are organized;
- how the *tools and methods* are used; and
- the organizational structures, i.e., how the relevant organizational participants get involved.

Table 2-1 compares Teece's micro-foundations with Dawidson's *organizing mechanisms*. Organization processes, tools, and organization structures are common to both and are included in this research. *Skills* and *disciplines*, although included in Teece's

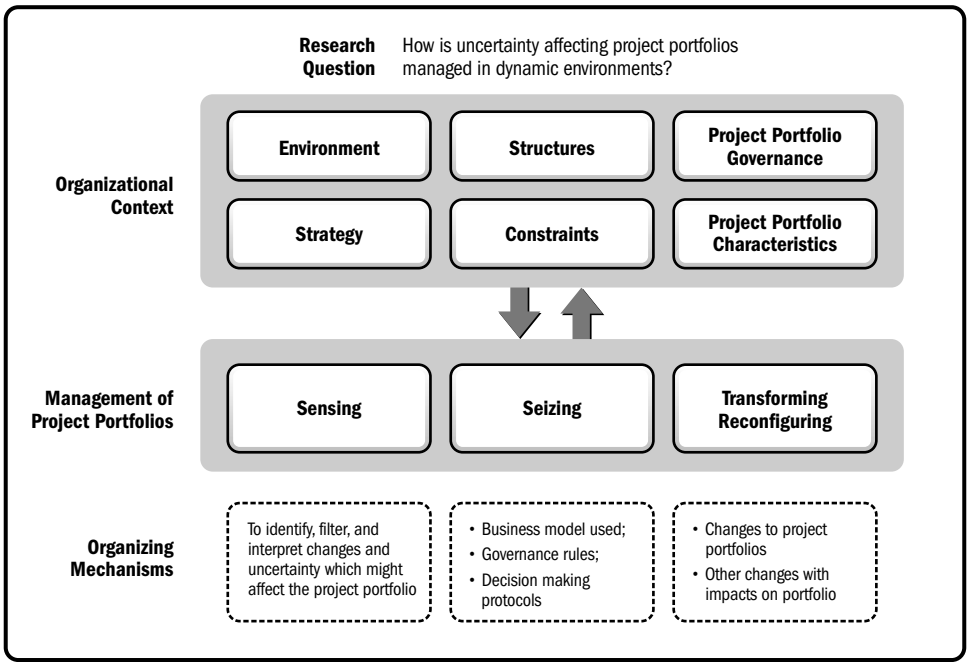

Figure 2-1. Graphical Representation of Conceptual Framework Used for Data Collection

Table 2-1. Specifying the Organizing Mechanisms Studied in this Research

Microfoundations (Teece, 2009)	Framework for the Study of Organizing (Dawidson, 2006)	Organizing Mechanisms Studied in this Research
Distinct Skills	–	Excluded
Processes	Organization Processes	Organizational Processes
Procedures	Tools and Methods	Tools
Organizational Structures	Organizational Structures	Organizational Structures
Decision Rules	–	Basis for PPM Decisions
Disciplines	–	Excluded

micro-foundations, are excluded from the scope of this research. However, the specific decision rules used for PPM, called basis for PPM decisions in this research, was included as part of the analysis.

The term *organizing mechanism* is the term that is selected to represent the lowest level of the framework. The term includes the following items:

- organizational processes;
- tools and methods;
- organizational structures; and
- basis for PPM decisions.

2.3 Distinguishing *Reconfiguring* and *Transforming*

During the data analysis phase, it became clear that the conceptual framework, presented in Chapter 2, had to be modified to better reflect the reality observed. It was therefore decided: to split and properly define the two concepts *reconfiguring* and *transforming* and to show different orders of dynamic capabilities being observed in the context of PPM.

The initial conceptual framework was composed of three main concepts: *sensing, seizing,* and *reconfiguring/transforming* as presented in Figure 2-1. This framework was used initially to analyze the mechanisms identified in documents and by interviewees. However, during the interview coding it became apparent that many of the mechanisms being classified under the category *reconfiguring/transforming* were addressing very different goals.

For example, the introduction of a new software process and the resource capability planning ended up in the *reconfiguring/transforming* group although both mechanisms appeared to be of a different nature. A second observation, during the data analysis, was the large number of newly introduced or newly modified processes or structures. Interviewees frequently had to ask if they had to describe the processes used in the previous year or the one being currently implemented. Such newly introduced mechanisms were marked and identified during the coding of the interviews.

During the data analysis, it became clear that the terms *reconfiguring* and *transforming* actually represent different concepts. The initial choice was based on the fact that Teece

(1997, 2007, 2009) uses these terms interchangeably. While the description and definitions of *sensing* and *seizing* are fairly clear in the literature, there seems to be a lot of divergence in the use of the third term (*reconfiguring* vs. *transforming*). This raises the question on the use of two terms. If they are meant to be synonym why use both terms. If they are meant to refer to different concepts, then it would be important to clarify their exact meaning and the differences between the two terms, especially when they are used as codes in data analysis.

In the two most cited articles on dynamic capabilities,[1] the word *reconfigure* is used in the definition of dynamic capabilities. For example, in the initial definition by Teece et al. (1997) dynamic capabilities was defined as the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments (Teece et al., 1997, p. 516). However, in more recent definitions, it was defined as follows:

> For analytical purposes, dynamic capabilities can be disaggregated into the capacity (1) to sense and shape opportunities and threats; (2) to seize opportunities; and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets. (Teece, 2007, p. 1339)

Eisenhardt and Martin (2000) also used the words *reconfigure* and *configurations* in their definition. They also specifically refer to resources:

> The firm's processes that use resources—specifically the processes to integrate, reconfigure, gain and release resources—to match or even create market change. The organizational and strategic routines by which firms achieve new resources configurations as market emerge, collide, split, evolve, and die. (p.1107)

However, in his publications, Teece often refers to a combination of terms such as in this citation:

> The ability to calibrate the requirements for change and to effectuate the necessary adjustments would appear to depend on the ability to scan the environment, to evaluate markets and competitors, and to quickly accomplish reconfiguration and transformation ahead of competition. (Teece & Pisano, 2003, p. 201)

Teece used both terms interchangeably. For example, in his book *Dynamic Capabilities and Strategic Management—Organizing for Innovation and Growth* (Teece, 2009), he uses predominantly the term *reconfigure* but occasionally uses the word *transform* as a synonym. As a case in point, the overall framework suggested by Teece uses the term *managing threats/transforming* (see Figure 1-4) while the whole chapter dedicated to its description refers to *managing threats* and *reconfiguration*.

Going back to the different definitions of dynamic capabilities proposed in the last 10 years and listed in Appendix C, it can be seen that some authors do not refer to the reconfiguration of resources but prefer to allude to the transformations of operating routines;

[1] Di Stefano, Peteraf, and Verona (2010) estimated that (Teece et al., 1997) was cited 1193 times and (Eisenhardt & Martin, 2000) was cited 470 times in management journals available in the Thomson-ISI Web of science database before 2008. These two articles on dynamic capabilities are therefore cited more often than all the other articles on this topic combined.

for example, "a dynamic capability is a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness" (Zollo & Winter, 2002, p. 340). More recently, it has been defined as "an organization's collective ability to create sustainable competitive advantage by developing, maintaining and renewing its capabilities through continuous learning by leveraging individual, organizational and environmental elements such as resources, skills, systems, structure and culture" (Bitar, 2004, p. 7).

This idea of treating dynamic capabilities as *routines to learn routines* was criticized by Eisenhardt and Martin (2000) as being "tautological, endlessly recursive, and nonoperational" (p. 1107). However, it is commonly used as one of the main themes in the dynamic capabilities literature and is still considered a useful concept in turbulent environments (Bitar, 2004; Winter, 2003; Zahra & George, 2002).

Transforming includes a number of concepts such as: (1) improving the *sensing-seizing-reconfiguring* mechanisms discussed previously, (2) the modification of the supporting environment (processes, routines, structure), and (3) knowledge management. Considering PPM as a dynamic capability, Killen (2008), Killen and Hunt (2010a, 2010b), and Killen, Hunt, and Kleinschmidt (2007a, 2008a, 2008b) focused primarily on the corporate learning and improvement process involved in PPM. This corresponds to the knowledge management component of the *transforming* processes. In addition, both the concept of organizational learning and *transforming* are also used by Bresnen (2009) to study project organizations in the construction industry and by Newey and Zahra (2009) to study PPM in the pharmaceutical industry.

In this research, the concept of reconfiguration is interpreted to represent the *organizing mechanisms* to modify project portfolios (e.g., launching new projects, merging projects, stopping projects, reassigning resources, and changing priorities) and to allocate resources. The terms *reconfiguring* and *transforming* are further defined in the next section, which describes the updated conceptual framework.

2.4 Updated Conceptual Framework

The proposed updated conceptual framework is presented in Figure 2-2 and is composed of two orders of capabilities, as suggested by (Collis, 1994) as discussed in section 1.6.2:

- A first order of capabilities, more operational, leading to the constant reconfiguration and realignment of resources based on sensed changes in the environments; and
- A second order leading to transformations, process improvements, and to changes in other organizational aspects impacting PPM.

2.4.1 Dynamic Capabilities Leading to Reconfiguring

The first-order dynamic capabilities deal with uncertainty for a given project portfolio and the definitions of *sensing* and *seizing* remain the same:

- *Sensing* is defined as *organizing mechanisms* to identify, filter, and interpret changes and uncertainty which might affect the project portfolio; and
- *Seizing* is defined as *organizing mechanisms* for deciding changes to the project portfolio once a potential need for change has been sensed.

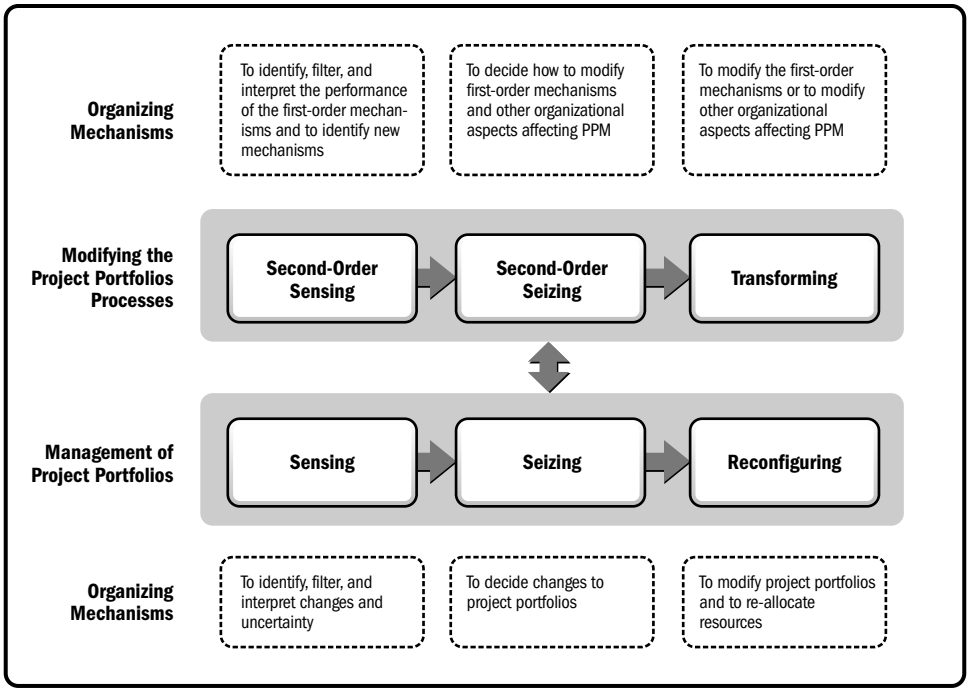

Figure 2-2. Graphical Representation of Conceptual Framework After Data Analysis

- *Reconfiguring* is defined as the *organizing mechanisms* to modify the project portfolio and to allocate human and financial resources within the portfolio. This includes *organizing mechanisms*:
  - to change the project portfolio structure, including any changes in the project configuration (new projects, new sub-portfolios, termination of projects) and project scope prioritization;
  - to modify the project scope and project interdependencies; and
  - to change the allocation of financial and human resources to the projects in the portfolio.

2.4.2 Dynamic Capabilities Leading to Transforming

The second-order dynamic capabilities also involve three groups of *organizing mechanisms*, in this case *second-order sensing,*[2] *second-order seizing,* and *transforming:*

- *Second-order sensing* is defined as the *organizing mechanisms* to identify, filter and interpret the performance of the first-order dynamic capability (in this case PPM) as well as the identification and development of new practices, tools, and methods (see Figure 2-3). While the focus of the *first-order sensing* is on external and internal

[2]Because the terms *sensing* and *seizing* were also used for this second level, the expressions *second-order sensing* and *second-order seizing* are introduced to avoid confusion with the processes of the first order leading to *reconfiguring*.

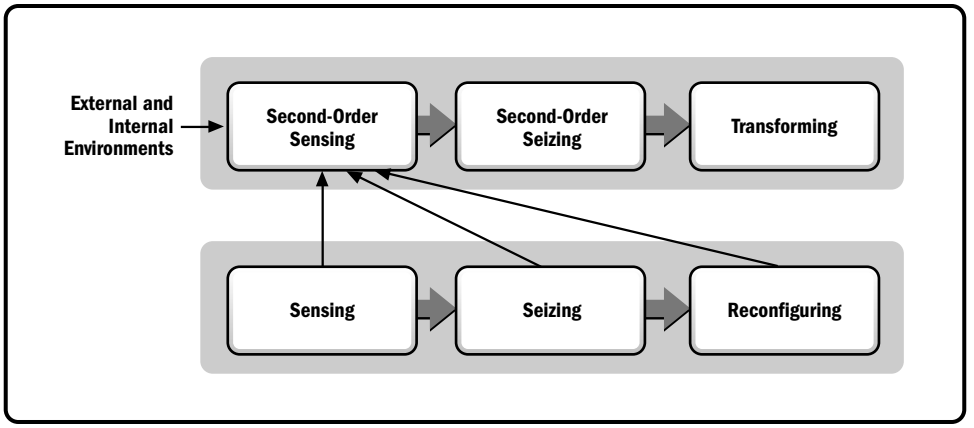

Figure 2-3. *Second-Order Sensing* and *Seizing* Leading to *Transforming*

conditions which might have a direct impact on the portfolio content (i.e., project scope, portfolio structure, resource allocation, and prioritization), the *second-order sensing* focuses on the ways of working, practices, and standards which might be identified and introduced in the organization, or developed internally.

- *Second-order seizing* is defined as the *organizing mechanisms* that are put in place to decide how to modify the first-order mechanisms and how to modify other organizational aspects affecting PPM. These changes might include, but are not limited to corrective actions, new routines, structures, and tools to improve the performance and to support PPM.
- *Transforming* is defined as the *organizing mechanisms* to modify the first-order mechanisms or to modify other organizational aspects affecting PPM. This includes
  - modifying the first-order *sensing-seizing-reconfiguring* mechanisms used in PPM (for example changing the governance structure, modifying the rules to structure the project portfolio used for reconfiguring, adding a new sensing mechanism), as shown in Figure 2-4; and
  - introducing new structures, processes, or tools to support the PPM activities. This might not directly result in changes in the first-order *sensing-seizing-reconfiguring* mechanisms (e.g., modifications to the software development process and new architecture to support a more flexible product structure).

2.4.3 Higher-Order Capabilities

It should not be forgotten, that there exists a third order of dynamic capability related to the portfolio selection itself, as displayed in Figure 2-5. This strategic order of dynamic capability corresponds to what is most often depicted in the literature on dynamic capabilities. Budgets and human resources are allocated to project portfolios based on vision, mission, and strategies. Changes in external environments have direct consequences on these decisions.

This research studies a number of portfolios that have been established for a number of years and for which a budget, a vision, and a mission have been approved. The process

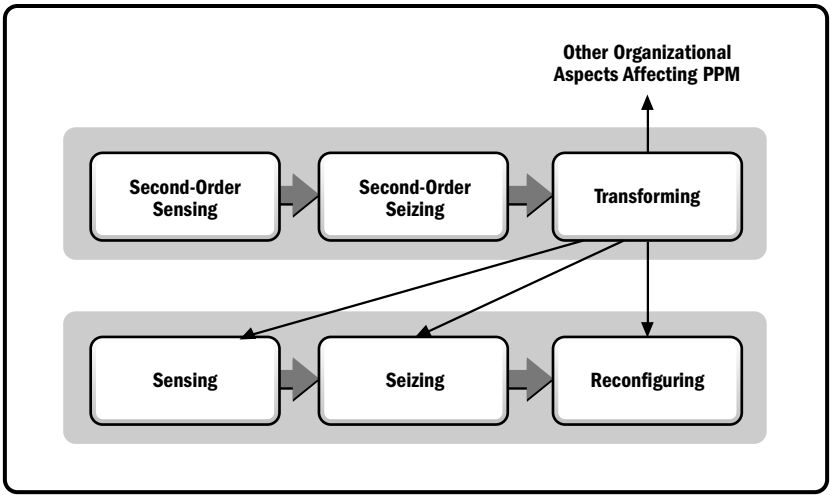

Figure 2-4. ***Transforming***

leading to the establishment of these portfolios is not formally investigated. This explains why the third order (strategic) level, depicted in Figure 2-5, has not been developed in the updated conceptual framework of Figure 2-2.

The updated conceptual framework described in this section is used to structure the presentation of the results. The following chapter presents the different types of uncertainties and the *organizing mechanisms* identified in the four portfolios according to the conceptual framework discussed in this section.

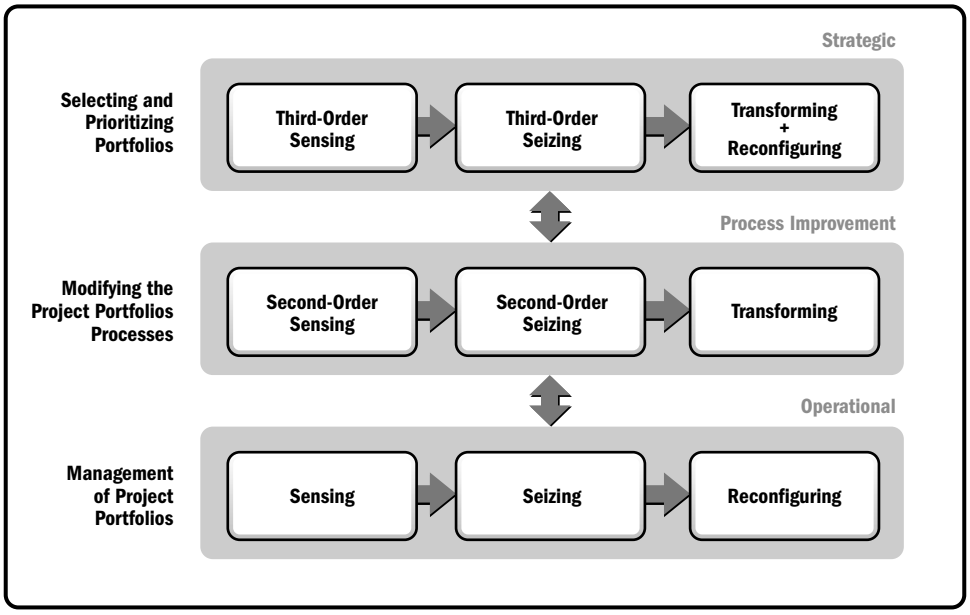

Figure 2-5. Three Orders of Dynamic Capabilities

Chapter 3

Methodology

This chapter summarizes the research strategy and the methodology used for this research. The rationale for the use of multiple cases, the case study design, and methods are described. The chapter concludes with limitations and exclusions to the study and the ethical aspects that were taken into consideration during the research.

3.1 Research Strategy

3.1.1 Selecting a Methodology Matching the Research Objectives

According to Punch (2006), when selecting a research methodology, it is most important that the questions and the data required to answer these questions should match, and this in turn is dependent on the research objectives and the status of the knowledge on the topic.

The objectives of the research can be summarized as follows:

- to identify the *organizing mechanisms* used to manage uncertainty affecting project portfolios in dynamic environments;
- to evaluate the use of the dynamic capability framework for the study of project portfolios;
- to study project portfolio management at the operational level using concepts borrowed from sensemaking (traditionally used to study the interpretative mechanism at individual level) and dynamic capabilities (traditionally used to study strategic processes at corporate level); and
- to provide feedback to academics, practitioners, and standard bodies on potentially useful practices in the field of project portfolio management.

As is presented in Chapter 2, the research in PPM has primarily focused on project selection and there have been only a few publications on the management of project portfolios once project are selected, especially in dynamic environments. Based on the above objectives and on this observed state of knowledge, it was decided, for this research, to use an in-depth study of a limited number of cases. According to Yin (2003), case studies are the preferred strategy when:

- *how* or *why* questions are being posed ("such questions deal with operational links needing to be traced over time, rather than mere frequencies or incidence" [p. 6]);
- when the investigator has little control over events;
- when the focus is a contemporary phenomenon within some real-life context; and
- when very little is known about a topic.

The research question meets all four of these conditions. The research question is a *How* question: *How is uncertainty affecting project portfolios managed in dynamic environments?* The study addresses uncertainty and unexpected events for which the investigator has no control. Finally, as mentioned previously, there is little known on the operational aspects of PPM, which is a contemporary phenomenon.

It should be noted that the use of case studies is more a choice of the scope of what is to be studied (Stake, 2005) rather than a choice of the methodological approach because the cases can be investigated with a vast array of quantitative, qualitative, or mixed methods. Qualitative methods were selected for this research. The focus in this case is less on large samples but on careful selection of the cases (see further discussion on case selection in section 3.3). Because it was important to acquire and understand the context of the organizations where the mechanisms are put in place. This could be done most easily through the analysis of documents, such as process descriptions, portfolio plans, and minutes of meetings and the detailed interpretation by the people interviewed.

The objective of many scientific inquiries is to develop theories that can be generalized and can explain some form of causality of some phenomenon (Kinloch, 1977; Sutton & Staw, 1995; Weick, 1995b). This type of study, called an explanatory study, attempts to identify why a certain phenomenon takes place. This level of theorizing is only feasible when a phenomenon has been observed and data has been systematically collected about it. However, in this research, the characteristics of the phenomenon itself are not well understood. It would therefore be premature to attempt to investigate causality. Instead, a descriptive study is performed to collect, organize, and summarize information about the phenomenon. The description includes how things relate to each other and a summary of specific information that might lead to some further theorizing. The objective of a descriptive study is not to identify causality but rather to demonstrate that a certain phenomenon exists and to describe it in such a way that further empirical investigations can subsequently be carried out. This is analogous to the ethnographic descriptions that served as the foundations for subsequent anthropological theories.

According to Punch (2006), the amount of structure and specificity that is planned in the research can vary greatly; ranging from prestructured (with prespecified questions, tightly structured design and pre-structured data) to unfolding (with general open-ended questions, loose design, and data not pre-structured). An approach situated somewhere in between these two extremes is used. The conceptual framework, described in the previous chapter, initially guided and structured the investigation. However, some of the research performed at later stages unfolded from the analysis of the gathered data initially and provided additional insights. In addition, based on the data analysis of the first two cases, the conceptual framework was modified.

In summary, the research strategy used for this research has the following characteristics:

- based on the study of a limited number of well selected cases;
- using qualitative methods;
- descriptive study rather than explanatory;
- pre-structured in its conceptual framework and evolves based on early findings; and
- identifies *organizing mechanisms* put in place to respond to uncertainty.

3.1.2 Overview of Research Process

Figure 3-1 shows an overview of the research process based on Eisenhardt (1989a) and Yin (2003). The following sections describe in more detail the activities in each phase.

- **Preparing for data collection:** Based on preliminary research questions and conceptual framework, an interview guide was tested with two pilot cases. Following the lessons learned from this preliminary investigation, the material was updated (see more details on preparation work in section 3.2).
- **Establishing criteria for case selection:** the criteria for the number and characteristics of the cases were then specified (see more details on the case selection criteria in section 3.3).
- **Selecting and describing cases**: Includes the case descriptions, i.e., organizational context, portfolio characteristics, match against selecting criteria, and cross-case comparison (see discussion on case selection in section 3.3.3 and a detailed description of the cases in Chapter 4).
- **Collecting the evidence:** This phase included collecting the evidence for two portfolios in a first firm. Data was then collected from two portfolios in a second firm (see more details on the data collection methodology in section 3.4).
- **Analyzing the case study evidence:** The interviews from the two cases in the first firm were coded and analyzed and this lead to an additional update of the conceptual

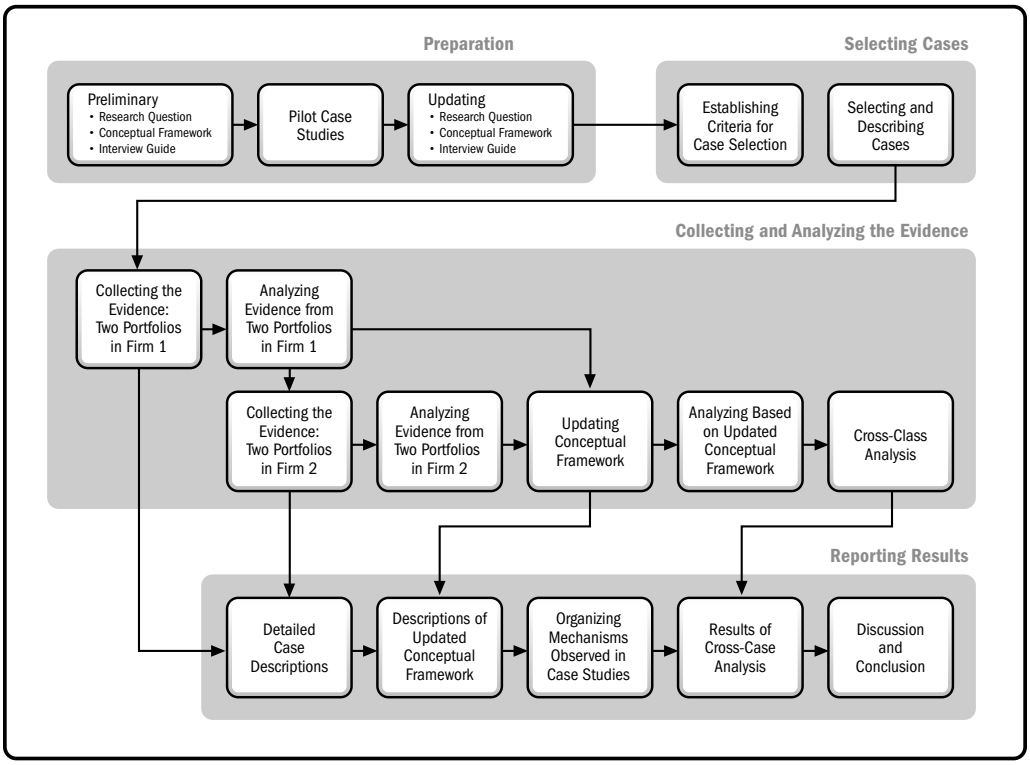

Figure 3-1. Overview of Research Process

framework. Following the data collection from two additional portfolios in a second firm, further analysis was performed individually for both firms using the updated framework. A cross-case analysis was then performed to identify differences, similarities, and patterns (the analysis methodology is presented in section 3.5).

- **Reporting the results:** Includes a detailed case descriptions, an overview of the different types of uncertainty facing the four portfolios, and the description of the *organizing mechanisms* (presented per firm rather than per portfolio) using the updated dynamic capability framework. This is followed by a cross-case analysis and a discussion (see more details on reporting the results in section 3.6).

3.2 Preparing for Data Collection

3.2.1 Testing the Instruments

A conceptual framework and interview guide based on the preliminary research question *"How are unexpected events affecting project portfolios identified, interpreted and managed?"* were tested prior to the actual case study investigation. The initial conceptual framework was focused on the project portfolio regulating process, under constraint, when unexpected events occur. Interviews were carried out during the summer of 2008: one with the person responsible for the project portfolio process deployment at a division of a Canadian utility company, *Util2008*, and one with the portfolio manager (within the PMO) of the IT division of a Canadian financial institution, *Fin2008*.[1]

Each interview was done on the interviewee's premises in Montreal, was recorded, and was transcribed verbally. This generated 74 and 50 pages of verbatim, respectively. The interviews were listened to multiple times, and they were read and annotated manually to identify key findings. Notes and observations were also taken during and after the interviews. Documents including: presentation material, reports, tables, and graphs (44 pages) were also gathered and analyzed.

The exploratory study performed during the summer of 2008 led to improvements to the conceptual model and theoretical foundation, changes to the research questions, some improvements of the methodology, an assessment of the suitability of the two organizations as case studies, plus a number of general observations.

3.2.2 Updating the Research Question and the Interview Guide

After analyzing the evolution of the multi-project plans of both enterprises over a period of more than a year and based on the interviews, it became obvious that a significant source of uncertainty was because of the definition of the project portfolio scope. It was actually so uncertain that it was rarely planned for a very long period in advance. The planning horizon was in weeks rather than months. However, despite being in very uncertain environments, the interviewees had difficulties relating to the concept of unexpected events. The concept of *uncertainty* seemed more appropriate than *unexpected events* for this study (see section 1.2.3 and section 1.2.4 for further discussion on this

[1]Both *Util2008* and *Fin2008* are fictitious names used to preserve the anonymity of the firms and of the people interviewed.

topic). Based on this finding the research question which was initially planned to be *"How are unexpected events affecting project portfolios identified, interpreted, and managed"* was changed to *"How is uncertainty affecting project portfolios managed in dynamic environments?* The interview guide was also updated based on the experience gained from the summer 2008 interviews.

3.3 Case Selection

3.3.1 Using Multiple Cases

An important question that arises when using a case study approach is the number of cases to investigate. While quantitative research requires a large number of cases to extract some validity based on statistical analysis, qualitative research using case studies might still provide interesting results even based on single cases. According to Yin (2003), there are many benefits of multi-case studies, even two-case studies over single cases, especially if they are performed in different contexts:

- They are regarded as being more robust. Miles and Huberman (1994) suggested that "multiple-case sampling adds confidence to findings. . . . If a finding holds in one setting and, given its profile, also holds in a comparable setting but does not in a contrasting case, the finding is more robust" (p. 29).
- They provide substantial analytical benefits.
- The contexts of the two cases are likely to differ providing opportunities for contrasting.
- They offer the possibility of direct replication, i.e., if an observation was made in one context, is it also present in another context?
- It reduces the likelihood of study of an exceptional single case.

The ideal number of cases would have been to reach a point where there is little value added to perform additional case analysis. However, the research was limited to four portfolios based upon the constraint imposed to complete a research within a prescribed duration. Based, on the results of this research, investigating replication in additional cases would provide additional research opportunities.

3.3.2 Case Study Selection Criteria

When selecting cases, Patton (2002) distinguished between random *probability sampling* (which is commonly used in quantitative studies) from *purposeful sampling* where the objective is to select information-rich cases strategically depending on the study purpose and resources. Two, out of the 16 different purposeful sampling strategies proposed by Patton, were selected for this research: *criterion sampling* and *intensity sampling*.

Criterion Sampling

The first strategy used was *criterion sampling* with the following criteria being used to identify and select cases for the study:

- Firms should have dynamic environments with a high level of uncertainty and/or high volume of changes to their project portfolio.

- Organizations must have well-established processes to manage their project portfolios including some mechanisms to handle changes.
- There should be a high project management maturity level.
- The firm should be supportive of this research and provide easy access to informants and documents.

The requirements specified were then assessed against the situation observed in a number of organizations. The two firms used for the pilot study were rejected on the basis of these criteria. *Util2008* had a very elaborate system to aggregate and follow-up project data at the portfolio level. They were also putting in place a very good PPM process. They have also been very supportive to the research and gave access to documents. Unfortunately, the initial interview indicated two major limitations to use *Util2008* as a case study:

- The planning horizon is very long (between 5 and 10 years) with a fairly small number of changes.
- Secondly, although they have been managing projects for many decades and have reached a high level of project management maturity, their project portfolio process is very new. They have less than one year of history. These two issues combined will make the identification of significant events very difficult.

The firm *Util2008* was rejected because the environment was not sufficiently dynamic, the number of changes was small, the market was monopolistic, and the planning horizon was long.

The firm *Fin2008,* despite being in a turbulent environment, was also discarded because the portfolio management practices had only recently been put in place. They lacked the history necessary to supply data for the study.

Two additional firms meeting the criteria were selected for the research. They are called *Company Soft* and *Company Fin* in this research and are described in detail in Chapter 4. Despite similarities related to the selection criteria (i.e., dynamic environments and well established portfolio management), they came from two different industries and had different governance characteristics thus displaying an element of variation in their environment which allowed comparisons.

Intensity Sampling

Both firms, *Company Soft* and *Company Fin,* manage project portfolios in dynamic environments. They manifest the phenomenon intensely but might not necessarily be considered extreme cases. This corresponds to what Patton (2002) called *intensity sampling*. The firms are very large and manage many project portfolios. Because the two firms manage a large number of project portfolios, an additional sampling within each firm was specified. The portfolios were selected according to the following criteria:

- The portfolio had been in existence more than two years, had to have encountered different types of changes, and had faced different types of uncertainties.
- The portfolio was complex and included a large number of dependencies between projects.
- The project and portfolio management practices were well established.

- There was access to documents and to people involved.
- The history of portfolio was well documented.

3.3.3 Cases Selected

Four portfolios in two firms were selected for this research. Having two portfolios per firm offered opportunities to validate if observations could be replicated within a given firm. The cases are described in more detail in Chapter 4.

The first company, *Company Soft*, is a large multinational firm with tens of thousands of employees out of which approximately 25 percent are in R&D. The products being developed are very complex, include both hardware and software, and are structured as systems composed of nodes, subsystems, and lower level software components interconnected using standard interfaces. Based on the criteria detailed in section 3.3.2, two portfolios at *Company Soft* were selected. The first project portfolio is called *Portfolio Soft1*. This portfolio is composed of a number of projects to develop a completely new product line. The second portfolio studied at *Company Soft* is called *Portfolio Soft2*. It was put in place to develop a mixture of hardware and software products used by other units in *Company Soft* including *Portfolio Soft1*. The main purpose of the projects in *Portfolio Soft2* are to reduce develop and integrate software and hardware components in order to reduce duplication and to seek synergy in the main product architecture. These common components are then used by the other units to build their specific applications.

The second company studied in this research is *Company Fin*. It is a large Canadian financial institution offering services to enterprises and individuals including loans, lines of credit, credit cards, accounts, savings, investments, and insurance. The *Portfolio Fin1* was implemented to comply with the Basel II agreement. This is an international agreement specifying the capital required by financial institutions to mitigate some of the risks that they face (Bank for International Settlements, 2009). The second portfolio studied at *Company Fin* is called *Portfolio Fin2*. It was established to introduce new accounting norms according to the International Financial Reporting Standards (IFRS). IFRS are principles-based standards, interpretations and a framework adopted by the International Accounting Standards Board (IASB). The implementation of IFRS is compulsory for Canadian publicly accountable profit-oriented enterprises for financial periods beginning on or after 1 January 2011. This includes public companies and other profit-oriented enterprises that are answerable to large or diverse groups of shareholders.

3.3.4 Cases Comparison

Table 3-1 summarizes the key characteristics of the four portfolios. The two firms presented in this chapter were selected to meet the criteria specified in section 3.3.2 for the firms and the portfolios. The cases offer a number of similarities and differences, which are discussed briefly in the following sub-sections.

Key Differences Used for Comparison

Having two portfolios per firm offers opportunities to validate if observations could be replicated within a given firm. This is particularly relevant because PPM and project management practices are often established and deployed at corporate level. This provides many

Table 3-1. Comparison of Cases

	Characteristics	Portfolio Soft 1	Portfolio Soft 2	Portfolio Fin 1	Portfolio Fin 2
Key Differences Used for Comparison	Industry	Software Development	Software Development	Financial Services	Financial Services
	Main Output	Complete Systems Include Documentation and Support	Software Platforms	Processes and Tools	Processes and Tools
	Size of Portfolio (Number of Current Projects)	Approx. 50 Projects	Approx. 25 Projects	Approx. 50 Projects	Approx. 25 Projects
Other Differences	Division	Product R&D	Product Platforms	Corporate Level	Corporate Level
	Resources	Internal (Matrix)	Internal (Matrix)	Mix of Internal & External	Mix of Internal & External
	Customer	External Customer	Internal Customer	Internal Organization	Internal Organization
Similarities	Size of Organization	Large Multinational	Large Multinational	Large (Mainly National)	Large (Mainly National)
	Amount of Change	Very High	Very High	Very High	Very High
	Dependencies Between Projects	Very High	Very High	Very High	Very High
	Project Management History	More than 30 Years	More than 30 Years	More than 30 Years	More than 30 Years
	Project Portfolio History	5 to 6 Years	> 5 Years	5 to 6 Years	5 to 6 Years
	Project Portfolio Planning Horizon	12 to 18 Months	12 to 18 Months	12 to 18 Months	12 to 18 Months
	Project Management Maturity	High	High	High	High
	Portfolio Management Maturity	Medium	Medium	Medium	Medium
	Project Governance Structure	In Place and Complex	In Place	In Place	In Place
	Project Management Tools	In Place	In Place	In Place	In Place
	Portfolio Management Tools	In Place	In Place	In Place	In Place

similarities between the cases (i.e., the different portfolios) but due to the particularities of the individual portfolios, differences might still be observed.

As shown in Figure 3-2, in addition to operating in different industries, one of the key differences between the two firms is the type of deliverables produced by the project portfolios. The products delivered by the two portfolios in *Company Soft* include systems composed of a number of nodes fully tested and integrated with previous versions of their product along with documentation and a number of services (such as installation, training and support). The portfolios in *Company Fin* supply conformity to international norms through IS/IT systems, modified or new processes along with training and support of the end users.

In both firms, a larger portfolio (with more than 50 concurrent projects) is compared to a smaller portfolio (less than 25 concurrent projects). Additional differences and similarities are described in the next sections.

Other Differences

The customers of the outcome of project portfolio differ between *Portfolio Soft1*, which has direct external customers, and the three others which deliver to internal customers, although the products developed by *Portfolio Soft2* still end up in a customer product.

At *Company Soft*, there is a match between the divisions and the portfolios and most of the resources allocated to the projects come from those divisions using a matrix organization. The resources are fully dedicated to projects and very few consultants are hired although

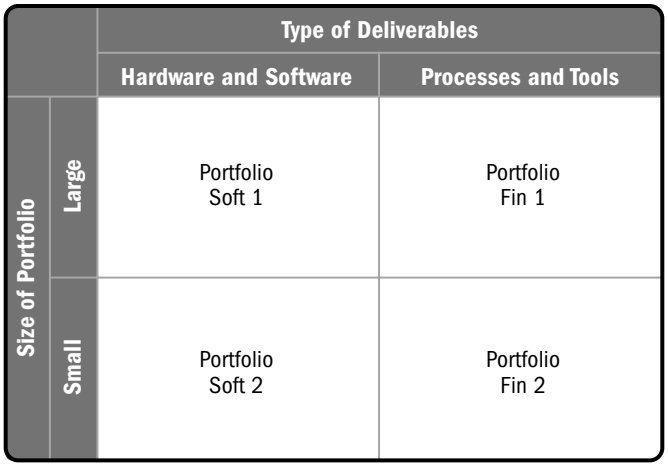

Figure 3-2. High Level Comparison of the Four Cases Investigated

cross-division resource allocation occasionally occurs. The two portfolios at *Company Fin* are managed at corporate level and affect almost all divisions and subsidiaries. The resources are borrowed temporarily from the operational work force and a large proportion of the workforce is composed of consultants hired specifically to work on projects.

Similarities

The two firms investigated are very large (tens of thousands of employees) and manage many project portfolios in parallel, which are selected and prioritized at corporate level approximately once each year. The two firms have very well established project management processes and the project maturity is high. Both firms have a history of many decades successfully managing projects and are considered *best in class* in their industries with respect to their project management. This includes well-established governance structures, and standardized project management practices and tools. The introduction of project portfolio management is still somewhat new (i.e., less than five years) in both cases. All four portfolios involved software development and are further decomposed into sub-portfolios and the dependencies between projects are very high; individual projects cannot easily be removed without affecting the rest of the portfolio.

3.4 Collecting the Evidence

3.4.1 Data Collected

Documents and verbal accounts via semi-structured interviews were used to understand the different processes followed depending on the characteristics of the events. Using the structure of the conceptual framework, Figure 3-3 describes the topics investigated in each area and the intermediate analysis performed starting with an initial analysis of the background information (including organizational context, portfolio history and characteristics and processes used to manage projects). A study of the changes to the project portfolio over a period of one to two years allowed a characterization of these changes and a classification into categories.

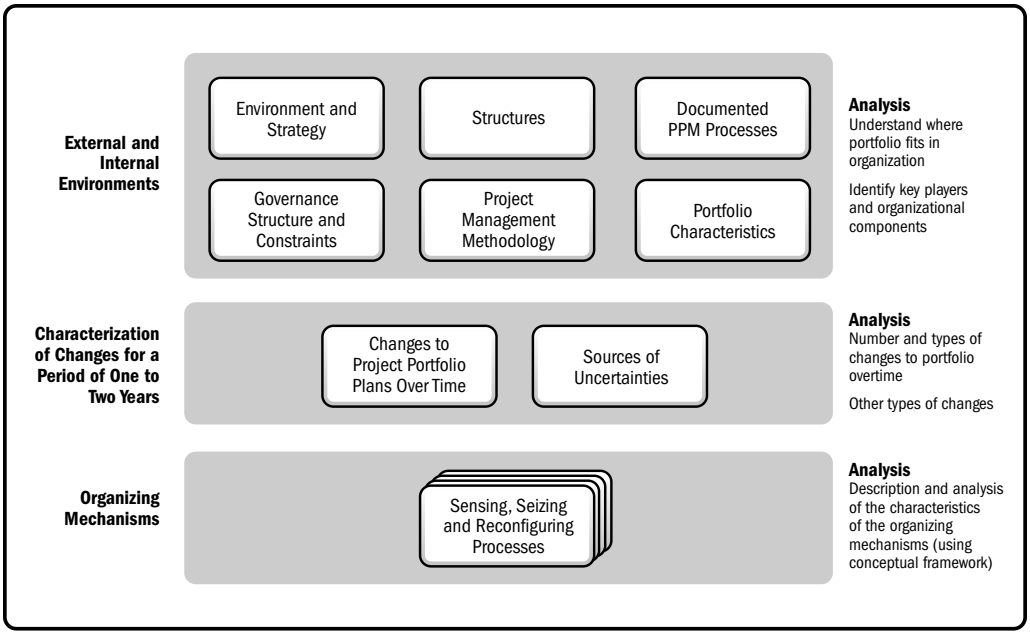

Figure 3-3. Overview of Data Collection Activities

Questions regarding sources of uncertainties and frequencies of changes were used to corroborate the findings. The interviews were used to understand the *sensing*, *seizing*, and *transforming/reconfiguring* mechanisms. This was followed by feedback sessions with some participants.

Table 3-2 maps the data collected and the collection methods for each area. For most areas, a combination of interviews and documents was used to ensure consistency and correct understanding by the researcher. This corresponds to *methods triangulation*, that is, "checking out the consistency of findings generated by different data collection methods" (Patton, 2002, p. 556). Complete access was granted to the intranet of *Company Soft*. This provided a large amount of information to be analyzed. In the case of *Company Fin*, documents were accessible but had to be requested and supplied by informants.

Background Information

Data was collected to understand the environment and the context of the people involved in management of the project portfolio:

- **Environment and strategy:** The organizational context of the firm includes: vision, mission, strategy, goals, and values. The specific environment in which the firms operate (market, competitor, and legislation) is also analyzed.
- **Governance and constraints:** Details of the governance structure and rules were collected. This covered the links between the corporate, the portfolio and project governance. This allowed a better understanding of the key stakeholders and their

Table 3-2. Areas Investigated, Characterization, and Data Sources

	Area Investigated	To be Characterized	Primary Data Sources	Complementary Data Sources
Background Information	Organizational context	Vision, mission, strategy, goals, market, competitor, values, org. structure	Documents: • Annual Reports • Public online information • Corporate Intranet	Main point of contact: • Validation and clarifications
	Governance and constraints	Processes, directives, rules and constraints, relationships between corporate, portfolio and project governance	Documents: • Process descriptions • Directives • Description of bodies involved in deciding and reporting • Organization Structure • Roles and responsibilities • Steering group meeting minutes	Main point of contact: • Validation and clarifications
	Characteristics of Project Portfolio	Structure of project portfolio Characteristics of projects Dependencies	Documents: • Multi-project charts summarizing project groups • Description of projects	Main point of contact: • Criteria group projects • Level of dependencies between projects
	History of the portfolio	How and why portfolio was put in place. Events prior to period under scrutiny.	Documents: • Any textual account from early period	Person involved in the early phase of portfolio: • Account of the early history of the portfolio
	Processes related to the management of the project portfolio	Process used to manage portfolio	Documents: • Process descriptions • Directives • Description of decision bodies	Main point of contact • Validation and clarifications
	Project Management methodology	Methods and tools used to plan, coordinate and control projects	Documents: • Process descriptions • Directives • Tools guidelines • Description of decision bodies	Main point of contact: • Validation and clarifications
Characterization of Changes (Period of one to two years in recent past)	Changes to the project portfolios	Types of changes Sources of uncertainty	Documents: • Portfolio plans • Steering group minutes of meetings • Project final reports Verbal accounts: • Interviewees list sources of changes and uncertainties	
Interpretation Modes for Sensing Processes	Organizing mechanisms	Sensing, seizing, reconfiguring/transforming	Verbal accounts: • Description of how changes were identified and translated into the project portfolio (or other changes)	Documents: • Documents used to assess changes (e.g., market survey, technology assessment, customer requests)
Validation of Results	Feedback on findings	Findings in previous areas	Feedback sessions: • Feedback session with key participants	

relationships. The constraints imposed on the project portfolio were also analyzed. This included the type of constraints, origin (i.e., who decides them if applicable), how frequently they are updated and what is the process to modify the constraints. This includes any document describing the decision bodies, the rules, documents and decisions used to manage the projects portfolios.

- **Structures:** This organizational structure was assessed to understand how the projects are structured. This included the functional organization, the utilization of external resources, and the alliances with external firms.

- **Project management methodology:** The project management methodology deployed by the organization is analyzed to help understand the level of project management maturity and experience of the organization with project management.
- **Documented PPM processes:** The documented PPM processes are used as background information to assess the level to which PPM activities are developed and used in the organization.
- **Characteristics of the project portfolios:** This included the analysis of documents describing the list of projects included in the portfolio with such parameter as size, duration, different levels of dependencies, use of resources, complexity, etc. The rules used to structure the portfolio and group projects were also investigated. The origin and the history of the portfolio served as a basis to understand the goal and the initial processes used prior to the period investigated.

The portfolio characteristics (e.g., number of projects, duration of projects, dependencies between projects) might bring important elements in the understanding of how the processes are selected and help answer the following question: What categories of changes are managed at portfolio level? Is the management of changes to the project portfolio dependent on the characteristics of the projects in the portfolio? Finally, special attention was put on studying how resources are reallocated from one project to another.

Characterization of Changes to the Project Portfolios

The documented traces left by changes over the period (updated portfolio plans, steering group meeting minutes, and project final reports) were analyzed to develop a preliminary characterization of the number and types of changes to the portfolio over time (and other types of changes having impacts on the portfolio). The analysis was mainly based on the comparison of the portfolio plans over time and a log of the changes between the different versions. This was complemented by other sources such as the minutes of steering group meetings, final reports, and progress reports. The ambition was to identify relationships between changes to portfolios and sources of uncertainty.

Investigating *Organizing Mechanisms*

Data was collected on the different *organizing mechanisms* used to assess the sources of uncertainty and understand how they translate into changes to the project portfolios. For *sensing*, this was based on the starting point suggested by Teece (2009):

- processes to direct internal R&D and select new technologies;
- processes to tap innovation;
- processes to tap in exogenous technology; and
- processes to identify target market segment, changing customer needs.

Seizing was the most complex aspect of the research. It included how managers translated the sensed external changes into changes to the project portfolio, such as:

- business model used;
- selection rules; and
- decision making protocols;

This was not always documented by the organizations and had to be investigated through interviews of the managers involved. Through verbal accounts, the different processes used to manage the impacts of changing environments were analyzed. Different events covering different types of changes and how they were handled by the managers were investigated. Two main approaches were used to investigate the research question. A first approach was to trace back in time a number of representative changes to the project portfolio. For example, if a new project was added, it could be investigated what happened prior to the decision to add the project: How was it triggered? How was it assessed? Who decided what? However, when there were a large number of scope changes the focus was not on the analysis of individual changes but on the mechanisms put in place to address the uncertainty associated with the specification of project content.

A second approach was to determine, through a series of interviews, which processes were followed once external changes were identified. This was based on interviews with portfolio managers, project managers, line managers and senior managers involved in steering groups.

Temporal Sampling

The research studied how management in these two firms handles change. This implied the notion of time. This could be handled in two ways: using longitudinal case studies or retrospective case studies. According to Leonard-Barton (1990), longitudinal studies are most appropriate when cause and effect are being investigated. However, these studies typically take more time and tend to gather more unnecessary data than other types of case studies.

Retrospective case studies were used. A period of between one to two years in the recent past (e.g., no earlier than June 2007) was analyzed. This provided sufficient data to analyze how changes are handled while quality and reliability of the data decreases significantly beyond two years. Documents become harder to retrieve and access to the people involved at that point in time also becomes difficult. However, data was collected to understand the history leading to the period under investigation.

According to Leonard-Barton (1990), the most significant limitation of a retrospective research is "the difficulty of determining cause and effect from reconstructed events" (p. 250). One additional weakness of retrospective studies is that "participant-informant in a wholly retrospective study may not have recognized an event as important, when it occurred and thus may not recall it afterwards" (p. 250). This is also the case in longitudinal studies where participants-informants might have difficulties identifying key events as they occur. However, this weakness was alleviated by analyzing written records corresponding to the events under scrutiny.

Another argument to use retrospective study instead of longitudinal studies is that according to Weick (1995a, 2001) it is very difficult if not impossible for people to make sense of their actions at the time they actually occur. Actions tend to be interpreted and justified afterwards.

3.4.2 Sources of Evidence

Documents were collected and analyzed with respect to descriptions of the project portfolios over time, major events, which resulted in changes to project portfolios, and the project portfolio change management process. Documents provide a better record of historical events (dates, decisions points, etc.) but lack the richness of exactly what happened (who was involved, what were the interactions, what was analyzed, etc.). The combination of the document analysis with interviews alleviates the deficiencies of each method.

Documents

Both *Company Soft* and *Company Fin* provided access to their documents either through a direct access to their intranet and internal libraries or through the intermediate of a point of contact. These documents were retrieved as soft and hard copies that were further marked up and analyzed. In each firm, points of contact helped to understand and interpret these documents and to show how representative the documents were of the period under investigation. The tables in Appendix D summarize the type of documents and the number of pages collected for each case.

Interviews

Interviews were performed with a number of actors that have been involved in the portfolio management process in the period under study. This corresponds to triangulation of sources, that is, "checking out the consistency of different data sources within the same method" (Patton, 2002, p. 559). Multiple interviews on the same topic also allow multiple viewpoints on the same events. It allows potential recollection in black periods—in periods which are less documented. For example, interviewee A might remember event 1 while interviewee B remembers event 2. Using this triangulation technique increased the *reliability* and *construct validity* (Patton, 2002). Attention was paid to the potential weaknesses that might bias the interview results: bias because of poorly constructed questions, inaccuracies due to poor recall by interviewees, reflexivity (i.e., interviewee gives what interviewer wants to hear).

An interview guide was used as opposed to more structured questionnaires. This left some room for probing and further investigating new areas identified during the interviews. The interviews were always performed by the same researcher, during working hours at the interviewees' workplace. The interview tapes were transcribed into verbatim which were stored and analyzed using Atlas.Ti® (see discussion on interview coding in section 3.5.3).

The interview guide proposed in Appendix E was developed and was structured according to the conceptual framework defined in Chapter 2. Questionnaires were prepared according to the data to be collected from the following roles: portfolio managers, senior managers, PMO managers, project managers, and line managers. The people interviewed were involved in at least one aspect of the project portfolio *organizing mechanism*.

Table 3-3 shows the sampling hierarchy for the two organizations and for the four project portfolios investigated. Forty-eight interviews with 43 people were performed. In *Portfolio Soft1*, the portfolio manager was interviewed three times, in *Portfolio Soft2* the product manager was interviewed twice, in *Portfolios Fin1* and *Fin2*, the portfolio manager was interviewed twice. Each interview took between 45 and 90 minutes. Appendix F gives the details of the number and durations of the interviews. For *Company Soft*, interviews were carried out in English, for *Company Fin,* all interviews were done in French.

3.5 Analyzing the Case Study Evidence

Miles and Huberman (1994) suggested analyzing the data as soon as it becomes available. This ensures that the questionnaires and the list of required documents are adequate for subsequent interviews. As mentioned in section 3.1.2, the data was collected and analyzed first for the two portfolios in *Company Soft*. The codes created and the conceptual framework

Table 3-3. Hierarchy of Samples—Number of Interviews

LEVEL 1 Organizations (n = 2)		Soft		Fin	
LEVEL 2 Portfolios (n = 4)		Soft 1	Soft 2	Fin 1	Fin 2
LEVEL 3 Interviewees (n = 48)		Interviews	Interviews	Interviews	Interviews
	Portfolio Manager	3		3	2
	Project Office Manager	2	1		1
	Senior Manager	1	1		1
	Product Manager	2	2	1	1
	System/Requirement Management	1	1	2	3
	Innovation	1			
	Project Manager	4	2	5	2
	Line Manager	2			
	Process	3			
	Other				1
	Sub-Total Portfolio	19	7	11	11
	Sub-Total Perform	26		22	
	TOTAL	**48**			

was then used to analyze the data gathered at *Company Fin*. This section briefly describes the techniques that were used to analyze the data, which includes:

- narratives of the cases;
- portfolio plans and other documents;
- interview coding;
- within-case analysis;
- update of the conceptual framework; and
- cross-case analysis.

3.5.1 Narrative

As suggested by (Langley, 1999), a narrative story of each case was written based on the different interviews and the documents collected. This included a description of the project portfolios, the context in which they were manage (structure, roles, and external environments), and main events affecting the portfolios and outcomes associated with these events. The narrative served as a preliminary step for further analysis and also served to present the cases to the readers for further replication.

3.5.2 Portfolio Plans and Other Documents

Portfolio plans and roadmaps are updated regularly to display the list of approved and planned projects over time. All four portfolio organizations updated these plans on a monthly basis. The type and frequency of changes in the portfolios were analyzed prior to

the interview to assess objectively the frequency and type of changes that were managed in the portfolios.

Additional steering documents were analyzed to better understand the environment in which the portfolios operated. This included annual reports, project and portfolio steering minutes of meeting, project final reports, roles and responsibilities, description of decision bodies, process descriptions, and directives.

3.5.3 Interview Coding

The interviews were transcribed and transferred to Atlas.Ti®, where they were coded and analyzed to identify patterns. A number of families of codes related to the conceptual framework were first created: organizational context, *sensing*, *seizing*, *transforming*, and *others*. The interviews of *Company Soft* were coded first. Based on this initial analysis, the conceptual framework was updated and additional codes were created. The coding for *Company Soft* was then reviewed in an additional iteration and updated accordingly. The coding for *Company Fin* followed using a similar approach.

Based on free coding within these families, 87 codes were created. The codes with few citations and the citations tagged with codes in the category *other* were reviewed in detail and merged when appropriate. This reduced the number of codes to 78.

3.5.4 Within-Case Analysis

The data collected was analyzed using the conceptual framework as a basis. The sources of uncertainty were first assessed and a connection to the different *sensing* mechanisms was sought. A complete flow from the source of uncertainty all the way through changes to project portfolios was investigated searching for some connections with *seizing* and *reconfiguring* mechanisms. Each case was initially analyzed as if they were unique cases.

3.5.5 Updating the Conceptual Framework

Once the analysis of case *Portfolio Soft1* was completed, it became apparent that the initial conceptual framework was not quite adequate to represent what was being observed. For PPM, *reconfiguring* meant the re-allocation of resources to match the changes in the environment while keeping the strategy for the project portfolio. Once the conceptual framework was updated to reflect a better distinction between *reconfiguring* and *transforming* (and the inclusion of *second-order sensing* and *seizing*), the cases, and especially *Portfolio Soft1* and *Portfolio Soft2*, had to be analyzed in a second iteration.

3.5.6 Cross-Case Analysis

The cases were compared to determine if some patterns emerged from the differences between the cases. By having four portfolios in two different firms and by analyzing the characteristics of the firms and of the portfolios, the objective is to identify some mechanisms that are put in place in one case but not the other.

As a step toward generalization, Yin (2003) advocated for a replication strategy to verify if the findings from one case can also be observed in other settings. Successive cases are

examined to see if patterns identified in one case are also observed in other cases. Another objective of cross-case analysis is also to help enrich the analysis, for example, to identify elements that might not have been observed in single cases.

The firms were selected to differ with respect to the type of deliverables. Within each firm, portfolios were selected to be different in size. During the data analysis, it was found that the portfolio size, i.e., that the differences in PPM practices within the firm, did not stand out as a significant variable to differentiate between the *organizing mechanisms* As a consequence, in Chapters 6 and 7, the results are presented together for both portfolios within the same firm to avoid repetitions. However, one of the cases, *Portfolio Soft1*, displayed a much more turbulent environment that resulted in a number of unique *organizing mechanisms*.

3.6 Reporting the Results

The results are reported in the second part of the report. It is structured according to the conceptual framework as follows:

- **Chapter Four—Detailed case descriptions:** It includes the context of the firm and of the portfolios, its history, project management practices in place, organizational context, and portfolio characteristics.
- **Chapter Five—Types of uncertainties for each portfolio:** These are presented first and are used as the main thread to investigate the different *organizing mechanisms*.
- **Chapters Six and Seven—PPM in dynamic environments presented per firm:** The *organizing mechanisms* were found to be very similar within a given firm. The results are presented per firm rather than per portfolio to avoid repetitions.
- **Chapter Eight—Cross-case analysis:** It is based on the key difference between the cases, patterns and differences are then presented.

The results are followed by a discussion, which summarizes the findings and the contributions for the fields of PPM and for dynamic capabilities. The report concludes with the contributions, the limitations, and opportunities for future research.

Chapter 4

Detailed Case Descriptions

This chapter describes the organizational context of the two firms and of the four portfolios that were selected for this research. The two portfolios in each firm are then described. This includes the history and goal of the portfolio, the organizational context specific to the portfolio, and the overall characteristics in terms of number of projects and their dependencies.

4.1. Case Description: *Company Soft*

Company Soft is a large multinational company with tens of thousands of employees out of which approximately 25 percent are in R&D. The product development is structured into three Development Units (DU) each responsible for the financial success and the development of product portfolios. These development units are further decomposed into product development units (PDU). The PDUs are responsible for the development of specific components of the products. Products are very complex, include both hardware and software, and are structured as systems composed of nodes, sub-systems, and lower level software components interconnected using standard interfaces.

A number of design centers around the world are involved in the development of the components within PDUs. This includes centers in Europe, Asia, and North and South America. There is an "n to n" relationship between design centers and PDUs. Design centers typically work for more than one PDU and PDUs have their product developed by more than one design center. Consequently, the employees of a PDU are rarely collocated in a single location.

Portfolios are managed at PDU level. The research was performed in the largest DU, which is composed of five PDUs managing a total of five project portfolios (i.e., each PDU is given the responsibility for one project portfolio). Two of these portfolios, called *Portfolio Soft1* and *Portfolio Soft2*, are studied. They are described in more detail in sections 4.1.2 and 4.1.3.

4.1.1 Organizational Context (Company Soft)

Company Soft supplies equipment, integrated solutions, applications, and services to large corporations. However, they derive most of their sales from large, multiyear agreements with a limited number of significant customers. *Company Soft* is considered among the leaders in their market both in terms of market share and product innovation.

Company Soft has traditionally based its revenues on the sales of complete systems using the hardware components (e.g., number and type of boards) as the sales unit. The software

and the maintenance were included or packaged at low cost. Because of market pressures from newcomers in the market over recent years, this strategy has gradually evolved to the sales of software applications independently from the hardware. In addition, the sales of services (including software integration and maintenance) have grown almost exponentially since the year 2001.

Their products are recognized for their high quality. This requires a high degree of product testing and the projects have traditionally received directives to deliver only products that meet or even exceed the customers' expectations. The convergence of multiple industries (such as telecommunications, internet, devices, applications, and multimedia) introduced new competitors with new software development approaches. In some cases, new competitors come from emergent countries with low-cost staffing, which managed to introduce products with more aggressive time to market (i.e., time to introduce a new product on the market from initial conception). This creates pressure to both reduce cost and time to deliver projects while the high quality culture remains.

History of *Company Soft*

In the 1970s, it starts to develop computer-based applications and became a market leader in their segment. As many other enterprises involved in information technology, their sales dropped very significantly in 2001. Since then, they have maintained a slow growth.

Although many of the product divisions have experienced declines, the division of *Company Soft* offering services has grown extremely fast in the last five years to the point of becoming the most important source of revenue for the company. Services include support, training, installation, integration with third party products, and operations of the products sold by *Company Soft*.

Project Management Practices at *Company Soft*

At the end of the eighties, *Company Soft* invests in the development of a project management model and in the standardization of their project documentation. The model includes gates for the business decisions, milestones for project control, and standard templates for project documents (such as status reports, quality plans, and project charters). The first version also includes the software development model but it gradually becomes a stand-alone project management framework, decoupled from the details related to the type of projects to be managed. This in-house developed project management model is fully deployed across the company via the training of all their project managers, a support network, and the active development and maintenance of the model. This provides a common terminology and process for all project managers and sponsors across the organization.

In the last 30 years, the enterprise has established a well-accepted project management culture within the organization. Between 1990 and 2000, their design centers document their practices and get certified ISO 2001. Many are also assessed for Capability Maturity Model Integration with most of them reaching maturity levels of 2 or 3. *Company Soft* is truly a project-based organization where almost every piece of work is associated with projects. Almost every person in the R&D organization works on at least one project but most often, on more than one project at a time. Examples of nonproject work are process improvement activities, annual assignments (for standards or innovation activities), and

line functions (e.g. budget productions). Since the major layoffs in 2001, there are no more consultants hired to work on the R&D projects. Projects are entirely staffed through the allocation of *Company Soft* resources.

The R&D divisions of *Company Soft* are structured using a matrix organization where functional line managers are responsible for the resource allocation and the processes used for the hardware and software development, (i.e., they are responsible for *who* and *how*). The project managers are assigned from the beginning of the pre-study until the project conclusion (i.e., when the products have been demonstrated to at least one customer and handed over to the maintenance organization). They are responsible for planning, monitoring, and controlling the project. This includes documenting the project, ensuring proper resource allocation (through functional line managers), reporting progress, and escalating any issue or risk.

Project managers receive an *assignment specification* from product managers. The document is only two to three pages long and specifies the target date, target cost, and a broad idea of the project content and targeted customers. Product managers are responsible for the content of the projects. They specify the initial content and are involved in any subsequent decision to accept or reject change requests for the project.

All PDUs have project management offices (PMO), although some might use slightly different names to describe these activities. PMOs at *Company Soft* always include project managers and project administrators but occasionally might include other functions such as quality managers, configuration managers, project financial controllers, operational developments. The key functions/objectives of the PMO are to ensure that all projects deliver according to the multi-project plan, that resources are allocated according to the directives, and that conflicts between projects are resolved. They also ensure the competence development of their project staff. Large PDUs have a central PMO supported by a network of PMOs with typically one in every design center or sub-organization of any significance.

4.1.2 Description of *Portfolio Soft1*

Based on the criteria detailed in section 3.3, two portfolios corresponding to two PDUs within the largest DU were selected for this research. The first project portfolio is called *Portfolio Soft1*. This portfolio is composed of a number of projects to develop a completely new product line.

History of *Portfolio Soft1*

Initial concepts leading to this project portfolio were first investigated in research labs as prototypes around the year 2000. This is followed by the launch of projects to develop it as a commercial product around 2005. This new product portfolio is considered disruptive technology because it is intended to replace and merge a number of existing products. Initially, this is structured as projects using resources across a number of PDUs. Since the product is completely new, there is no customer base yet. In addition, the PDUs are not yet structured in function of this new product line. When two small customers accept to evaluate the product in customer trials, this does not generate large revenues but helps to define the product through inputs and feedback from the customers. At the end of 2006, a PDU corresponding to this product and project portfolio is created.

The period studied for this research covers the period between mid-2007 to mid-2009. At that point, the PDU has already been established for more than two years but was not yet commercially profitable. They now have above 20 commercial systems installed with over 50 signed contracts for commercial launch. Most contracts include not only the purchase of the system but also a number of professional services from *Company Soft*.

Organizational Context Specific to *Portfolio Soft1*

In 2008, the PDU responsible for this portfolio included over 1,100 employees in seven design centers in Europe, North America, and Asia. The PDU is organized into the following departments: a PMO, a system group, an innovation group, six software development groups (based on the product structure), and an integration and verification (I&V) group.

Their environment is extremely dynamic and competitive. Because it is a completely new product, the main sources of instability are related to the product content, unstable standards and unclear product requirements from the customers.

Portfolio Soft1 is managed using the standard *Company Soft* project management model. Portfolio management practices are in place since the creation of the PDU. A portfolio management process inspired from *The Standard for Portfolio Management* (Project Management Institute, 2006, 2008b) is developed and documented by *Company Soft* and the DU is actively involved in supporting its development and disseminating its use. The PPM process is structured into three main components and includes a number of key decision points:

> **Portfolio aligning** describes the processes in which all new, potential and ongoing projects and programs are identified, categorized, and evaluated for strategic, financial, and resource availability fit.
> **Strategic balancing** includes project prioritization and balancing the characteristics of the projects against given parameters such as risks, expected revenues, and costs.
> **Portfolio monitoring and controlling** includes monitoring, controlling and reporting the performance of the project portfolio.

Characteristics of *Portfolio Soft1*

The *Portfolio Soft1* is composed of approximately 15 large projects/programs for a total of approximately 50 sub-projects/projects. The projects take between four months and 18 months from inception to completion. New projects start every three to six months. The planning horizon of the portfolio is between 18 months and two years. Anything beyond 18 months is considered long term. There is a monthly rolling forecast of all projects in the portfolio, which is documented in updated multi-project plans.

The larger projects delivering complete systems are composed of subprojects developing new versions of a number of nodes, in addition to the integration and verification subproject, and a subproject for the evaluation of the system at customer site. Within the sub-projects, the newly developed software is planned to be delivered every four to six weeks. The software components are then assembled and tested in a common environment. The products are structured as systems composed of a number of nodes interconnected using standard

interfaces. Projects related to different versions of a given node are sequenced and the early phases of subsequent projects overlap the previous projects in time. There are three main groups of dependencies:

> **Dependencies between subprojects of the same node:** functions being developed must often be built upon previous versions of the node. The consequences of this dependency are twofold. Projects cannot be completely parallel. They have to overlap them in such a way that the design base is sufficiently stable
> **Dependencies on same resource pool:** the resources are often allocated to more than one project. This is due to the specific competencies developed for each node. Some projects cannot be started or have to be delayed if resources are held longer than expected by previous (higher priority) projects. This creates some competition, which has to be resolved between the different projects.
> **Dependencies between the subprojects of a larger project:** for many features, some software has to be developed in more than one of the nodes of the system. In practice, this means that if any of the sub-projects is delayed in releasing their newly developed software, some (or all) of the features cannot be integrated and verified.

Because of the third dependencies (i.e., dependencies between nodes at system level), there is a major focus on delivering on time. Delay of one node has significant impacts on all other sub-projects, on subsequent node projects, and on product delivery to customer. For example, if one node is delayed, some of the features cannot be tested and this has a ripple effect on the subsequent deliveries in the main project.

Products are planned to be released to customers at fixed intervals. Product releases are done at different levels: main releases (twice per year), feature releases between main releases, product customization (requested by customers), and product adaptation (using the built-in product parameters allowing some flexibility). The actual product release strategy changed during the course of the product life cycle (see discussion in section 6.5.1).

The priority order for the projects within the portfolio is: (1) quality, (2) time, (3) cost, and (4) content. The quality priority is inherited from the tradition at *Company Soft* but there is a tremendous pressure to decrease time to market due to more aggressive competition. Content, being the lowest priority, is the main variable that can be changed. This is also the most uncertain aspect for which many different mechanisms have been developed.

In the case of *Company Soft*, the processes of project selection and termination are almost non-existent. The question is not so much which project to select but which functionality to develop in which project. In fact, the list of projects does not change significantly over time despite the recurrent comments by interviewees that many changes have to be handled all the time. A project road map and schedule are produced upfront with some vague idea of content. They know that content is extremely uncertain and that it will change along the way. However, they still want to communicate delivery dates to their customers. This is like publishing a train schedule. They plan the size of the trains, when the trains will leave, when they will reach destination, or when additional content can be added to the train. However, at the time of departure they do not know exactly what will be on the wagons, or even how many wagons will be on the train when they will arrive at their destination.

4.1.3 Description of *Portfolio Soft2*

The second portfolio studied at *Company Soft* is called *Portfolio Soft2*. It was put in place to develop a mixture of hardware and software products used by other PDUs in *Company Soft* including *Portfolio Soft1*. Throughout *Company Soft*, over 40 different platforms are used, developed, and maintained. Each platform can contain up to 20 different components including hardware, operating systems, middleware, software components, and interfaces. Most platforms include a large proportion of third-party products. The main purpose of the projects in *Portfolio Soft2* are to reduce the overall cost for the company by reducing duplication of effort and seeking synergy in the main product architecture. These common components are then used by the other PDUs to build their specific applications.

It is well understood at the corporate level that there are very significant benefits to having a single organization to develop and integrate such platforms and/or software components. However, this also generates a number of challenges for the organization; for example, *Portfolio Soft2* has conflicting requirements coming from the different units which have to be reconciled. It is clear during the interviews that *Company Soft* is continuously seeking the best way to handle the development of platforms and that they do not feel that an optimal set-up has been reached yet. The organization has changed every second year for at least the last ten years. In addition, the exact financing structure of the portfolio is always a challenge.

History of *Portfolio Soft2*

For the last 40 years, *Portfolio Soft2* used a number of different organizational set ups to support the platforms used by the different applications developed by *Company Soft*. For example, in 2007, it is structured as a development unit (DU) (i.e., at a higher level than a PDU) with the objective to achieve synergies by handling all platforms in one organization. Before that, the responsibility for developing the platform is owned by the main application using it. Before that, it is a separate platform organization. The location and responsibility for developing the platform regularly swing from a centralized to a decentralized organization.

At the time of the interviews, the organizational structure has recently moved to a PDU under the largest DU. They are also in the midst of migrating from large platform projects to smaller core component projects to increase flexibility and project planning precision.

Organizational Context Specific to *Portfolio Soft2*

In 2008, the PDU responsible for *Portfolio Soft2* includes over 500 employees in four design centers in four different countries in Europe and North America. The PDU is organized into the following departments: a PMO, a system group, two software development groups (based on the product structure), and an integration and verification (I&V) group. The PDU responsible for *Portfolio Soft2* is in the same DU as *Portfolio Soft1*. *Portfolio Soft2* does not have direct external customers. The products are all delivered internally to other units.

Their environment varies according to the product cycles of their internal customers. Some are very mature with well-established products installed in hundreds of sites and some (like *Portfolio Soft1*) develop completely new products with a very volatile customer base.

The main sources of instability are related to the product content and conflicting priorities between the different PDUs using the platforms.

Portfolio Soft2 is managed using the standard *Company Soft* project management model. The term portfolio management is not explicitly used by interviewees but the management practices include resource allocation and balancing, project prioritization, and addition of new project requests to the portfolio.

Characteristics of *Portfolio Soft2*

Portfolio Soft2 is composed of approximately ten concurrent projects lasting between four and 18 months. New projects start every three to six months. The planning horizon of the portfolio is between 18 months and two years. Smaller projects are composed of around 20 project members; larger projects could reach over 100 members. There is a monthly rolling forecast for all projects in the portfolio, which is documented in updated multi-project plans.

The projects are composed of a combination of small products that are tested to function together and will ultimately serve as a basis for application development by other PDUs. An important issue is to what extent the product should be tested by *Portfolio Soft2* rather than by the receiving organizations. Because of the large number of permutations of third party products that could be combined, another challenge is the specification of the exact configurations to be tested.

The dependencies are similar to the dependencies in *Portfolio Soft1*, described in section 4.1.2, i.e., dependencies between subprojects of the same node, dependencies on the same resource pool, and dependencies between the subprojects of a larger project. The most important dependency is the use of common resources allocated to projects.

The priority order for the projects within the portfolio are: (1) quality, (2) time, (3) content, and (4) cost. The quality priority is inherited from the tradition of *Company Soft*. However, there is occasional pressure to deliver earlier to allow the receiving PDUs to start developing applications earlier.

The target size of projects is an important management decision. Smaller projects are more flexible but ultimately might result in the testing of a larger number of configurations of products. The product manager at *Portfolio Soft2* explains this trade-off as follows:

> *We have rather huge platform products and we try to split up the components to avoid double development. The good thing about having a platform is that we can guarantee that these pieces fit together, work together, and are verified together. When you split up into components, you can get smaller projects, faster projects, you can pick what you need. The drawback is that you get a huge project with a very long integration and verification time. There is also a risk in getting a multiplicity of released items out on the market which tends to increase the maintenance cost drastically.* (Product Manager—*Portfolio Soft2*)[1]

[1]Citations from interviewees participating in the research are indicated in italics. They have also been edited slightly to improve readability and French citations have been translated.

4.2 Case Description: *Company Fin*

The second company studied in this research is *Company Fin*. It is a large Canadian financial institution offering services to enterprises and individuals including loans, lines of credit, credit cards, accounts, savings, investments, and insurance.

Tens of thousands of employees work for *Company Fin*[2] with most employees dedicated to the operations of the enterprise. Although they manage hundreds of projects per year, they cannot be considered a project-based firm per se. Examples of projects managed by *Company Fin* include:

- the development and deployment of new services;
- IS/IT;
- the introduction of new processes to improve efficiency or to comply with financial regulations; and
- the development and deployment of new technologies across the branches (e.g., bank tellers, credit card readers).

4.2.1 Organizational Context (*Company Fin*)

Like many other Canadian financial institutions, *Company Fin* remains profitable during the period 2007 to 2009 despite the turmoil in the international economy and more specifically during the recession in the USA. However, *Company Fin* has to devalue billions of dollars of assets related to asset-backed commercial papers. Consequently, they are forced to decrease their dividends compared to previous years. More importantly, the senior management becomes more aware of the risks associated with certain types of investments and for the need to improve the internal managerial and accounting controls.

In Canada, financial institutions are regulated by the Office of the Superintendent of Financial Institutions (OSFI). The OSFI mandate is to safeguard policyholders, depositors, and pension plan members from undue loss with the objective to maintain public confidence in a competitive financial system. In the province of Quebec, a similar institution called the Autorité des Marchés Financiers (AMF)[3] regulates the financial sector in the areas of insurance, securities, deposit institutions, and the distribution of financial products and services.

There are approximately 20 domestic banks in Canada, about the same number of subsidiaries of foreign banks, and hundreds of credit unions (which are cooperative financial services). However, the Canadian market is dominated by the top seven to eight institutions.

History of *Company Fin*

Company Fin was founded more than a hundred years ago. It started as a small institution with just a few branches but expanded rapidly with hundreds of branches in Canada. Despite being severely shaken by the great depression in the 1930s (when the company reduced the number of branches, the number of customers, and the total assets), they manage to continue their growth during the Second World War. Like many other financial institutions

[2]The specific number of employees is not specified to preserve the confidentiality of the enterprise's name.
[3]The institution does not use any English denomination. The name means *Financial Market Authority*.

in Canada, they start to diversify their activities, in the 1960s, with the acquisition of an insurance company. They also invest directly in a number of industrial firms. From the 1970s, they start to diversify their activities to offer a much larger range of financial services such as investments, funds, and trusts.

Project Management Practices at *Company Fin*

Company Fin has a central PMO providing support and reporting on all the projects in the firm. The PMO does not oversee the projects directly. Standard project management practices have been developed and are maintained by the PMO (e.g., templates and process descriptions). The projects are managed by project managers in the different business units and the relevant departments such as IT, customer services, and commercial services. The project managers must report progress, risks, and issues to the steering groups in the local organization. On a monthly basis, they must also report progress to the PMO which provides an independent assessment of the project status to senior management.

Company Fin has been managing projects for more than 20 years. During this period, they develop an in-house project management model and established different forms of PMOs, both centralized and decentralized.

The development process is composed of three stages and six phases as follows:

- **Stage 1:** Initiative
  - o Identification
  - o Feasibility
- **Stage 2:** Project
  - o Design
  - o Execution
  - o Deployment
- **Stage 3:** Operation
  - o Post-Implementation

The first stage serves to identify and structure the projects to be executed and includes a feasibility phase. Stage 2 includes the execution of the project that concludes with a hand-over to operation in post-implementation phase. Between each of the phases, gate decisions must be granted to continue to the next phase. This is a business decision taken by the portfolio manager or by the relevant steering group, which is based, among other things, on the status of the project, the business case, and the status of other projects in the portfolio. Each phase is managed as a project with a beginning and an end. The processes defined in the *PMBOK® Guide* (Project Management Institute, 2008a) are also used within each phase: initiating, planning, executing, monitoring and controlling, and closing.

Portfolio management is handled at the corporate level. The requests for funding from the different units are analyzed and compared on a yearly basis and budgets allocated for portfolios and programs. At *Company Fin*, the term *program* is more commonly used than the term *portfolio* even in the cases where the number of projects is large and the group of projects is diverse and spread over several years. A PPM process is not formally documented but a multi-project environment has been in place and managed for many years.

4.2.2 Description of *Portfolio Fin1*

The *Portfolio Fin1* was put in place to comply with the Basel II agreement. This is an international agreement specifying the capital required by financial institutions to mitigate some of the risks that they face (Bank for International Settlements, 2009). The Basel II Framework is intended to promote a more forward-looking approach to capital supervision, one that encourages financial institutions to identify the risks they may face, today and in the future, and to develop and improve their ability to manage those risks. One of the financial benefits of complying with the Basel II Framework for *Company Fin* is an opportunity to decrease the amount of capital that they have to reserve in case of crises. This is in addition to the operational benefits of improved management controls and risk management.

History of *Portfolio Fin1*

The portfolio was established in 2004 and was planned to continue at least until the end of 2010. The same portfolio manager has been in place since 2005. An initial project is put in place to study the Basel II agreement and to assess to what extent *Company Fin* complied with the requirement of the agreement. Based on the gaps identified, the portfolio is structured using an initial list of projects with their assigned priorities and sequence in the roadmap. In many cases, the scope is spread over a number of years either through multiple projects or through multiple delivery phases within a project. Most projects are a combination of process development and tool development typically including new data collection procedures, new approval processes, and new reports.

Organizational Context Specific to *Portfolio Fin1*

Portfolio Fin1 is by far the largest project portfolio at *Company Fin* and as such draws very significant financial resources (in hundreds of millions of Canadian dollars) and human resources over several years. The main goal of the portfolio is to demonstrate compliance to the Basel II Agreement for the financial authorities. However, the benefits are threefold:

- to improve the firm's efficiency,
- to avoid and/or reduce losses related to risks, and
- to reduce required capital to cover potential exposure to risks.

The latter is considered the most important benefit. *Portfolio Fin1* has support at the highest level of the organization and covers all divisions and units of the firm (i.e., central banking, investment, insurance, and funds). This is considered a very high priority portfolio and something that has to be done.

In order to leave as much autonomy to the different business units as possible, projects have traditionally always been managed and steered separately within the different units. The centralization of portfolio management function is considered a necessary precedent for the following reasons:

- the strategic importance of the compliance to the Basel II agreement at the corporate level;
- the inter-dependencies between all projects;
- the requirement that all units follow similar processes; and
- to facilitate the monitoring and controlling of the portfolio by senior management.

The deliveries are meant to be processes and tools for internal use. The receivers of the projects are internal employees who will be trained to use these processes, collect data, and analyze reports.

The main driver for the portfolio is a number of very important deadlines where *Company Fin* has planned to be externally audited for compliance to the agreement. A second driver is that the sum of the expenditures of all projects within the portfolio cannot exceed a given and approved yearly budget.

Project managers are trained to use the internal project management model. They are also requested to produce regular status reports to the program managers, the portfolio managers, and the central PMO.

Characteristics of *Portfolio Fin1*

Portfolio Fin1 includes four programs covering approximately 150 projects over a period of seven years. Approximately 50 projects are managed concurrently every year. The four programs correspond to five different risk areas: credit risks, market risks, integrated risk management, and operational risks and regulatory risks (the latter two being combined in the same program).

There are around 500 people per year assigned to the projects of *Portfolio Fin1*. The human resources are based in Canada and include over 50 percent of external consultants. The remaining resources come from different departments of *Company Fin*. The resources assigned to the projects almost always have other operational functions to perform, which most often have precedence over the project. There are only a small number of full-time employees dedicated to the portfolio, primarily project managers, project administrators, and business analysts.

All participants interviewed consider the number of dependencies between projects extremely high. The dependencies are predominantly between the projects of the same program. The main dependencies mentioned are these:

- The development of all the components for the five risk categories are performed in a common tool, sometimes using common user interfaces and common platforms.
- between processes developed and the tools to support them (including the parallel development of a manual process in some cases).
- Use of the same resources in more than one project.
- Requirements handled by more than one project.

The projects also include a very important deployment phase. In many cases, the solutions developed have to be rolled-out in hundreds of branches over several months. This includes installations, configurations, support, and training.

4.2.3 Description of *Portfolio Fin2*

The second portfolio studied at *Company Fin* is called *Portfolio Fin2*. It was put in place to introduce new accounting norms according to the International Financial Reporting Standards (IFRS). IFRS are principles-based standards, interpretations and a framework adopted by the International Accounting Standards Board (IASB). The use of IFRS is

mandatory for Canadian publicly accountable profit-oriented enterprises for financial periods after 1 January 2011. This includes public companies and other profit-oriented enterprises that are answerable to large or diverse groups of shareholders.

The objective of the migration from the Canadian General Agreed Accounting Principles (GAAP) towards IFRS is to provide a more consistent and comparable reporting standard offering an improved basis for decision-making for businesses and investors. The adoption of IFRS is intended to improve the clarity and comparability of financial information globally and to increase efficiency by eliminating the need for reconciliation of information reported under different national standards.

History of *Portfolio Fin2*

The *Portfolio Fin2* is launched in August 2007 and is planned to last approximately four years (i.e., until the launch of the official migration to IFRS in January 2011 is successfully demonstrated). This includes a complete year of overlapping with previous systems and practices in 2010 to ensure integrity and comparability of the data and reports.

The portfolio has a difficult start. The portfolio manager is changed four times in the first two years. Initially consultants are assigned to this position but are found to be unsuitable to deal with the different divisions and departments of *Company Fin*. The most recent portfolio manager is an experienced project manager who has been reassigned from the corporate PMO.

An initial project is put in place to study the IFRS norms and to assess to what extent *Company Fin* complies with the requirement of the norms. Based on the gaps identified, the portfolio is structured using an initial list of projects with their assigned priorities and sequence. In many cases, the scope is spread over a number of years either through multiple projects or through multiple delivery phases within a project. Most projects are a combination of process development and tool development, typically including new data collection procedures, new approval processes, and new reports.

Organizational Context Specific to *Portfolio Fin2*

Portfolio Fin2 is not among the largest project portfolios at *Company Fin* but regardless attracts significant senior management attention. Although the benefits of the conversion to IFRS are hard to quantify financially, the portfolio is considered compulsory. The goal of the portfolio is never challenged although the exact scope of the portfolio has to be defined in more detail through feasibility studies and scope definition activities managed by the portfolio. The delivery date is imposed externally as 1 January 1 2011.

The deliveries are processes and tools for internal use. The receivers of the projects are therefore internal employees who are trained to use these processes, collect data, and analyze reports. Projects follow the more traditional approach at *Company Fin* to let the different units manage their own projects when appropriate.

The main drivers for the portfolio are a number of very important deadlines where *Company Fin* is to be externally assessed by accounting firms for compliance to the norms. A second driver is that the sum of the expenditures of all projects within the portfolio cannot exceed a given and approved yearly budget.

Project managers are trained to use the internal project management model. They are also requested to produce regular status reports to the program managers, the portfolio managers, and the central PMO.

Characteristics of *Portfolio Fin2*

Portfolio Fin2 includes three programs covering a total of approximately 25 projects over a period of three years. One of the programs integrates the output of the two other programs to produce the final accounting reconciliation. The portfolio structure evolves over time and different strategies are employed. Projects are initially established according to the different norms. Typically, one norm equates to one project. The programs are then organized according to the target internal customers:

- **Solutions impacting the branches:** These solutions impact tools and processes affecting hundreds of branches. This is the largest and most complex of the three programs.
- **Solutions impacting the corporate level and the different specialized units:** In many cases, this is managed by the unit itself under supervision of the portfolio management team of *Portfolio Fin2*.
- **All projects having direct impact on the production of the annual reports:** This is considered an integration project with the most dependencies on the two other programs.

There are approximately 150 people per year assigned to the projects of *Portfolio Fin2*. Each project is relatively small, composed of between five and 10 people. The human resources are based in Canada and are composed of a mixture of consultants and of resources coming from different departments of *Company Fin*. The resources assigned to the projects almost always have another operational function to perform, which most often has precedence over the project. There are only a small number of full-time employees dedicated to the portfolio, primarily project managers, project administrators, and business analysts. There are a number of instances where full-time employees are transferred as dedicated resources to the portfolio and replaced locally either by consultants or other full time employees. The justification for these transfers is the scarcity of specialized expertise externally.

The number of dependencies between projects is considered high by all participants interviewed. The main dependency is between the first two programs and the integration program dealing with the production of annual reports. Both programs have to collect data in a format suitable for the production of the financial reports produced by the third program.

Chapter 5

Types of Uncertainties

This chapter presents the types of uncertainties that were identified by the interviewees in the four project portfolios. This was used to determine the frequency of occurrence and their impact on the project portfolios. A link to the *sensing* mechanisms was also sought.

5.1 Type and Impact of Changes on *Portfolio Soft1*

Interviewees were asked to assess the type of changes and the uncertainty facing the organization managing the project portfolio. For example, the *Portfolio Soft1* portfolio manager assessed the changes as follows:

- two to five significant changes per year (an example of such significant change would be the signature of a large contract with a customer);
- 15 to 20 changes per year to the portfolios due to portfolio performance (the most typical change being delays in a project with cascading effects on other projects);
- over 50 changes per year related to content changes impacting more than one project or subproject due to the uncertainty in the exact specifications of the product to be developed; and
- major organizational restructuring approximately every 18 months.

Answers by the different participants were compared and analyzed for patterns. Figure 5-1 displays the eight categories of changes identified by the participants of *Portfolio Soft1*. The following sub-sections present the main drivers of change in approximately decreasing order of significance. They are described below according to their rates of change and their impacts. In the case of *Portfolio Soft1,* the main sources of uncertainty are related to the scope changes. This is followed in importance by project performance.

5.1.1 New Product

Because the product is very new, a very large number of features have to be put in place at the beginning to convince the customers that the product is viable. In the early phases of the product life cycle, it is not clear which features have the highest priority to reach the market. Although *Portfolio Soft1* attempts to define and agree on the scope in early phases of the projects using pre-studies, feasibility studies, and gate decisions, the scope constantly has to be revisited due to changing customer priorities.

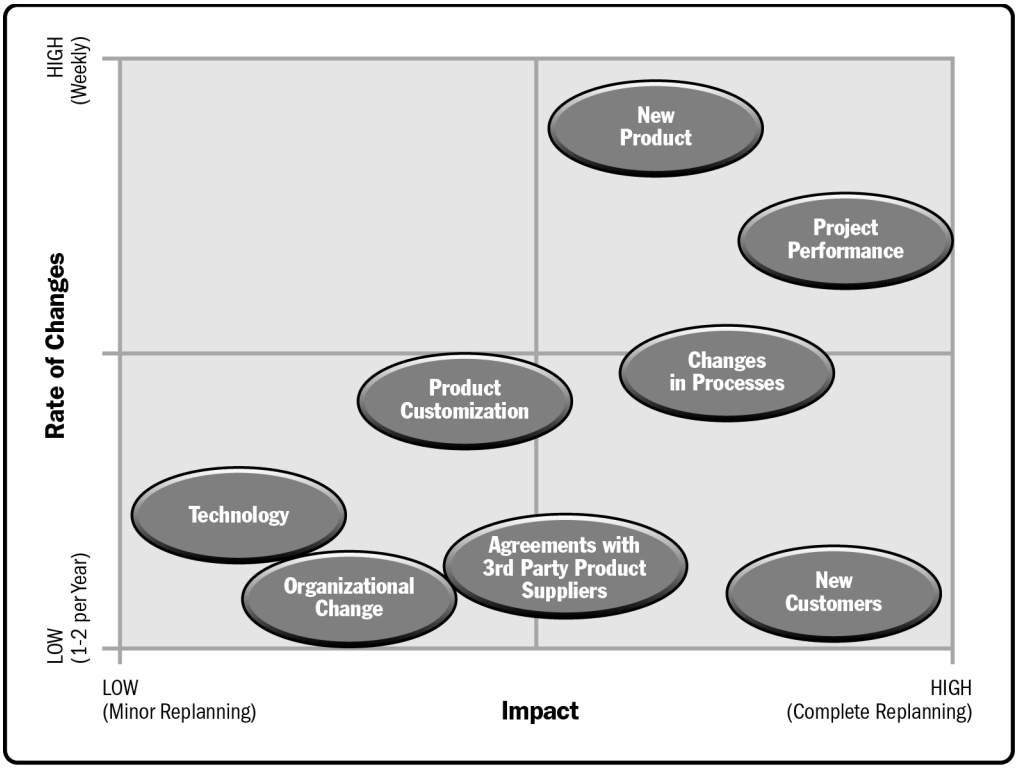

Figure 5-1. Impact and Rate of Change at *Portfolio Soft1*

The level of dependencies between the different projects in the portfolio is also very high. Because the different projects are interrelated and must be developed towards a common release, most scope changes affect more than one component of the software system. In *Portfolio Soft1* there are over 50 changes per year related to scope changes impacting more than one project or subproject. This is in addition to changes affecting individual nodes (which are in the hundreds). The high level of uncertainty related to the content is mentioned in almost all interviews at *Portfolio Soft1*.

5.1.2 Project Performance

Due to the high level of dependencies between projects, any major problem with project performance, such as delays or budget overruns in one of the projects has ripple effects on other projects. These effects are twofold: (1) the functionality-base is not there on time for subsequent projects to update and build upon, and (2) the resources are kept longer than expected at the expense of subsequent projects. Since the projects share the same resource pools, when a project has to keep resources longer than planned the subsequent projects have to re-plan their resources and in most cases delay their project.

The changes related to project performance are not so much to realign with the portfolio strategy but to synchronize between projects and to ensure that the most critical functionality will still be delivered on time, that resource allocation is still balanced with availability, and

that the portfolio is still within budget. The causes of these problems with project performance were not specifically investigated. Many interviewees mentioned that they would rather maintain the date by reducing the scope of the projects in order to avoid such cascading effects. There are around 15 to 20 changes per year to each portfolio due to project performance.

5.1.3 Changes in Processes

Portfolio Soft1 uses project management and software development methodologies, which have been put in place and improved by *Company Soft* over many decades. However, the requirement for increased flexibility results in multiple attempts to modify the development process. This includes the introduction of different variants of *agile* processes, software release strategies, new integration, and testing approaches, in addition to the implementation of a new financial system across the enterprise. *Portfolio Soft1* introduced a resource planning process and tool by which line managers and project managers have to submit their resource demands and allocations on a monthly basis. All these changes have impacts on the project portfolio structure which results in attempts to reduce the duration and length of projects, attempts to reduce the dependencies between projects, and separation of the prestudy for each project into a continuous activity outside the projects. It is hard to estimate precisely the number of process changes during the year but considering the number of comments regarding this issue, it could be estimated to be in the region of five to 10 per year with one to three having very significant impacts.

5.1.4 Need for Customization

Portfolio Soft1 attempts to develop flexibility in their products and the intent is to develop a standard product that can be customized using configuration parameters. This is not always possible and despite these attempts, it is found that most customers need special customization. A number of special high priority, billable customization projects are therefore put in place. Although these projects are small in comparison to the ongoing development projects they still compete for the same resource pool. This type of request occurs approximately once a month.

5.1.5 New Customers and New Market

Portfolio Soft1 tries to enter new markets with their innovative products, in some cases targeting a completely different set of customers. They make the decision to invest in the products with the expectation that the customers will replace some of their existing software and hardware in order to reduce their total cost of ownership and develop new products and services of their own. *Portfolio Soft1* does not have any contracts with customers when they establish the *Portfolio Soft1* in early 2005. At the end of 2006, they sign two contracts with major customers who decide to evaluate the products in their lab and a few months later with a limited subset of their end customers. The advent of these contracts has very significant impacts on the content of *Portfolio Soft1*, which becomes much more tailored to the needs of these two customers at the expense of the development of a potentially more standard product. This creates an enormous inflow of new requirements most of which are considered *must have* functionality to be developed very urgently. Consequently, the capacity of the R&D organization is exceeded and has to be rebalanced by cutting out or postponing some content.

After these two initial contracts, *Portfolio Soft1* wins around 40 small contracts and tries to develop a more standard product using a portfolio of products that will suit a larger number of customers. Then, during the spring of 2009, a letter of intent is signed with a very important and influential customer. The ongoing portfolio has to be completely reshuffled to suit the needs of this very important customer. Although such significant events are fairly rare (approximately once a year), they are at the heart of the main source of uncertainty for those managing project portfolios in *Portfolio Soft1*.

5.1.6 Changes in Agreements with Third-Party Suppliers

Portfolio Soft1 integrates a number of third-party products. Business decisions have to be made on a regular basis on whether to make or buy. There are a number of occurrences where the termination of an agreement with a supplier results in the creation of a replacement project and inversely a replacement project is terminated because it was decided to use a third party product. These changes are somewhat similar to the changes in scope discussed above but are less frequent, approximately once or twice a year.

5.1.7 Structural Reorganizations

Company Soft has a history of reorganizing their line organization every 12 to 18 months. *Portfolio Soft1* is no exception and goes through approximately three to four reorganizations during a five-year period. This includes the creation of the PDU concept, creation of new PDUs, merging of PDUs, transfer of PDUs, transfer of responsibilities between design centers, and closure of some units. Even if these structural changes have major impacts on the personnel, the impacts on the project portfolios are expected to be minimal and the project target dates are expected to be maintained despite these organizational changes. Here is how a project manager at *Portfolio Soft1* summarizes the impacts of these types of changes:

> *We have had significant challenge in terms of the transfer of design from one site to another but we have not re-planned the project because of that. This has been a background activity handled by the line organization in the PDU. There is no impact as long as they can provide project resources that can keep the time plan.* (Project Manager–*Portfolio Soft1*)

5.1.8 Technology

Surprisingly changes in technology are not considered frequent nor as having significant impacts. The interviewees consider that technology could be planned at least six months to a year in advance and included in the project plans accordingly. There are only very rare cases of changes to the portfolio due to changes in technology. This is considered the most stable or at least the most predictable area as mentioned by the person responsible for the product specification in the system group of *Portfolio Soft1*:

> *New technologies impact what we do down the road but normally they do not have major impact on what are we doing in this quarter or next quarter. In most cases, changes in strategy, new technology arriving and so on does not require change management on the requirements that are already in the process.* (System Group Manager–*Portfolio Soft1*)

5.1.9 Summary of Changes in *Portfolio Soft1*

Eight sources of changes to project portfolios have been identified: (1) specification of new product; (2) project performance; (3) changes in processes; (4) need for customization; (5) new customers and new markets; (6) changes in agreements with third-party suppliers; (7) structural reorganizations; and (8) technology. The main source of uncertainty is related to scope changes due to the development of a completely new product in a constantly evolving in a turbulent market. Surprisingly the evolution of the technology (of the supporting software and hardware platforms) is not considered a prime source of change. In addition, changes in business strategies (which are one of the two project portfolio changes mentioned in *The Standard for Portfolio Management* [Project Management Institute, 2008b]) are not observed. Project performance (the other source of change identified in the PMI standard) is an important source of change. The sources of changes observed here are much more varied than those identified in the literature.

5.2 Type and Impact of Changes in *Portfolio Soft2*

Figure 5-2 displays the seven categories of change identified in *Portfolio Soft2* and which are described in this section according to their rates of change and their impacts. The following subsections present the main drivers of change in approximately decreasing order of significance. In the case of *Portfolio Soft2*, the main source of uncertainty is related to the evolving priorities due to the number of internal customers. This is followed in importance by project performance.

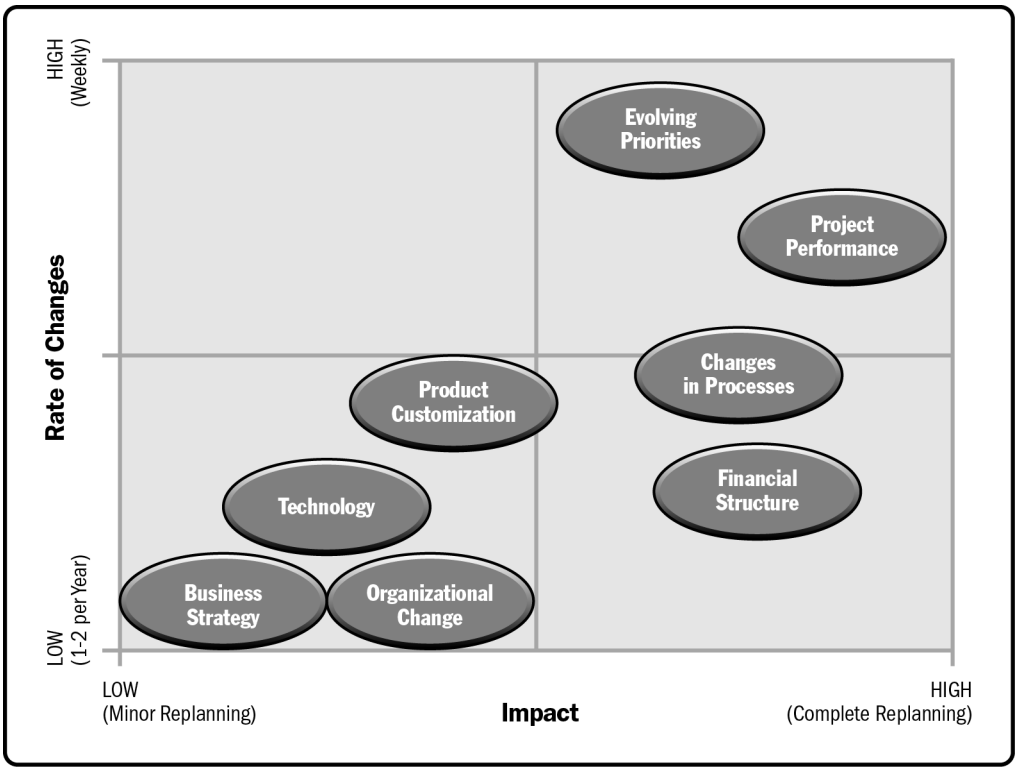

Figure 5-2. Impact and Rate of Change at *Portfolio Soft2*

5.2.1 Evolving Priorities

For many years *Portfolio Soft2* develops a number of platforms to be used by the different PDUs. This results in conflicting and evolving priorities between these different internal customers. A number of product boards are put in place to specify and prioritize the requirements between the different users with the objective to minimize the platform cost and maximize the synergy between the different components across the different PDUs. This is analogous to the multiple customers that *Company Soft* has to manage in their other product lines.

A key difference, however, is that *Portfolio Soft2* attempts to fund the development of the platform and cover its cost only. They do not try to sell and make profits directly from the products. Complications result from the priorities assigned to the different funders of the project portfolio, which is further discussed in section 5.2.3 on financial structure.

The level of dependencies between the different projects of the portfolio is very high. Because the different projects are interrelated and must be developed towards a common release, most changes of scope affect more than one component of the software system. Although priorities are set when projects start, the business situation of the different stakeholders evolves rapidly and the priorities between the different features under development have to be revisited constantly. Interviewees in *Portfolio Soft2* consider their environment as more stable than other *Company Soft* product lines environments. There are approximately 25 such changes per year.

The changes related to project performance are not so much to realign with the portfolio strategy but to synchronize between projects and to ensure that the most critical functionality is still delivered on time, that resource allocation is still balanced with availability and that the portfolio is still within budget. There are around 15 to 20 changes per year due to project performance.

5.2.2 Changes in Processes

Portfolio Soft2 uses project management and software development methodologies, which have been put in place and improved by *Company Soft*. A number of process improvements and process changes are mentioned during the interviews. One of the most significant changes is the introduction of a new financial and accounting system to be used by the projects to plan and monitor the project budgets with time sheets and accounting entries. Another significant process change is the introduction of a monthly resource planning routine.

When the PDU introduces a new process (for software development or project management), they use one of the ongoing or planned R&D projects as the deployment mechanism. Most projects include some form of process improvement. The process improvement deliverables are included in the project scope and given a priority against other items in the project requirement list. The frequency of change is estimated to be approximately five to ten per year but with one to three having very significant impacts.

5.2.3 Financial Structure

In 2007, *Portfolio Soft2* has more than 40 different financial streams that have to be managed. The flow of money and its distribution over time varies according to the evolution of the funding units. A number of different schemes to allocate and manage the financial structure of the project portfolio are implemented over the years. None of them is considered completely satisfactory. This generates a lot of philosophical discussion about fairness between the major stakeholders.

A first approach, which is attempted, is to split the project content according to the potential revenues expected by each unit using the product. In this financial structure, project scope might have initially been defined according to a financial distribution of 50 percent, 30 percent, and 20 percent between three major sponsors (with other units benefitting without directly financing the project). However, when project changes are requested they have to be evaluated in relation to the financing. If during the course of the project, one of the PDUs is shut down (or simply does not require this functionality any longer), thus removing a portion of the financing, the remaining funders have to absorb the cost. This situation is considered overly complex and creates constant tensions between the units.

A second approach is to make the first requester of the functionality pay for its development and let the others benefit once it is developed. The concept behind this approach is to let the rest of the organization benefit from the development of functionality that the first organization is willing to finance anyway. However, this creates a different problem in practice. If a unit pays for a specific functionality, they will tend to develop specifically for their own requirements without due consideration of other units' needs.

A third approach is in the process of being implemented when the interviews at *Portfolio Soft2* are carried out. The R&D funding is grouped into three main streams according to the Business Units, which are at the highest level of the organizational structure. The intention is that it will simplify the reallocation of funding in the case of internal reorganizations within these three units. Steering groups and product councils are created to decide on the allocation of funds to the different projects.

5.2.4 Structural Reorganizations

Portfolio Soft2 is used to frequent structural re-organizations. Approximately once a year a new organizational structure is put in place. New structures tend to follow the system architecture and/or the alignment to the product marketing organization. A pendulum also swings between having the platform development centralized and common to all applications and having it decentralized in each of the main application product development units. A third type of organizational change is the transfer of responsibilities between design centers. The concern to reduce cost constantly pushes *Portfolio Soft2* to move the development and maintenance of certain software components to low cost countries. These transfers are handled by the line organizations and their ambition is to minimize the impacts on ongoing projects.

5.2.5 Technology

Changes in technology are not considered frequent nor as having significant impacts, at least to ongoing projects. The interviewees consider that technology changes rarely have impacts on the current or subsequent quarter. Therefore, they do not require change management for ongoing projects.

There was one mention of a hardware upgrade that had to be done very late in one of the projects. Although this was a late change, it was understood that hardware platforms evolved at a given frequency. The timing of this upgrade was not exactly as planned and had to be justified to the steering committee.

5.2.6 Change in Business Strategy

Portfolio Soft2 is undergoing a change of its strategy from a platform development organization to a component organization. The concept is borrowed from an enterprise in the automotive industry as described by a product manager:

> *They have V-8 engine, they have a gear box and the drive line they have the steering wheel and these they have used a platform. So then they have different bus platforms for short bus and long and different truck platforms. [. . .] Now they have gone away from that and decomposed the platforms into components. Now they have a number of engines, they have a number of gear boxes, they have the steering wheels, etc. And from the components they assemble trucks, buses, and so on. For example, all trucks from that company are having the same front window. So when you smash your front window anywhere in the world, there is always a spare part available. (*Product Manager-*Portfolio Soft2)*

Applied to *Portfolio Soft2*, this concept represents a significant shift in strategy and in the business model. Instead of 18 month projects to develop, test, and integrate platforms including multiple components which are distributed to all the other PDUs, they develop individual components (or occasionally a small group of components) which can be picked and chosen from. Despite this very significant strategy change, the ongoing platform projects are not affected. They are requested to complete their deliveries as originally planned. The new strategy is only in force for projects launched after the decision change in business model.

5.2.7 Summary of Changes in *Portfolio Soft2*

Seven sources of change to project portfolios are identified: (1) scope (evolving priorities); (2) project performance; (3) changes in processes; (4) financing structure; (5) structural reorganizations; (6) technology; and (7) change in business strategy. The main source of uncertainty is related to scope changes due to conflicting and evolving priorities between the internal customers.

5.3 Type and Impact of Changes in *Portfolio Fin1*

In response to the questions regarding the type of changes and the uncertainty encountered by the organization managing the project portfolio, the portfolio manager *of Portfolio Fin1* assesses the changes as follows:

- over 10 significant (i.e., having impacts beyond single projects) requirement and scope changes per year;
- approximately three to four major changes per year, that is, changes having potential impact on the whole portfolio;
- three to four major company re-structurings during the life of the portfolio; and
- very large number of changes handled at project level in addition to changes due to performance of projects.

Figure 5-3 displays the seven categories of uncertainty according to their rates of change and their impacts. The figure summarizes the responses from all interviewees. In

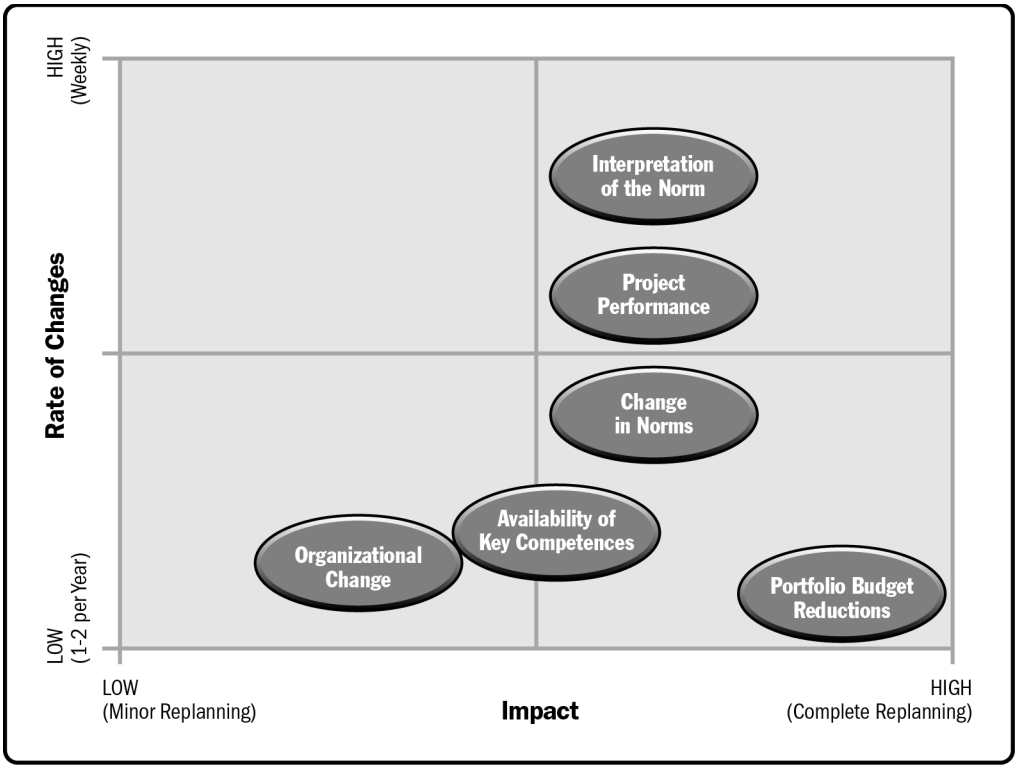

Figure 5-3. Impact and Rate of Change at *Portfolio Fin1*

the case of *Portfolio Fin1*, the most significant source of uncertainty is *scope change* due to changes in the interpretation of the regulatory norms by the employees of *Company Fin* and by the Canadian financial authorities.

5.3.1 Interpretation of the Norm

The most frequently mentioned source of change during the interviews is not so much the changes in the international norms themselves but their interpretation by employees of *Portfolio Fin1* and occasionally by external consultants involved in the projects. Canadian financial authorities are also interpreting the norms and most often their directives come many months after the *Portfolio Fin1* projects have been launched. *Portfolio Fin1* has to guess what the regulatory bodies' interpretations will be.

The project methodology includes the approval of the project scope by the stakeholders at given gate decision points. However, there are numerous instances where the receivers (customers) change their mind on the exact requirement to be implemented after the project has started execution. In addition, there are at least six mentions of changes of interpretation due to new personnel assigned to the project. There is an average of 50 change requests per year (of which 85 percent of them are due to scope changes) during the four years for which data is available. The scope changes are primarily due to the interpretation but a few times per year the norm itself changes.

5.3.2 Change in Norms

The international bodies responsible for the norms release documents defining the norms as the programs unfold. Because of the planned duration of the projects and the external deadlines imposed to comply with these norms, the project sponsor has to take some risk and approve the start of some key projects regardless of this uncertainty. Changes in the norms occur between one and six times per year.

5.3.3 Project Performance

The project performance (time, cost, and scope) are monitored and reported on a regular basis to the portfolio manager and to the sponsor. Any deviation has to be documented using a change request at the portfolio level. There are two types of change requests: requests for additional funds (if scope remained unchanged but more money was required) and scope change request (covered in a previous section). Approximately 15 percent of the change requests are related to additional funds (i.e., in most cases incorrect planning). This allows the portfolio manager to take the required course of action: to reallocate money from other projects, to use contingency money, or to postpone other projects. The changes related to project performance are not so much to re-align to the portfolio strategy but to ensure that the resource allocation is still balanced and that the portfolio is still within budget. In the case of *Portfolio Fin1*, the main constraint is on budget control at the portfolio level.

There are a number of instances where the project scope has increased significantly in comparison with the initial estimates. This scope creep is often due to the opportunity seen by the stakeholders to use the *Portfolio Fin1* business case to develop some additional features, which have little to do with the norms implemented by *Portfolio Fin1*.

5.3.4 Portfolio Budget Reduction

During 2009, *Portfolio Fin1* has to reduce the budget because of the crisis that hit the financial sector. Two main strategies are deployed: consultants are replaced gradually by less costly employees on the projects, and (b) the least urgent projects and functionality are delayed to 2010. Although this event only happened once, it had a very significant impact when it occurred.

5.3.5 Availability of Key Competences

Company Fin has to free up its resources from the operational activities to reassign them temporarily to projects. Resources are not typically dedicated to project activities and are not familiar to project management. For those resources that have to split their time between projects and nonproject activities, projects rarely have the highest priority in comparison to activities such as the production of the annual reports.

There are numerous accounts of key resources being pulled out of projects to be reassigned to other more pressing activities. Another example is resources assigned only for a given phase of projects (for example, feasibility) and being replaced in the following phase. For the project managers, this involves training the resources and bringing their level of competence and comprehension of the project up to par with other participants in the projects.

A third case mentioned is the replacement of the business representative responsible to specify the requirements for one of the project. The replacement challenges some of the previous decisions and norm interpretation made by his predecessor. Consequently, the project has to issue numerous change requests to either remove or add functionality.

5.3.6 Organizational Change

The *Portfolio Fin1* has been in place since 2004. During the lifespan of *Portfolio Fin1,* there were three to four major restructurings of the company. One major reorganization affecting both portfolios is ongoing in 2009 during the time of the interviews. The changes to the portfolios due to the reorganizations are not overly significant. They are, for example, new people assigned to projects (with new learning curves to build up competence and comprehension of the project) and slowdown in the project due to uncertainty for the personnel involved. However, the content and the structure of the project portfolios remain largely unchanged.

One of the consequences of reorganizations on *Portfolio Fin1* is that the deliverables of the projects had to suit the new structure, for example, for reports and access to the tools. In other words, it is the specifications of the products under development that are affected in addition to the reallocation of resources due to the re-organization.

5.3.7 Summary of Changes in *Portfolio Fin1*

Six sources of changes to project portfolios are identified: (1) interpretation of the norm; (2) changes in norms, (3) project performance; (4) portfolio budget reduction; (5) key competences; and (6) organizational change. The main source of uncertainty is related to scope changes due to the interpretation of the norms. Changes in strategy are not observed during the two-year period analyzed for the two portfolios in *Company Fin*. It can be argued that some of the changes described above might be considered as changes in how the strategy should be implemented but not so much changes in the strategy itself.

5.4 Type and Impact of Changes in *Portfolio Fin2*

Figure 5-4 displays the five categories of uncertainty according to their rates of change and their impacts. In the case of *Portfolio Fin1,* the most significant source of uncertainty was *scope change* due to changes in the interpretation of the regulatory norms by the employees of *Company Fin* and by the Canadian financial authorities.

5.4.1 Change in Norms

The international bodies responsible for the norms release documents defining the norms as the *Portfolio Fin2* portfolio unfolded. In many cases, they are not actually approved when a project starts. Because of the planned duration of the projects and the external deadlines imposed to comply with these norms, the project sponsor has to take some risk and approve the start of some key projects regardless of this uncertainty. Changes in the norms occur very frequently (i.e., more than 10 changes per week) and have to be analyzed constantly for their impact on the ongoing projects. There is one example in *Portfolio Fin2* where a planned modification of the norm had been cancelled by the international bodies. Even though money had already been spent on feasibility and design, the corresponding project had to be cancelled.

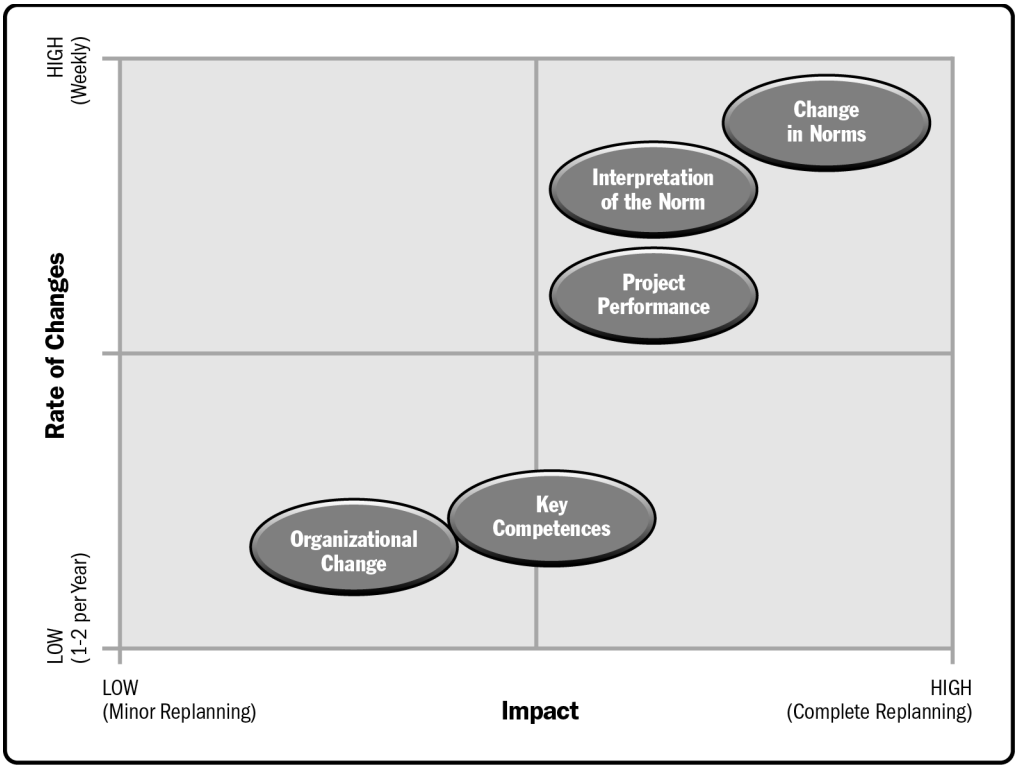

Figure 5-4. Impact and Rate of Change at *Portfolio Fin2*

5.4.2 Interpretation of the Norm

One of the most frequently mentioned source of change is the interpretation of the norms by external consultants hired to interpret the norms and by *Company Fin* employees involved in the projects. There is one case where they do not want to comply with a specific norm based on their interpretation. Although they have started a project and reached the completion of the feasibility, they are lobbying and fighting against its application to their firm. After many months, they finally convince the issuers of the norms and the external auditors that *Company Fin* could be exempted from this particular norm and therefore cancel the project despite having invested a large amount of money. *Portfolio Fin2* only documents large change requests. There are approximately 10 changes per year due to changes in norms.

5.4.3 Project Performance

Project performance (time, cost, and scope) is monitored and reported on a regular basis to the portfolio manager and to the sponsor. Any deviation has to be documented using a change request at the portfolio level. *Portfolio Fin2* does not use two categories of change requests to distinguish requests for additional funds and scope change request. For them all change requests are treated equally.

There are two instances of scope creep where the scope increases dramatically, in one case fifty fold. This means that the project no longer fits in the budget originally assigned

and a business case has to be presented again in comparison with other projects. The requirements serving as the foundation are identified for this particular project. This means that new projects have to be launched in subsequent years. There is also a project delay, which has cascading effects on the use and timing of resources in subsequent projects.

5.4.4 Availability of Key Competences

The portfolio manager is changed three times during the period under study. According to the sponsor, the first portfolio manager does not have enough leadership, is escalating too many issues, and does not have sufficient knowledge of the organization. This means that during transaction periods some of the projects are affected or have to be subsequently re-planned.

The most recent portfolio manager challenges and realigns the structure of the portfolio that, instead of being aligned with the norm structure, is organized in function of the receivers and users of the tools and methods. Most of these changes are directly related to the change of the key resource (i.e., the portfolio manager) after the portfolio has been launched.

5.4.5 Organizational Changes

The *Portfolio Fin2* has been in place since the end of 2007. One major organizational restructuring of the company is underway during 2009. The impacts on the portfolios due to the reorganizations are not considered major. In *Portfolio Fin2*, some of the project deliverables have to be modified, for example, the accounting reports have to reflect the new structure and in some cases there is uncertainty regarding the right person to decide on the new report structure. A more serious impact is, according to the portfolio manager, that this creates a climate of uncertainty which affects the performance of the resources assigned to the project who are wondering where they will end up in the new structure.

5.4.6 Summary of Changes in *Portfolio Fin2*

Five sources of change to project portfolios are identified: (1) changes in norms; (2) interpretation of the norm; (3) project performance; (4) key competences, and (5) organizational change. The main source of uncertainty is related to scope changes due to the changes of the norms.

Chapter 6

PPM in *Portfolio Soft1* and *Portfolio Soft2*

This chapter describes the mechanisms put in place at *Company Soft* to cope with the uncertainty described in sections 5.1 and 5.2. It is structured according to the framework discussed in Chapter 2, that is, one level leading to *reconfiguring* and one leading to *transforming*, with each level decomposed into three processes. Because of the large number of similarities among the *organizing mechanisms* put in place in a given company, the results for both portfolios at *Company Soft* are presented together to reduce the amount of repetition. When an *organizing mechanism* only applies to one project portfolio, the sub-heading title indicates it clearly. Once examples of some *reconfiguring* mechanisms are presented, it becomes easier to discuss how they are identified and decided upon through the *sensing* and *seizing* mechanisms. Therefore, the presentation of each process is presented from right to left in the conceptual framework drawing.

6.1 Reconfiguring

This section presents the mechanisms used in *Company Soft* to reallocate resources and reconfigure the project portfolios. This section refers to the third box of the first-order level as highlighted in black in the lower part of the simplified conceptual framework of Figure 6-1.

As a reminder, *reconfiguring* is defined as the *organizing mechanisms* to modify the project portfolio and to allocate human and financial resources within the portfolio. This includes *organizing mechanisms*:

- to change the project portfolio structure, including any changes in the project configuration (new projects, new subportfolios, termination of projects) and project scope prioritization;
- to modify the project scope and project interdependencies; and
- to change the allocation of financial and human resources to the projects in the portfolio.

Figure 6-2 summarizes the key components of *reconfiguring* observed at *Company Soft*. They are organized according to the time horizon (i.e., short-term, medium-term, or long-term) of *reconfiguring* actions. The following sub-sections describe each *reconfiguring* mechanism in more detail. The two mechanisms, which had been newly put in place, recently modified or transformed, are highlighted with a bold border (and are discussed

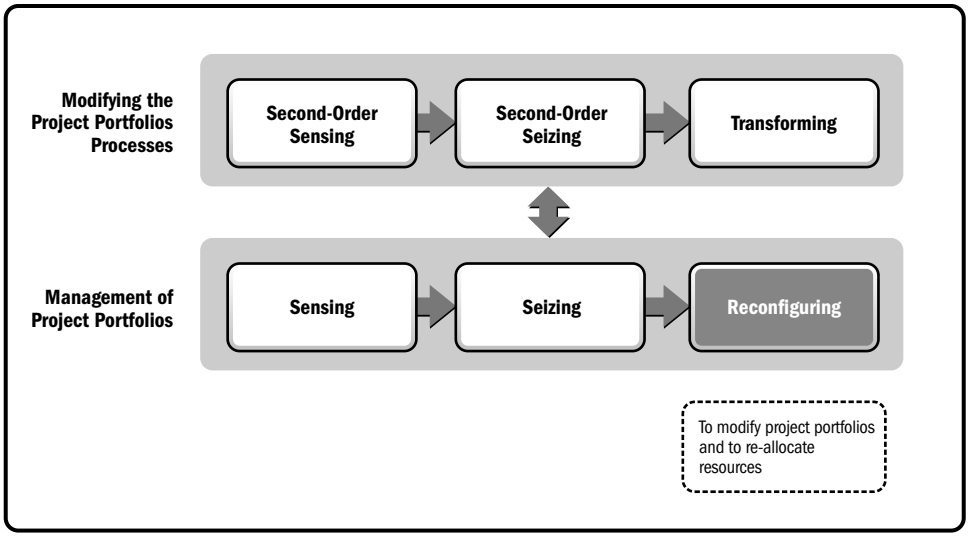

Figure 6-1. *Reconfiguring* Mechanisms in the Conceptual Framework

further in the context of *transforming* activities in section 6.5). Numbers in parenthesis in the subsection titles correspond to the numbering in the summary figures.

6.1.1 Scope-in versus Scope-out (R1.1) - (*Portfolio Soft1* only)

Three years ago, *Portfolio Soft1* used what they called a scope-out strategy, a methodology inherited from their project management tradition. They consciously started projects with a scope much larger than the capacity of the organization; going through the early phases of the projects (i.e., the prestudy and feasibility phases) allowed them to gradually decrease the scope of the project until the scope matched the organizational capacity to deliver. This occasionally caused some problems when the scope included too many compulsory or high priority features.

During that period, they frequently used scenario analysis techniques to plan and identify options when changes were requested to their already overloaded projects. In addition, change control boards for each project were used to monitor and control the baselined content.

This created a lot of wasted effort because many of the features for which prestudies were carried out never reached the execution phase. The manager of strategic planning at *Portfolio Soft1* summarized the reasons for transitioning to a new approach as follows:

> *We were scoping out, scoping out all the time, so we wasted a lot of effort doing feasibility on things maybe we shouldn't be doing or we had to cut out later on. At one point, they did some statistics that, probably 50 percent of all of the systems work that we did was a waste, because we never got to the market. Instead of doing that we decided to do it the other way, we should only scope-in the things that really, really matter based on the customer requirements. And then we study it and we want to make*

sure that whatever we study there is almost a 100% success rate that it gets into the next release of the product. (Strategic Planning Manager – *Portfolio Soft1*)

Portfolio Soft1 faces a very turbulent environment in which the product specification is very fuzzy and the customer demands continuously changing. In such a context, they try to minimize rework by postponing decisions until more information is available. They introduce a development process that allows them to postpone scope decisions as much as possible. These techniques of late locking and successive commitments correspond to what Olson (2006) calls flexibility in the process.

Because of the high level of uncertainty, *Portfolio Soft1* develops and implements a number of innovative approaches to help them remain flexible while reducing wasted efforts. They know that project content cannot be planned more than a few months (even sometimes few weeks) in advance. However, they still feel the obligation to communicate product release schedules to their customers. This gradually evolves towards what they

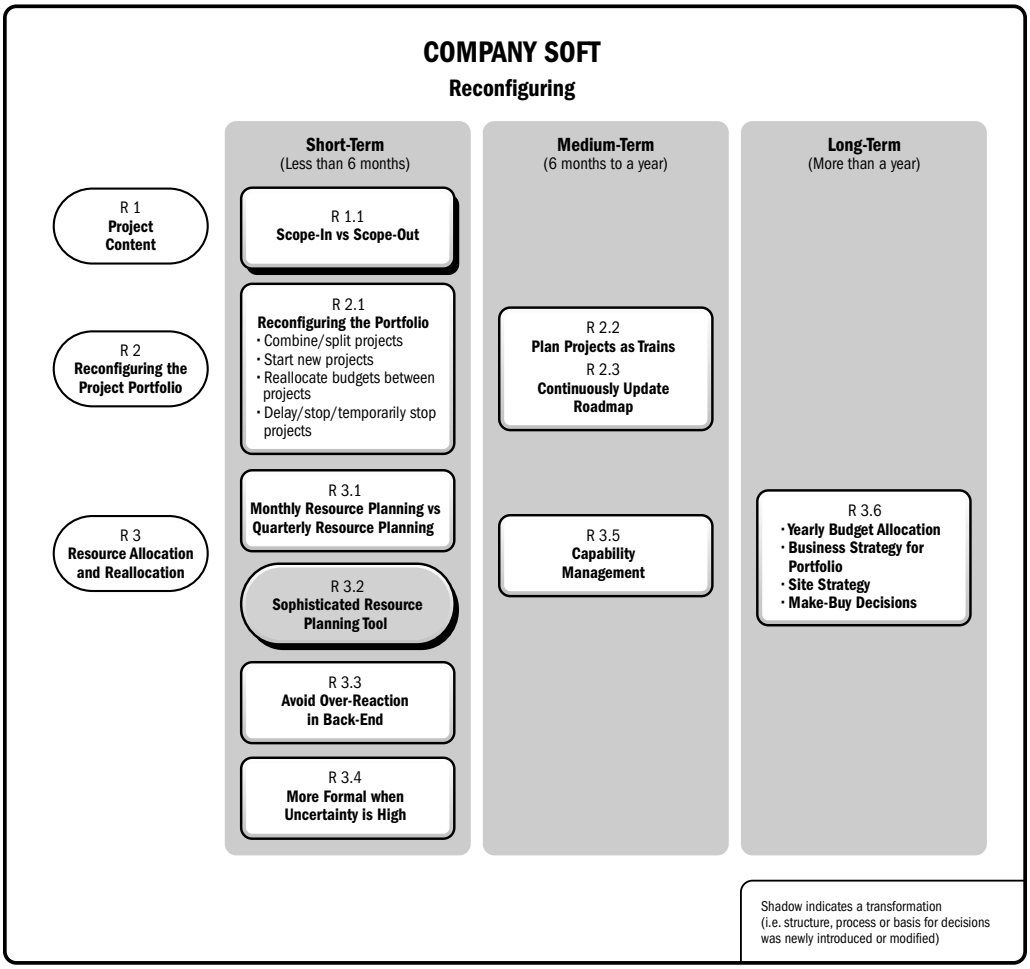

Figure 6-2. *Reconfiguring* Mechanisms at *Company Soft*

call a scope-in strategy. Quick studies and prestudies are done continuously (using the prestudy machine described in section 6.2.2) and content is gradually added to projects. The company uses a development model similar to *agile*. Target dates and approximate size of the project are assigned early in the development process. However, the content is defined continuously during the development phases with small delivery packages duration. These packages are then integrated into their software system in a lab and tested completely. Each delivery package includes the following phases: feasibility, design, and test. Each project includes five to six delivery packages, each lasting around four to six weeks.

When projects are initiated at Tollgate 0 (TG0), the objective is that only about 50 percent of the content is planned at TG1. This corresponds to the features having the highest priority. At this time, all hardware requirements for the release(s) should have been understood. Subsequent work packages are left available for subsequent addition of content; the project portfolio plan becomes a way to communicate the planned deliveries to customers without necessarily committing to its content. At TG2, the objective is to have reached 90 percent of the scope capacity if the project, leaving 10 percent for additional features during the project execution until TG3 where 100 percent of the content should be defined.

6.1.2 Reconfiguring the Project Portfolio (R2)

Short Term Reconfiguring of the Project Portfolios (R2.1)

Company Soft tries to deliver new releases of their product according to a fixed schedule. Despite these attempts, there are still regular changes to the projects in the portfolio, for example,

- **Project split into two projects:** This occurs when a project is considered too large or if a subset of the project scope was required for delivery to a specific customer before the end of the project.
- **Project stopped:** Stopping a project is very rare at *Company Soft*, is done reluctantly, and is an indication of failure. There is a mention of a project that has been launched to bring a given functionality in-house instead of buying it from a third party supplier. However, during the execution, it is realized that the cost of the project is not justified in comparison with the off-the-shelf product despite the opportunities to bring the competence in-house.
- **Project merged to the following project:** In *Portfolio Soft2*, there is one occurrence when a project outcome does not have a receiver. Because the design base is reused by the following project, all resources are reallocated to the next version of the project. This can be considered a special case of stopping a project.
- **Project temporarily put on hold:** There is a clear example of a project which is put on hold during the feasibility phase when the project manager realizes that the required resources will not be made available on time for the execution. In other words, the project has originally been planned too early in the multi-project plan. The project is not stopped but rather put on hold temporarily and the following tollgates are delayed accordingly.

- **New projects started:** Resources are normally fully allocated to projects in the short term (i.e., upcoming three to six months). This makes the addition of new projects difficult. There are some mentions of small projects being added which could gather some free resources or could negotiate with ongoing projects to free up some resources. The system manager at *Portfolio Soft2* provides the following example:

  In one case we had a new project that came up and we had resources that were available at the time so the bulk of the resources for this project was available but then we wanted few other resources from other projects and some of the deliverables had to be pushed up a little bit to accommodate for the need of those resources. (System Group Manager – *Portfolio Soft2*)

- Every effort is made to minimize the impact on ongoing projects. This is done only when there is a very good business case: most often an urgent feature to be delivered to an important customer. In the longer term, it is standard practice to launch new projects as resources are freed up from projects.
- **Project delays and cost overruns:** *Company Soft* knows the consequences of delays for the customers and for the organization. When a project is delayed, resources have to be held longer than expected and subsequent projects have to be replanned. In addition, resources that have been planned for subsequent projects have to be reallocated to the delayed projects. Every effort is therefore made to deliver on the promised dates. This includes overtime, reducing scope, removing planned test cases, etc.
- **Project execution moved to a different design center:** Although this type of modification to the project portfolio does not affect the project scope per se, it has significant impacts on the resource allocation. Such moves are most often done when the product is reaching its end of line and the PDU wants to reduce the hourly rates for the maintenance and upgrades of already established products.

Plan Projects as Trains (R2.2)

In the literature, the project selection process is depicted as a funnel. This has been replaced at *Company Soft* by a process analogous to the publishing of a train schedule where the train's arrival date and total capacity are known at the outset. However, the train leaves the station half-empty and content is added at several stops along the way. The notion of change to the scope is no longer relevant since the scope is progressively defined. Using this approach, there is no longer a need for change control boards, which have been replaced by the requirement request board (see section 6.2.2). The question becomes not so much whether the train will leave or not but rather what will be put on the different wagons at the time of departure and as the train progresses toward its destination. The scope does not have to be completely specified at the time of the train departure.

The duration of projects is approximately one year. However, within the projects delivery packages are planned every four to six weeks. Delivery packages include scope definition, design specification, software development, and complete testing. This gives ample latitude to add content during the project execution in subsequent packages; an approach which

reduces the need to continuously issue change requests. The director of the PMO of *Portfolio Soft1* summarizes this concept as follows:

> *Your multi-product plan becomes pretty much just wagons so that's the way we are moving, now how to add requirements into that is just to put another train, and they come and they go according to a certain schedule.* (Director of PMO – *Portfolio Soft1*)

Although the project content is continuously being defined and redefined during the project execution, the interviewees rarely use the word change in their discourse. This is because the planning horizon for a given scope (i.e., delivery package) is very short (i.e., approximately one month instead of approximately 12 months in the previous process). Interviewees rarely spoke about project selection and prioritization. They do not conceive project portfolios as a funnel or a shopping list to choose from. Projects are considered instead as vehicles to continuously deliver and update products.

Continuously Update Roadmap (R2.3)

The multi-project plan is normally composed of all known projects for the coming 18 to 24 months. This includes approved projects under execution but also future projects with tentative dates for key milestones and tollgates. At *Company Soft*, the steering groups plan a number of releases per year for the different nodes of the system. A typical target is two releases per year. It is mentioned during the interviews that a more frequent release would be difficult and costly for their customers to integrate into their systems.

The multi-project plan is updated monthly as a rolling forecast. Target release dates are considered very important. They are communicated to the customers as commitments from *Company Soft*. This allows customers to start planning their product rollout well in advance. Although the name and schedule of all projects are published, it is recognized that because of the high level of uncertainty, the exact content cannot be specified in detail up-front. Different mechanisms, such as the prestudy machine and the requirement request board are then put in place to manage the content of the projects as a continuous activity.

Once project managers get assigned to one of the future projects, more detailed planning information becomes available and tollgate dates get planned. For example, if a multi-project plan shows a tentative project being planned for the following year, the target tollgate dates are then shown as tentative. However, when project managers are assigned to the projects and the project planning begins, tollgate dates get firmed up. This rolling wave of project planning provides an ongoing basis for resource planning and for resource allocation (a topic discussed in the next section).

6.1.3 Resource Allocation and Reallocation (R3)

Monthly Resource Planning (R3.1)

Company Soft has a long tradition as a project-based organization handling multiple projects in parallel. More than 90 percent of the people in the R&D organization are assigned to one or more projects. The company is structured in a matrix organization based on multiple projects concurrently ongoing in multiple sites and multiple divisions. Some form of resource planning process has been in place for more than 15 years and is very well

established with clear roles and responsibilities, documented processes, corporate tools, and even user groups. It was initially driven by the finance department which needs the resource requirements to plan headcounts and to plan and monitor project portfolio budgets. The financial department then consolidated the budgets and the resource requirements at the portfolio level.

In addition, the line and project managers also use the resource planning data to plan the allocation of the resources to the projects. The regular process includes requests by the project manager for a number of hours (or full-time equivalents), per period (normally months), per role (e.g,. system tester, designer), and per organization. The line managers then respond with allocation of either bulk hours for a given role, for example, 3000 hours for testers between 1 May and 1 August, or specific names John Smith between 1 June and 15 July. This is based on the constraints and priorities given by product management and the PMO director. On the one hand, line managers try to match the capacity of their organization with the project demands, that is, the line managers assess if the resources in their department are properly allocated to projects (i.e., under- or overallocated), and on the other hand, the project managers determine if their projects are resource covered. They are able to compare their requirements with the allocation and determine the extent of the gaps for specific roles and periods.

Company Soft put in place a regular resource planning process based on sophisticated tools to monitor the allocation of the resources to the projects. In both portfolios, the responsibility to assign resources to projects is clearly a line manager function that is following the priorities assigned by the portfolio management. For many interviewees, portfolio management and resource balancing is more or less the same thing. There are a number of references to *capability management* and *pipeline management* (influenced by publications, such as (McGrath, 2004) understood as the ability of the organization to determine what is the capability of the organization in the future to undertake additional projects.

Projects normally start assuming that resources would be freed up by previous projects at a given time. However, if previous projects are delayed, the timing of the availability of some resources makes the project execution impractical. This is depicted by examples from *Portfolio Soft1* and *Portfolio Soft2:*

> *Our main problem was that the project preceding us and developing our design base had just started. And we could never catch up of course because we have to have our design base product ready before we start on our own development. So actually there was a period from April 2007 to October 2007 where we put the whole thing on hold. We kept some feasibility ongoing. I was only assigned part time, Integration and Verification was stopped, and the nodes development were working for the previous project* (Project Manager – *Portfolio Soft1*)

> *Typically what is happening is that we have planned this project and we estimate that this project will take one year and cost x person-months and maybe that was correct. However, the resources get tied up in a previous project which gets delayed. So we get a knock-on effect. Everything was correct in this project but the resources were not freed up in time. So this is typically the things that can happen.* (Product Manager – *Portfolio Soft2*)

Such events are very frequent at *Company Soft* where the line managers must regularly reassign resources from one project to another and constantly negotiate with project managers. This activity must sometimes be done on a weekly basis. Such situations are typical of the matrix organizations. However, it is important to note that the frequency of such reallocation becomes routine and an inherent function of the portfolio management in dynamic environments. Any change, any uncertainty in a given project implies direct consequences on the other ongoing projects especially if dependencies between projects are high.

Sophisticated Resource Planning Tool (R3.2)

Company Soft has developed an internal web-based tool to support this process. This means that data are continuously being kept up-to-date by project managers and line managers. This allows all the governing functions to base their decisions on more reliable resource data while continuing to provide the necessary data for the quarterly financial forecast. *Company Soft* also tried without success to purchase and deploy a commercial product integrated with their human resource and accounting systems. Most enterprise project portfolio management systems evaluated were offering functionalities to support the project selection and evaluation functions but most systems were not geared for the intensive resource allocation process required by *Company Soft*. This required an enormous amount of time, money, and effort but was considered the right course of action for this specific environment. Despite a costly project to evaluate tools to support the resource planning function, *Company Soft* decided to continue to rely on their internally developed application.

Avoid Over-Reaction in the Back-End (R3.3)

At *Company Soft,* the line manager is normally responsible for the resource allocation to projects. They have to determine who should work on which project at any point in time. This is normally accomplished by allocating resources to projects for different percentages of time over given periods. However, when faced with a very changing environment with numerous requests for fast changes, a line manager responsible for the back-end activities (i.e., integration and testing) indicated that she learned to never over-react to demands for changes until everything is confirmed, planned, and requested. This, she says, is to protect the organization from continuously re-allocating resources:

> *If the integration and verification group was to follow all changes we wouldn't do anything, other than just changing our project plans. So instead of just changing the plans every week we try to be a bit cool. The plan should be as good as possible and then we need to wait until the nodes sub-projects are a little bit further in their planning, so we can rely on what is being presented to us. Things are turbulent in the front-end and it costs a lot to act on the changes. If we act too quickly then we have to change and change and change and change, rather than to focus on what you are doing now.* (Line Manager – *Portfolio Soft1*)

This approach is somewhat counter-intuitive. It might have been expected that in very turbulent environments, the *reconfiguring* strategy would have been to reallocate resources quickly.

More Formal when Uncertainty is High (R3.4)

At *Company Soft*, a project organization is composed of subprojects, which are further composed of cross-functional teams, that is, teams of representatives from different functional groups such as design, coding, testing, documentation. Project managers ensure that the different teams know exactly what they have to develop through a number of meetings (kick-offs, reviews, etc.). The ordering process between the project managers and the teams is formalized by a document called an assignment specification. This is a two- to three-page document specifying the content to be delivered, the dates expected, the budget expected, etc. The team has to respond with a delivery plan, a cost estimate, and a duration estimate.

Team leaders and project managers are very familiar with this process, which can occasionally be fairly informal. However, according to a project manager in *Portfolio Soft1*, the ordering process becomes more formal when the level of uncertainty is very high:

> *If there are a lot of uncertainties then we will always be more formal. This will also be the case when the complexity and risk level of the feature is high [...] because then we don't want the development teams to start and go ahead with activities that we might have to redesign later. So then we have a more detailed discussion on what they are allowed to start development on and what they are not allowed to start development on because we don't have the full picture yet.* (Project Manager – *Portfolio Soft1*)

The main reason for this increased formality is to minimize the impacts of rework and to ensure that the decision to execute is consciously taken by the project organization.

Capability Management - Medium-Term (R3.5)

The resource planning and reallocation within project portfolios includes the short-term aspects discussed in the previous section: continuous resource planning, timing of resources and reallocation of resources, and the priority conflict between operational activities and project activities. All these processes have a time horizon ranging from a few weeks up to approximately a year. In addition, *Company Soft*, tries to introduce some additional planning activities to bridge the gap between their business plan which plans four to five years ahead and the portfolio activities which plan 12 to 18 months in the future. Interviewees called this planning activity *capability management*. The exact interpretation of this term seems to vary considerably throughout the organization. However, the most typical usage refers to the process of analyzing the requirements for the number of people required to meet the needs of the business plan. This includes the analysis of the required competence build up in comparison to the needs of the product development in the product life cycle:

> *So it was very obvious that rolling forecasts of specific individuals for the next 18 months was not the type of capability plan that they were looking for to answer this portfolio plan. We had to start to understand first of all the portfolio plan to see if we have the right kind of people with the right competencies. Capability has different meanings to different people. There's organizational capability, strategic capability and resource capability. Resource capability is very much about renewal of resource competences. And that is also not to be confused with capacity, capacity like the number of man-hours you can you put out in a year.* (Operation Development Manager – *Portfolio Soft1*)

A number of senior managers at *Company Soft* point out that they are under pressure to increase R&D efficiency. One of the medium- to long-term strategies used to get the most of the R&D money is to identify the most cost-efficient location to execute the different project tasks in the project portfolio. There is normally a mapping done between the departments of every R&D site and the project portfolio in terms of headcount, hourly rates, and competences required versus available. *Company Soft* tries to match the resources with the project demands instead of the other way around. The PDU manager of *Portfolio Soft1* sees this as his responsibility:

> *I am involved in translating the portfolio content into a budget so that we can look at our agreements, our run rates, headcount, and where we can best execute the job. So if we look at the work required to develop a given object in the portfolio we can say for example, we can do that in low cost country. I am also involved in the make/buy analysis where we look at a product's maturity; we estimate what is its strategic value to the company in comparison to our internal competence.* (PDU Manager – *Portfolio Soft1*)

Long-Term Capability Planning (R3.6)
When the competence is of strategic importance for *Company Soft* every attempt is made to develop it internally and ideally as close as possible to the head office. If it cannot be developed quickly, alliances will be created with third party suppliers (part of the make/buy decision). As the product matures and the competence becomes less strategic, the responsibility of certain products will be moved to low cost countries. For example, *Portfolio Soft1* will rather use their top skilled resources to develop the leading edge technology rather than for the maintenance of their established product line. *Company Soft* also tries to maintain some level of flexibility in their site strategy by developing primary and secondary sites. One location is responsible for a product and a second site supports with resources and competence when there are peaks in demand. This provides some flexibility if the complete responsibility needs to be transferred from one of the two sites. In some countries, they also try to maintain some flexibility in the number of resources available for their portfolio. This is normally done by sites supporting more than one product as mentioned by the *Portfolio Soft2* PDU manager when talking about the R&D site in Russia:

> *We have some buffers in Russia where we have some kind of agreement where we have around 20 people that can ramp up with no additional costs. We have also some possibilities in the USA where it is quite easy to move people around.* (PDU Manager – *Portfolio Soft2*)

6.2 Seizing

This section presents the different *seizing* mechanisms used in the two portfolios at *Company Soft* to determine and decide on the *reconfiguring* actions discussed in the previous section. This section refers to the *first-order seizing* as highlighted in black in the lower part of the conceptual framework of Figure 6-3. *Seizing* includes *organizing mechanisms* for deciding changes to the project portfolio once a potential need for change has been sensed.

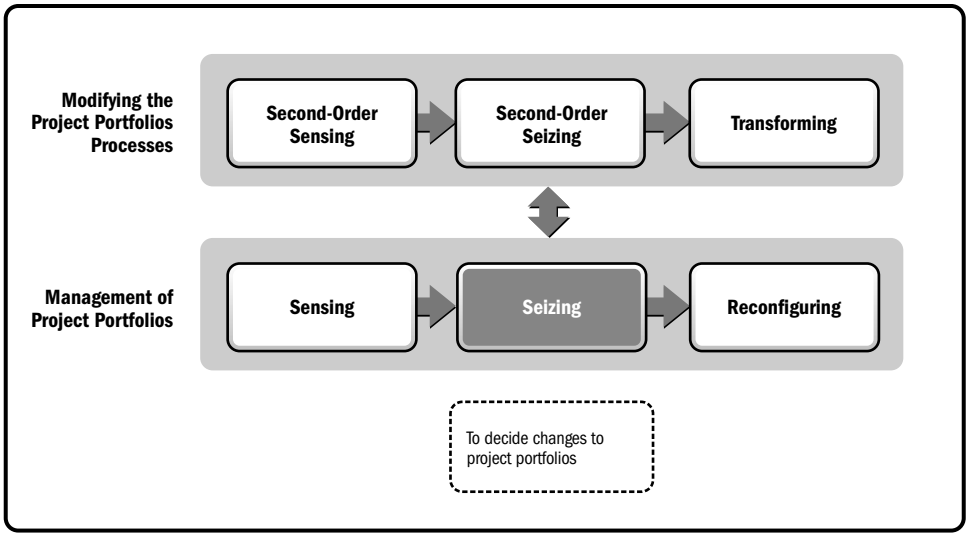

Figure 6-3. Seizing Mechanisms in the Conceptual Framework

As shown in Figure 6-4, the *seizing* mechanisms can be grouped into three main categories:

- product portfolio management;
- project scope management; and
- project portfolio governance.

These three components can be further decomposed into a number of structures and processes, discussed in the following sections. Two mechanisms which have been newly put in place, recently modified, or transformed are highlighted with a bold border (and are discussed further in the section 6.5, on *transforming*).

6.2.1 Product Portfolio Management (SZ1)

Three mechanisms have been grouped under the heading *Product Portfolio Management:* product planning board (structure), product management process (process), and the business model used for *seizing* decisions.

Product Planning Boards (SZ1.1)

Planning the scope of projects at *Company Soft* is a very complex process involving a large number of committees and decision boards. Appendix G summarizes the roles of some of these boards. At the highest level, the *Product Area Product Council* defines the longer-term strategy for the product and takes the product decisions. Product decisions include, but are not limited to opportunity analysis, start project investment, include in portfolio, start project, start of sales, end of sales, and end of support.

There is then a cascade down according to the level of authority and the level of the product in the hierarchy (e.g., system, node, and feature). For example, the *Product Management*

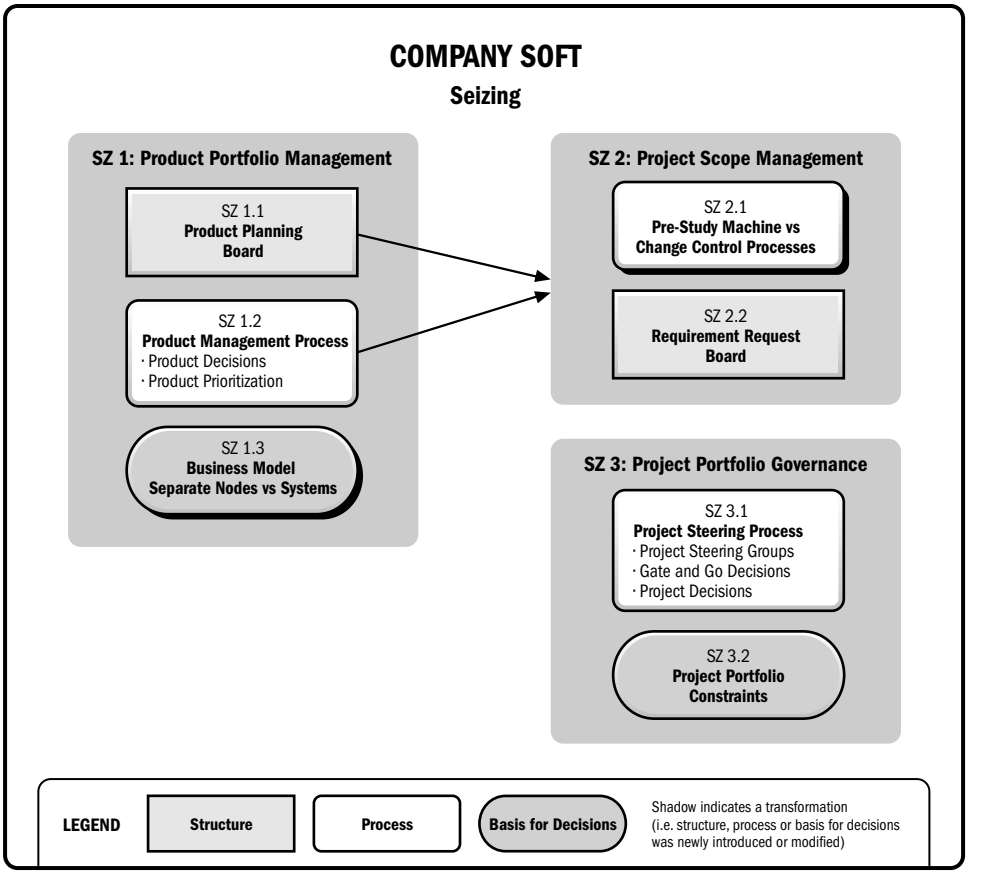

Figure 6-4. Seizing Mechanisms at *Company Soft*

Forum is a preparatory meeting to *Product Council* and handles minor product decisions and some product issues delegated by the *Product Area Product Council.* At the operational level (i.e., at the level closest to the continuous scope definition of the project portfolio), the *Product Planning Board* is the main coordination forum for product managers.

In that board, they set priorities between features and between nodes, as explained by a product manager at *Portfolio Soft1*.

> *We have what we call a product planning board. Every requirement will go into the product planning board and what we do is to analyze the requirement and see if it's possible to develop it, what priority it will have, how it will affect the system. And then we have to decide if it goes into the future product plan or if it goes in as a change request for an ongoing project. This goes for all the requirements even if it's future requirements.* (Product Manager – *Portfolio Soft1*)

Portfolio Soft2 also has similar product management forums with the additional complexity that representatives from their different internal customers are represented to lobby for their PDUs when defining the portfolio content.

Product Management Process (SZ1.2)

Company Soft clearly makes a distinction between product portfolios and project portfolios. The first refers to the appropriate mix of products, including the specification of the required attributes, the definition of the market demand and planned growth, business case, etc. This is normally displayed as a product roadmap showing the delivery of key packages of products over time. The project portfolio refers to the translation of the product portfolios into a series of projects delivering the required releases over time. The product management process is very well documented.

The complete product life cycle includes a number of subprocesses:

- define business opportunities;
- define content;
- market launch;
- increase business; and
- phase-out.

The role of the product managers includes the specification of the project content. The product managers are involved in both *sensing* and *seizing* activities, in particular requests for change to the project portfolio.

Clear and formal product decisions between each phase of the process have been defined. Examples of such decisions are opportunity analysis, include project in portfolio, start of product sales, start of product phase-out, end of support, and product termination. These decisions are in direct relation with the project portfolio decisions and the gate decisions of the project.

This process and the clear definition of product and project decisions lead to formal decisions on resource allocation to projects within the portfolio (as described in the *reconfiguring* section 6.1). They are good examples of *seizing* mechanisms in dynamic environments.

Business Model (SZ1.3)

The business model defines how enterprises deliver value to customers. According to Teece (2009), business models

> reflect management hypothesis about what customers want and how an enterprise can best meet those needs, and get paid for doing so. They embrace (1) which technologies and features are to be embedded in the product or service; (2) how the revenue and cost structure of a business is to be designed and if necessary "redesigned" to meet customer needs; (3) the way in which technologies are to be assembled; (4) the identity of market segments to be targeted and (5) the mechanism and manner by which value is to be captured. The function of a business model is to articulate the value proposition. (p. 24)

From the choice of business model ensues many other decisions. It forms the basis for the planning of the product, which translates in the case of PPM, into the product portfolio and project portfolio structure. It also covers how the product will be delivered, will be sold, and will be released to customers. The reason that business model is discussed under *seizing* is that it forms the basis for selecting opportunities, grouping features and products,

packaging them together. Consequently, alignment with the strategy is maintained through the project selection and resource allocation.

At *Portfolio Soft*, the business model evolved from delivering fixed standard projects to customers (a model which was very successful for other *Company Soft* products) to delivering a product which is easily adaptable to customer needs. This is because no customer wants exactly the standard solution. They all have specific needs and exceptions and the standard product has to be adapted to their needs anyway. There is therefore a very strong push towards highly flexible and configurable products which make it more complex to integrate and validate. *Company Soft* is trying to develop nodes individually but still offers what they call *business solutions*. This corresponds to a combination of nodes which can be selected but which are known to offer certain services together. The sale of the product includes a large element of services to configure the product. This contributes to the revenues of the services division.

At *Portfolio Soft2*, they moved from an organization developing platforms to one developing components. As described in section 5.2.6, *Portfolio Soft2* changed its business strategy (and even its name) from a *platform* development organization to a *component* organization. The concept was borrowed from an enterprise in the automotive industry (where they shifted from developing platforms for car and truck platforms to developing components such as engines, differentials, etc.).

Applied to *Portfolio Soft2*, this concept represents a significant shift in strategy and in the business model. Instead of 18-month projects to develop, test, and integrate platforms including multiple components which would be distributed to all the other PDUs, they now develop components (or occasionally a small group of components) which can be selected individually. This very significant business model change has a direct impact on the type of projects and on the structure of the portfolio. This new business model drives many of the business decisions related to the release and packaging of the scope into the projects.

The decision to change the business model is a very important *transforming* decision (which is discussed in section 6.5). Once a given business model is selected, it can remain in place for many months (if not years) as the regulating mechanism for the dynamic capability flow of *sensing-seizing-reconfiguring*. However, if it does not meet the particular environment in which it applies, organizations modify it. This is the case for both *Portfolio Soft1* and *Portfolio Soft2*, which decided to modify their business model.

6.2.2 Project Scope Management (SZ2)

Prestudy Machine versus Change Control Boards (SZ2.1)

The software development process at *Company Soft* historically included four phases: prestudy, feasibility, design, and test. Parallel projects include all phases and each project would manage the different phases as shown in Figure 6-5. This is then followed by release activities and deployment at customer sites.

The traditional approach to address scope change at *Company Soft* is through change control boards (CCB). The boards are composed of the project management team and of product management who must evaluate the demands for changes to the project scope, which

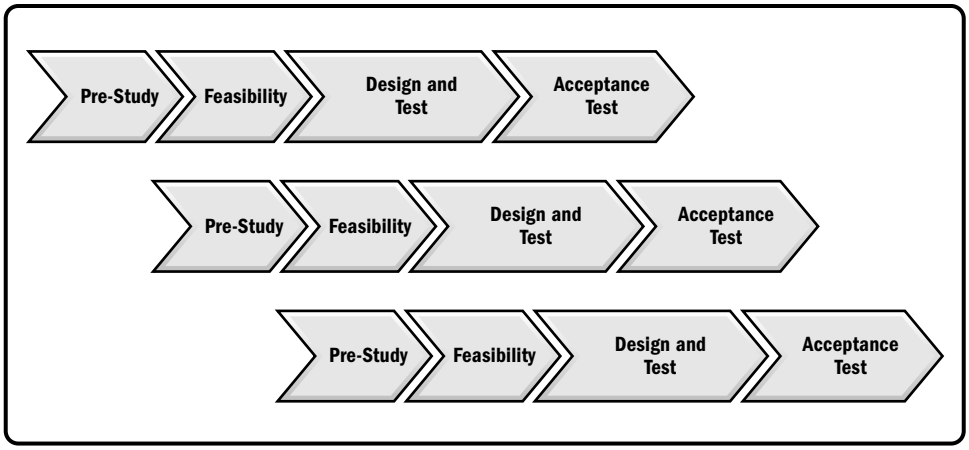

Figure 6-5. Traditional Approach Using Pre-studies Within Projects

are formally documented into change requests. Change requests are sent and assessed for their impact on the project. CCBs are typically used by project managers to control the scope of the individual projects. Formal decisions are taken to either implement the change request (and if so in which delivery) or to reject it. When *Portfolio Soft1* was established, the amount of scope change in the first few projects was extremely high. The management felt that there was a lot of waste on studying and designing features which had to be removed later. Three interviewees mention that there used to be a 50 percent hit rate on the requirements, that is, only 50 percent of the requirements identified in the early phase of the projects reached the end of the projects.

Because the inflow of new requirements is continuous during the year and the project scope cannot be planned for the whole year, it was decided to combine the prestudy activities that used to be performed in each project into common activities, called the prestudy machine (as shown in Figure 6-6). In this model, the inflow of requirements to the projects goes via a common process where the inflow of new requirements is assessed, filtered, and prioritized using a very formal process.

Based on shorter studies, product management can decide to remove a requirement from the inflow, to include it in an ongoing project, or to wait to include it in future projects. Using the prestudy machine model, the addition of requirements into the projects is no longer considered *changes* but becomes more the normal way of working. The line manager of the system group summarizes this new way of looking at scope management as follows:

> *Since we have scope-in, we don't see additional requirement as changes anymore. That's the normal way. We get new big, high priority requirements in and then we might need to put some more people in the pre-study machine. We would handle that and then maybe, later on, move them back to the main development. The pre-study machine is not really a project, it continues each year.* (System Group Manager – *Portfolio Soft1*)

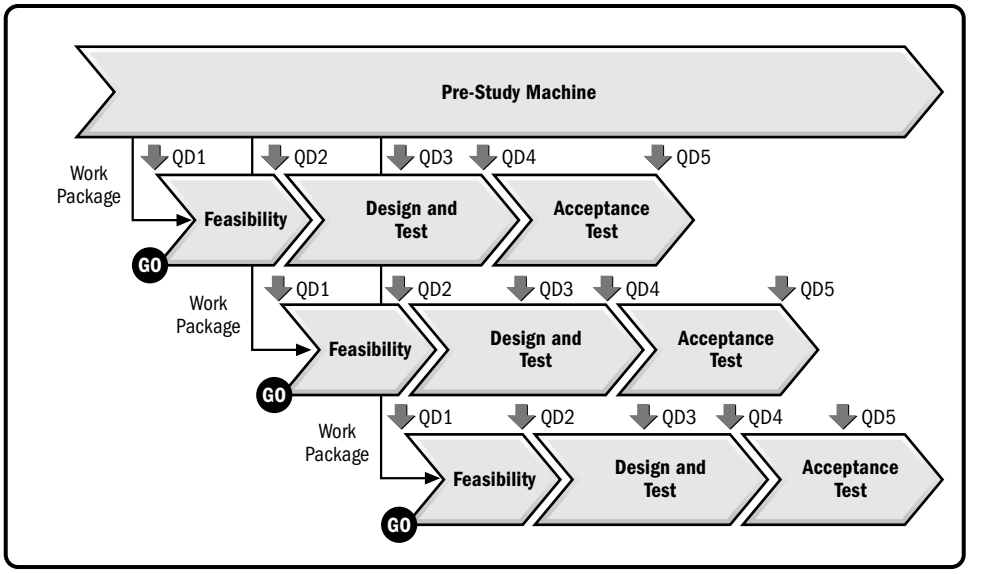

Figure 6-6. Prestudy Machine Overview

(Source: Internal document at *Company Soft*)

For the manager responsible for the pre-study machine, this is a step towards a more process-oriented approach. For him projects should be kept for unique undertakings not for enterprises that develop products on a continuous basis:

> *Projects are supposed to be extraordinary; different from the everyday business it should be separated in time and scope and budget and resources used. However, we know today that the most efficient way of developing software is to have the same team working together for a long period of time. That tells me that we are not having a specific assignment for this group for a limited time, i.e., we do not have projects.*
>
> *You could argue that project management methods, as they have developed, is a way to make things more orderly, more visible, and more manageable. And they are very good as long as you can specify you want to do. Now let's go and do it. But we have a problem with projects in very dynamic environments because they are not unique in time and it is not even known what it is supposed to do. To organize it as project is pretty stupid. We should see most of what we do as continuous processes not as projects.* (System Engineer [responsible for pre-study machine] – *Portfolio Soft1*)

To support the prestudy machine process, a new board was created, the requirement request board. The role of this board is discussed in the following subsection (SZ2.2). The introduction of a completely new process at project portfolio level supported by a new board is another example of a *transformation* to adapt to highly volatile environments (which is discussed under *transforming*, in section 6.5). Since the prestudy machine has been introduced, it is felt that there is no longer a need for change control boards at the individual project level.

Requirement Request Board (SZ2.2)
The requirement request board is chaired by a senior member of the system group in collaboration with product management. Its main responsibility is to analyze the inflow of requirements using the prestudy machine. This process is continuous and is run in parallel with the feasibility and execution of ongoing projects as shown in Figure 6-6. The roles of the requirement request board are threefold:

- to translate the customer needs identified by product managers into product requirements;
- to evaluate the development cost and duration; and
- to decide into which project to include the new requirements. The investigations of individual requirements are fairly quick and lead to a decision to incorporate them in a specific delivery package of a specific project.

6.2.3 Project Portfolio Governance (SZ3)

Project Steering Process (SZ3.1)
Project portfolio governance is typically described in the literature as a small number of interlinked bodies having specific and clear responsibilities within a hierarchy. In the PPM literature, the governance structure is typically described using a limited number of well-defined roles: sponsors, portfolio managers, PMOs, a portfolio governance board, and project managers. For example, Müller (2009) displays portfolio management as a direct link between the board of directors and the project/program steering groups, which could be supported by a combination of strategic and tactical PMOs. *The Standard for Portfolio Management* (Project Management Institute, 2008b) describes the role of the portfolio manager in detail along with the different subprocesses included in portfolio governance but makes little mention of the governing bodies.

In comparison, the governance structure put in place at *Company Soft* is much more complex and the portfolio governance responsibility is spread among a multitude of intertwined bodies and groups each responsible for a subset of the governance aspects. In *Portfolio Soft1,* there are numerous boards such as: key project operation steering groups, operation steering group, project steering group, operations management team, product handling board, product councils, product priority board, requirement request board, product management forum, node planning board, and assignment handling boards (see Appendix G). Table L-1 describes the steering bodies while Table L-2 describes the committees involved in deciding the scope of the projects within portfolios.

The portfolio management function is not centralized into a single person with all the responsibilities of a portfolio manager. The responsibility is split among dozens of people each looking after specific aspects (product managers, product development unit manager, node managers, portfolio planners, and financial controllers). The person having the role of project portfolio manager in *Portfolio Soft1* takes care of the project portfolio with respect to balancing resources and budget. This excludes the responsibility for content and business profitability, which is covered by the product management role. Product managers are responsible for the scope of projects and product road map, the product development unit

manager is responsible for the optimal use of the R&D resources, and the PMO director who is responsible for the planning and monitoring of the projects. The PMO director is also responsible for the most efficient delivery of projects, that is, to ensure that the tools and methods are in place to ensure the delivery on time, cost, and scope. There are also different levels of planning boards to ensure that the organization has enough capacity and competence to execute all the projects being requested. These boards support the *resource balancing* function.

Project Portfolio Constraints (SZ3.2)

It was expected in this research that at the project portfolio level the three variables used in project management (time, cost, and scope) would be present and handled in a similar way. However, during the interviews, it was clear that one of the variables, the project portfolio budget, was always untouchable. In all portfolios, the overall yearly budget for a given project portfolio is considered fixed and non-renegotiable. Portfolio budgets are approved at a very high level in the organization after long analysis and negotiations in the allocation of money between portfolios or product areas.

This means that when individual project budgets within the portfolio are exceeded, some rebalancing has to be done to remain within the portfolio budget. This takes one of the following two forms:

- reassignment of money from one project to the other while staying within the overall portfolio budget; or
- delay of some projects (or some parts of projects) to the following year.

An additional constraint is the allocation of portfolio budget within calendar years rather than for the required duration of the complete portfolio. At the highest level, allocation of financial resources is cascaded down to large project portfolios, which are broken down into smaller portfolios (or sub-portfolios or programs).

6.3 Sensing

This section presents the different *sensing* mechanisms which are put in place in the two project portfolios at *Company Soft* to identify the changes in the environment and translate them into potential new (or changed) requirements for the projects. This section refers to the *first-order sensing* as highlighted in black in the lower part of the updated conceptual framework of Figure 6-7.

Sensing refers to structures, tools, and processes to sense, filter, and interpret changes and uncertainty. In the PPM context of *Company Soft*, this includes the proactive assessment of the evolution of third party products, technology, competition offering, the match between the products offered and the customer needs, new customers, market growth, and new applications of the products.

Figure 6-8 displays the relationship between the sources of uncertainty and the *sensing* mechanisms at *Company Soft*. The *sensing* mechanisms are linked to the *seizing* mechanisms, which are used to decide on the resulting reconfigurations and reallocation of resources in the project portfolios.

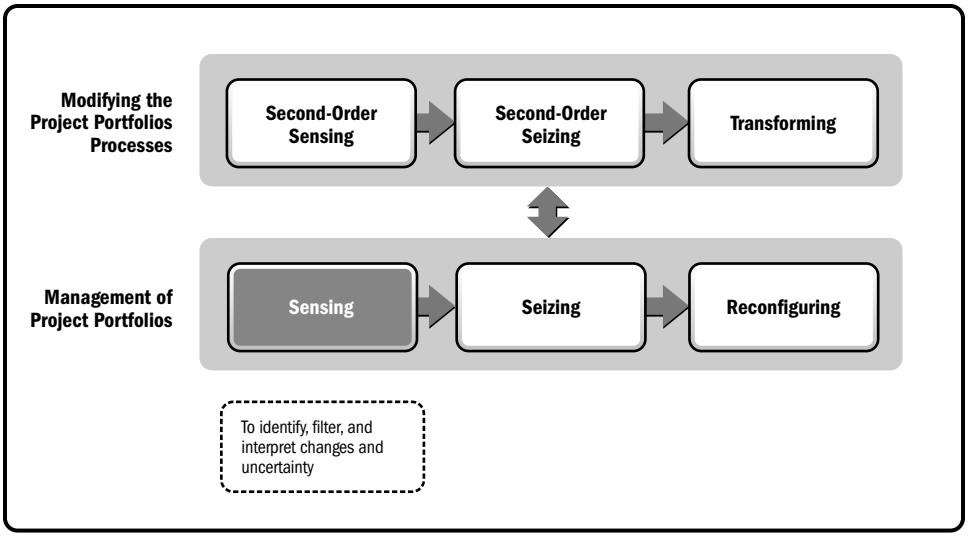

Figure 6-7. *Sensing* Mechanisms in the Conceptual Framework

The mechanisms are categorized as: structures, processes, or tools according to the color legend in the figure. Mechanisms which were newly put in place, recently modified, or transformed are highlighted with a bold border. These modifications to the *sensing-seizing-reconfiguring* result from transformations that are discussed in section 6.5.

6.3.1 Dedicated Role for Specifying Content (SS1)

The identification of customer requirements and its translation into product specifications is most likely the most important *sensing* mechanism in a new product development project portfolio. In the case of *Portfolio Soft1* and *Portfolio Soft2*, this responsibility is assigned to product managers who are responsible for keeping in contact with customers through the sales and marketing departments. Product managers are responsible for the business success of the products and, among other things, have to decide on the scope of projects. This includes the identification of any subsequent changes and its inclusion into the relevant projects when required. They are responsible for all product content and ultimately the product benefits. However, they are rarely assigned a role within the projects. They are considered to be the people placing orders to projects. Respondents frequently point to product managers as being the prime source of changing priorities and project scope.

In the case of *Portfolio Soft1*, there are many product managers (around 50 people) within a product management department. The manager of that department is responsible for the complete scope of the project portfolio but has delegated the responsibility of the different components of the product to the respective product managers. It could therefore be argued that the manager of the product management department is responsible for the complete portfolio content, although not directly but through a complex mixture of delegation of authority to product manager, evaluation and prioritization processes, and governance boards.

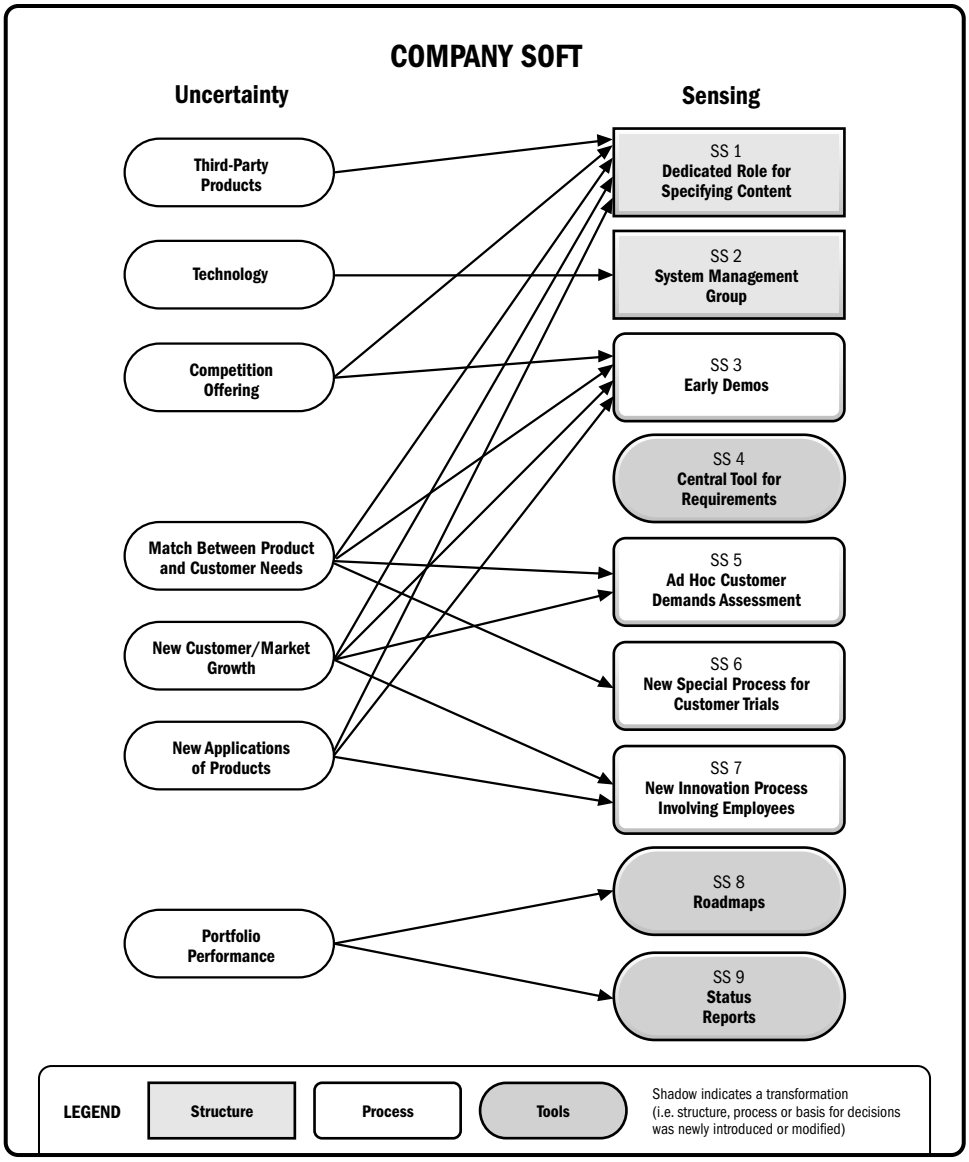

Figure 6-8. *Sensing* Mechanisms at *Company Soft*

Portfolio Soft2 also has a product management group although much smaller than *Portfolio Soft1*. Product managers are responsible for identifying the requirements and project scope and for sending assignment specifications to projects (i.e., the specification of what projects have to deliver in terms of scope, target date, and target budget). Product managers have to stay in touch with the market which in the case of *Portfolio Soft2* is the different internal PDUs using their platforms (or components). As in *Portfolio Soft1*, the manager of the product management group is responsible for the entire product line and delegates some authority to product managers at the lower level products.

Links to Seizing

It is not always 100 percent clear how to dissociate the *sensing* and the *seizing* functions when it comes to determining how a given structure or process is put in place in a complex organization such as *Company Soft*. Because they are heavily involved in both functions, the product manager is an example of a dual *sensing-seizing* function. Product managers are not only involved in assessing the trends in the customer needs (through the *sensing* functions) but they must also translate them into project requirements through the *seizing* mechanisms of product portfolio management (SZ1), discussed in section 6.2.1.

In the case of *Company Soft*, the identification of the requirements is done first by product managers. The requirements are then filtered and prioritized by the product management processes and the product management boards. This might be followed by a number of cycles between the project scope processes and product management processes (based for example on the estimation of the cost to develop a given feature).

The *sensing* mechanisms used by the product managers (and described in more detail in the sub-sections 6.3.2 to 6.3.7) are used to identify the requirement (somewhat like a radar screen) and to serve as filtering functions (like funnels for ideas). The key elements of these functions are

- to identify these requirements;
- to rank the importance of the requirements against each other; and
- to interpret weak signals which might become important later.

6.3.2 System Management Group (SS2)

The establishment of a system management group responsible to identify technology advancements and potential technology improvements to their products is a standard practice at *Company Soft*. System architects and technical coordinators from this group are assigned to the projects. Their main roles are these:

- to follow technology evolution (both internally and externally) and identify consequences for the products;
- to assess impacts of new requirements on the projects using quick studies. These studies take around two to three weeks to be written (compare to two to three months for a complete pre-study) and provide a high level cost estimate and an idea of the complexity to implement the requirement;
- to follow-up the implementation of the requirements and ensure that they would comply to the initial intent of the customer requirements; and
- to maintain the integrity of the overall system architecture.

Different techniques are put in place to keep the organization abreast of the evolution of the technology as described by the director of the system group at *Portfolio Soft2* mentioned:

> *Technology advancements come from my department. You have to be looking out there for what seems to be happening in the technology and then reflect that back. [. . .] There are few ways of doing it and we do them all: one is to participate in various fora within Company Soft and have a broad network of people. The other one is also having discussions and work groups with our customers because they sometimes come up with*

technology advancements. This is in addition to trade shows, contacts with product managers and marketing, etc. (Director of System Group – *Portfolio Soft2*)

The system group in *Portfolio Soft2* is composed of approximately 20 people. They act as an important interface between product managers and the projects. While product managers focus on the project content and the overall profitability of the product, the system managers translate customer requirements into technical specifications of the products to be developed. System managers (sometimes called technical coordinators) are normally assigned to coordinate pre-studies, that is, the activity to estimate the work involved to implement the requirements, and to follow-up on their implementation in the projects. In the case of *Portfolio Soft1*, such a coordinator is a dominant figure to decide in which project (or which delivery of which project) requirements will be assigned.

Links to Seizing

System managers are not only involved in the identification of technologies which might impact the product but also are involved in the decisions on how to implement these requirements in the product. This connection is done via the project scope management mechanisms (SZ2), which is described in section 6.2.2. In practice, the project portfolio scope has to be balanced between the technology evolution (for example, improved platforms that improve the performance or the architecture) and the development of new functionality.

6.3.3 Early Demonstrations (SS3)

Prototyping and early delivery are well-established techniques to proactively get feedback from customers when the exact needs are highly uncertain or ill defined. Such techniques are used in both portfolios, at *Company Soft*, although to different extents and for different purposes. In *Portfolio Soft1*, this is used to develop new ideas and show potential new products to customers in very early development stages in their own laboratories, at customer sites, or in trade shows. This technique is used to identify and validate the product requirements at low cost before the development of the complete product, which involves more extensive testing and documentation.

In trade shows, prototypes can be shown to customers to generate reactions on the functionality, to probe interest to become beta site candidates, and to assess interest from the market. Demonstrating a potential product, even if much of the functionality is far from being ready, provides means whereby potential customers can voice their reactions and generate ideas alongside representatives from *Company Soft*.

Trade shows are yearly events and cannot provide continuous opportunities for *sensing* the customer needs. Demo rooms are therefore set-up very close to the design center and are used as showcases for applications of potential products. Customers, employees, and third party suppliers are invited to see the demos, give feedback, and ask questions. For any participant to these demos, it is very clear that they are in the middle of the development area with direct access to developers and engineers. This is very different from the room used by the marketing department for completed products, which is more luxurious and sales focused. In the early demo laboratory, everything is put in place in the lab to trigger discussions, suggestions, and ideas. All this early interaction with potential customers

contributes to a better comprehension of the product requirements and continuously generates changes to ongoing and future projects.

Portfolio Soft2 has less elaborate prototypes. However, in the same spirit they try to release early deliveries (i.e. not fully tested products of their platforms and components) to internal customers in order to gain feedback. This also allows the receivers to start developing their own applications earlier. When such releases occur, the exact state of the product is clearly presented and communicated to the receivers.

Links to Seizing

The *sensing* of the environment through demos and early prototypes generates requirements which are treated in the same manner as any other requirement by product managers (SS1), and the system management group (SS2). They are documented using a central tool; they are evaluated, categorized, and prioritized via the product scope management mechanisms (SZ2) which are described in section 6.2.2.

6.3.4 Central Tool for Requirements (SS4)

As discussed under SS1 and SS2, product managers and system managers continuously translate customer needs into product requirements. This can rapidly amount to thousands of requirements with different levels of evolving priorities that must be continuously managed. A tool is therefore required to support these activities.

The specification of requirements involves a large number of people at *Company Soft*: product managers, system managers, project managers, and software developers. This process includes assessing priorities, business cases, impacts on the different nodes of the system, etc. Once requirements are approved for specific projects, they can always be changed afterwards using change requests and through the requirement request board. This creates a very complex administrative task to collect, prioritize, analyze, and map all requirements to the different projects. Centralized tools to manage and control the requirement specifications are implemented and deployed to assist in this task and as the PMO director commented:

> *We have continuously increased the alignment of how we handle requirements through the organization. Some years ago there were different requirement tools in the different parts of the organization; I think that it was quite messy. Everyone had their own way because they had their own ways of driving the design of their specific node. Now we use a common tool and the more you use that tool, the more transparency you get. Everybody knows what is coming. You can actually monitor that in a common space.* (PMO Director – *Portfolio Soft1*)

This becomes particularly useful when only a subset of requirements is implemented in a given project and subsequent updates are developed in subsequent projects. An additional benefit is the ability to assess the quality of the product delivered by mapping the test results to the scope specification.

Links to Seizing

Although the tool is first and foremost meant for keeping an inventory of the product requirements, it is also used to document the impact, the priorities, and grouping of product

specifications to the projects in the portfolio done in the *seizing* activities. Once requirements are selected, additional information is added in the requirement database during all project phases (e.g., functional specification, design specification, test reports).

6.3.5 Ad Hoc Customer Demands Assessment (SS5)

The *sensing* mechanisms (SS1 to SS3) discussed previously are proactive. They are put in place knowing that changes and uncertainty will be continuously present and not only a one-time event. In both portfolios at *Company Soft*, there are numerous occurrences of customer demands for modifications and customization once projects have been approved. There is not a uniform process to address these ad-hoc demands but they normally come through the local contacts, that is, sales and marketing representatives in the country of the customer. They are most often treated like any other requirement using the central requirement tool.

Company Soft treats all these demands very seriously. One of the managers responsible for organizational development mentioned a case where a customer demand was left unanswered for many months because of internal re-organization. When the customer realized this, it became a very high priority, which had to be included in an ongoing project with highest priority. This also resulted in a much higher cost.

Following this event, *Company Soft* started to *measure* the time between when an idea is identified from customers and the time it is included in a project. These measurements showed that although the time to design and develop the product once the content is defined is equivalent to the competition, the front-end period to decide the content is much longer than for competitors. This focus on time to decision allowed them to identify the critical bottlenecks in the decision process preceding the launch of projects or the inclusion of features in projects.

Links to Seizing

The ad hoc demands have to be assessed using quick studies to understand, at a high level, the impacts on the system and on the ongoing projects. Their priorities have to be compared to ongoing activities on a case-by-case basis using the normal project planning process (or the change request process described in SZ1 in section 6.2.1).

6.3.6 New Special Process for Customer Trials (*Portfolio Soft1* Only) (SS6)

Portfolio Soft1 introduced specific activities related to customer trials. Trials are used by some customers to compare the different vendors against each other using a set of test cases representative of their requirements. Some of these evaluations can take many months. In such evaluations, vendors must meet a predefined percentage of test cases to be considered in the following phases of the evaluation process. This is considered an important mechanism for the following reasons:

- to identify product requirements against customer demands;
- to compare *Portfolio Soft1* products against competitors' products; and
- but ultimately to get contracts with large customers.

Trials with some strategic customers are considered key to *Portfolio Soft1* success. The qualification for subsequent market evaluations is based on the successful completion of test cases that has to exceed 90 percent. A special program was therefore set-up to ensure that test cases would be executed successfully in the customer labs. The team on site is supported by designers back in the R&D centers who can patch the system quickly to make it work. It is made known to the customers that some of these features are prototypes and that they could not support large number of customers but at least test cases are demonstrated quickly.

This process is presented under the *sensing* section because although some development is performed (through *seizing* and *reconfiguring*), the features developed are not considered permanent and have to be redone using the normal product development process. The feedback received during the trials is used to identify additional requirements or modification to the existing requirement for future projects. This is an ideal *sensing* mechanism; being at the customer site with an interested customer testing the product and requesting enhancements before the final product development. One of the senior managers of *Portfolio Soft1* comments as follows:

> *Now what drives our portfolio content is often customer demands coming in very quickly and saying "We want this, we want that" rather than through the traditional demands from the market, i.e., collect the information, write the portfolio plan, and send it to the R&D organization. Now it's trials, I think, which is the key process driving the content.* (Senior Manager – *Portfolio Soft1*)

During the trials, customers occasionally make demands just to test the ability of *Portfolio Soft1* to deliver products quickly. Customers understand that the product is not quite ready but they want to ensure that the bases for future development are in place.

The introduction of this new process is an example of a transformation of the processes introduced to cater for a change in the external environment, in this case to adapt to new ways customer demands flow into the organization. This is discussed further as a *transforming* mechanism in section 6.5.

Links to Seizing and Reconfiguring

The special customer trial process is an exception to all the established routines. It is linked not only to the *seizing* mechanism but also to the *reconfiguring* mechanisms. A project manager is assigned to these activities, which is treated as a special high priority project to be executed in parallel with ongoing R&D activities. The project manager has a high degree of authority and the latitude to by-pass many of the more lengthy development processes.

Functionality can be developed on site. This deviates from all the traditional high-quality processes for which *Company Soft* has built its reputation. When it is not possible to implement directly on site, resources at the design center are reallocated rapidly and design is done quickly sometimes prior to receiving all the necessary approvals. Everybody knows that the priority for these resource reallocation requests is very high. The project manager mentioned that he had to sort out a lot of the paper work (including financial agreements) after the work is carried out.

Such parallel process goes beyond the *sensing* mechanism only. It is a process that goes across the whole product definition and development processes. It disrupts the *governance* process and the resource allocation process. Although it meets the requirement for high response time, which is important to the customers, the managers of *Portfolio Soft1* know that it cannot be used continuously in the normal product development cycle. However, it is an indicator that it is possible to implement routines to deviate from routines.

6.3.7 Innovation Involving Employee Contributions (*Portfolio Soft1* Only) (SS7)

Employees are encouraged to submit ideas for new functionality, which might be of interest to potential customers. An internal competition is put in place to generate interest for new services for customers by being able to show them potential applications of the product. The winning employees receive a small gift but the most appealing reward is that they are invited to help implement their ideas in the demo lab. This in turn allows demonstrating some of the potential new products to customers (as discussed in section 6.3.3).

The first year this contest was launched, the management of *Portfolio Soft1* received 300 ideas from employees primarily from the head office location. It became a challenge in itself to manage so many ideas. The following year the firm decided to provide some themes to limit the number of contributions. The result was actually the reverse from the one expected with over 500 ideas coming not only from the head office but also from all the design centers in the PDU. This new process was also introduced in recent years and could be considered a *transformation* of existing processes (see discussion in Section 6.5).

Links to Seizing

Applications identified during the innovation contest are not incorporated automatically in the project portfolio. Prototypes and demos are developed first. Based on the feedback received from customers on these demos, product requirements are specified and issued to the product portfolio process (as described under SZ1.2).

6.3.8 Roadmaps and Multi-Project Plans (SS8)

At *Company Soft*, there are numerous levels of plans ranging from higher level (less detailed) to lower level (more detailed):

- product roadmaps;
- product plans;
- multi-project plans; and
- project plans.

Product roadmaps are high-level plans showing the key product deliveries over an 18- to 24-month period. This is an intermediate planning document between the business plan covering a three to five year planning horizon and the multi-project plan displaying ongoing projects. A product manager at *Portfolio Soft1* made a distinction between the product

road map, which is communicated to the customers, and the product plan, which is used as targets of the project portfolio:

> *We have two kinds of product plans. What I'm talking about here is the product plan that we are sharing with the PDU and that leads to the project planning. We also have a sort of window out to the customers that we call the product roadmap. It's not always exactly the same because we, for strategic reasons, it might be a bit different towards the customers than into the R&D organization.* (Product Manager – *Portfolio Soft1*)

Multi-project plans list all ongoing and future projects. They look like Gantt charts with only one or two lines per project indicating the key milestones, tollgates, and deliveries. Although multi-project plans cover a similar planning horizon as the product road map, they are more detailed, show the different system nodes, and the project phases. Multi-project plans also clearly distinguish between planned and approved projects from target (not yet approved) projects. Multi-project plans are updated on a monthly basis to incorporate the decisions and updates approved at the steering committees while product roadmaps are updated very rarely (once or twice a year). While it is standard practice to baseline project plans at *Company Soft*, the multi-project plans never get baselined. It is perceived as a continuously updated working document; with details and refinements being added regularly. The schedule of each individual project is published once the level of confidence has reached the appropriate level but the multi-project schedule always includes some future projects for which dates will be planned and confirmed later.

The roadmap, the product plan, and the multi-project plan are presented as *sensing* mechanisms because these three levels of planning clearly indicate the uncertain components. They also provide some opportunities for modifications on a continuous basis. Finally, all these plans are used as objects to communicate the understanding about the state of the project portfolio. For example, plans, regardless of their levels, clearly distinguish between approved and tentative items. They are used as *boundary objects* (Carlile, 2002; Ewenstein & Whyte, 2009) to communicate across departments to express the different understanding about the state of project portfolios.

Links to Seizing

Multi-project plans are used as boundary objects and are reviewed in the project steering groups. They also get updated based on steering group decisions. They serve as a reference to monitor the status of projects through the status reports (SS9) discussed in the next section.

6.3.9 Status Reports (SS9)

At *Company Soft*, there are numerous levels of project portfolio status reports:

- multi-project status overview;
- project status reports presented to steering groups; and
- written project reports (weekly and monthly).

The multi-project status overview is produced by the PMO director and is presented to steering groups. It follows a corporate standard with one line per project, where the current and future status is displayed in graphical form using colors (green, yellow, red) to indicate the status of schedule, cost, quality, and scope. Project managers present the status of their project to the different steering groups, using a presentation template displaying: achievement since last report, planned activities in the coming time period, escalation issues, and risks.

The status reports are presented as *sensing* mechanisms because they are tools to monitor the performance of projects faced with very high levels of uncertainty. Despite the fact that they are given guidance on their goals and objectives, regular monitoring and control is deemed necessary in this environment.

Links to Seizing

In both portfolios, the steering bodies presented in section 6.2.3 are put in place to decide on a number of issues related to the project portfolio: business decisions, project approvals, etc. Some of these boards are also put in place to monitor the performance of the portfolio through the performance of projects. This takes the form of regular meetings (either biweekly or monthly) where each project manager reports issues, delays, cost overruns, and major scope changes. If a project gets delayed, the level of dependencies between the different projects almost always causes some knock-on effects on other projects. This is because the project outcome would not be available in time for subsequent projects or because resources would be held longer than expected in the delayed project.

Apart from the steering bodies themselves, the assessment of these impacts on other projects are taken on a case-by-case basis. Interestingly, the manager responsible for resource planning at *Portfolio Soft1* admitted that there is no formal process or bodies to analyze impacts of decisions taken for one project on other projects with the exception of the knowledge by the steering group members. According to the interviewees, the steering group often makes decisions without necessarily analyzing all the impacts on other projects. This is left to the different project managers who have to analyze the impact of such decisions on their projects and then report on the following steering group meetings.

6.4 Links between Uncertainty and *Sensing* Mechanisms

As can be seen in Figure 6-8, because product managers (SS1) have a key role in specifying the product content, they are also facing most of the uncertainty areas, especially those related to the identification of customer needs: match between product and customer needs, new customers, and new application for products. They must follow the market trends such as the third-party product offering, the competition offerings and the market growth. To some extent, they must also keep abreast of the technology evolution but this is primarily delegated to the system management group. Any new technology identified by the system management group (SS2) or ad hoc customer demands (SS5) have to be considered and prioritized against other requirements and other requests. The monitoring of the portfolio performance is mainly the concern of the PDU management team and of the PMO director. Only in cases, where there are severe deviations is the product management involved

to maintain alignment with the PDU strategy. *Company Soft* implemented a common tool (SS4) to specify and follow-up changes to the requirements.

Demos at tradeshows (SS3) are used to reduce the uncertainty related to fulfilling customer needs with the potential product. It is also an opportunity to gather information on the competition's offering who also present their offering at customer shows. New customers and market interest can also be measured by early demonstration of the capability of the products. Finally, the in-house laboratory is used as a *sensing* mechanism for new applications of products.

The new special process for customer trials (SS6) was implemented to address the uncertainty related to the match between product and customer needs. In fact, this was even more specific to cater for the needs of the customer evaluating *Portfolio Soft1* products in these sophisticated trials. Because the resources required necessary to implement this process, *Portfolio Soft1* could only use it for a very limited number of key customers.

Because *Portfolio Soft1* develops a completely new product line and the exact applications are unknown, they want to generate ideas from their employees (SS7) to identify these applications. This is a form of proactive *sensing* mechanisms to address the uncertainty related to the product application.

Most of the *sensing* mechanisms presented in this section address *foreseen uncertainty* (as defined in section 1.2.4). Roadmaps and multi-project plans are mechanisms put in place to address *variations* resulting from the ability to plan projects completely accurately. Considering the number of variables (such as project scope, estimated cost and duration per feature, availability, and competence of resources) software projects at *Company Soft* cannot be planned with very high accuracy many months in advance.

6.5 *Transforming*

In the updated conceptual framework, *transforming* describes the higher-order activities of improving the PPM activities. This refers to the following two broad categories of actions:

- modifying the first-order *sensing-seizing-reconfiguring* mechanisms used in PPM; and
- introducing new structures, processes, or tools to support the PPM activities.

Transforming is the third element in the second-order sequence of the conceptual framework as highlighted in black in Figure 6-9. Although *transforming* comes third in the second-order sequence, it is presented first in this chapter. Once examples of some *transforming* mechanisms are presented, it becomes easier to discuss how they are identified and decided upon through the *second-order sensing* and *second-order seizing* mechanisms.

Figure 6-10 displays the *transforming* mechanisms observed at *Company Soft*. Row T1 entitled *Transforming the First-Order Process* includes the modifications to the first-order mechanisms. This includes the modification of existing processes or the introduction of new process, which are marked in bold in Figure 6-8, for *sensing*, Figure 6-4 for *seizing*, and in Figure 6-2 for *reconfiguring*. Transformations do not always involve the modification of the first-order mechanisms, it sometimes require the introduction of very new mechanisms.

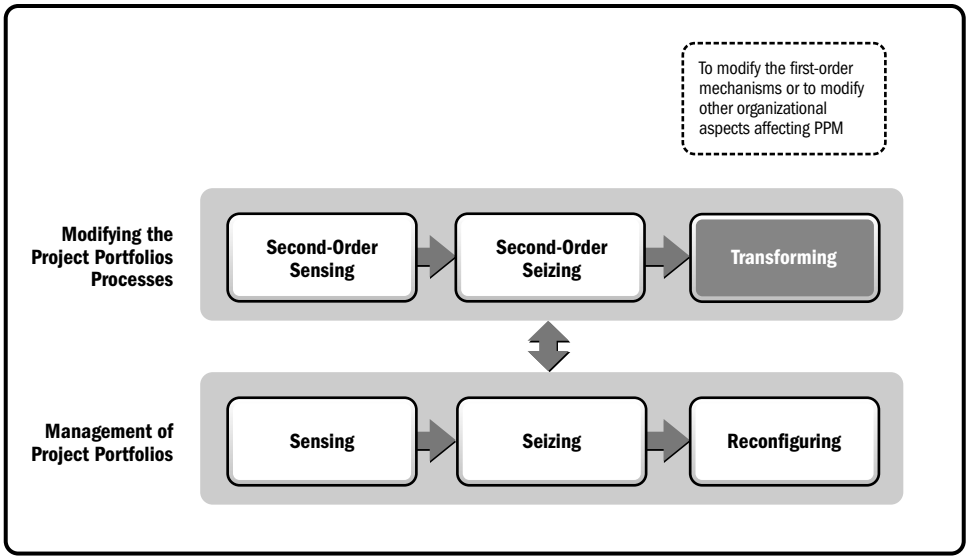

Figure 6-9. *Transforming* Mechanisms in the Conceptual Framework

Transforming mechanisms have been classified as follows:

- project management processes (T2);
- product development processes (T3);
- organization structure (T4); and
- product structure (T5).

The codes T1 to T5 refer to the different rows in Figure 6-10 and are used to facilitate cross-references in the following subsections. Each header includes the reference to the relevant code.

6.5.1 Transforming the First-Order Sensing-Seizing-Reallocating (T1)

When the *first-order sensing-seizing-reallocating* mechanisms were analyzed in depth, it became clear that these mechanisms are not static. There are many instances when interviewees mentioned that new processes have just been implemented or are in the midst of being evaluated or being deployed. Such mechanisms are clearly marked in bold in the figures to indicate that they have been newly introduced or modified.

The following transformations are presented in this section:

- T1.1: *Transforming* the *sensing* mechanisms—New process for customer trials;
- T1.2: *Transforming* the *sensing* mechanisms—New innovation process involving employees;
- T1.3: *Transforming* the *seizing* mechanisms—Changing the business model;
- T1.4: *Transforming* the *seizing* mechanisms—Moving from change control process to prestudy machine;

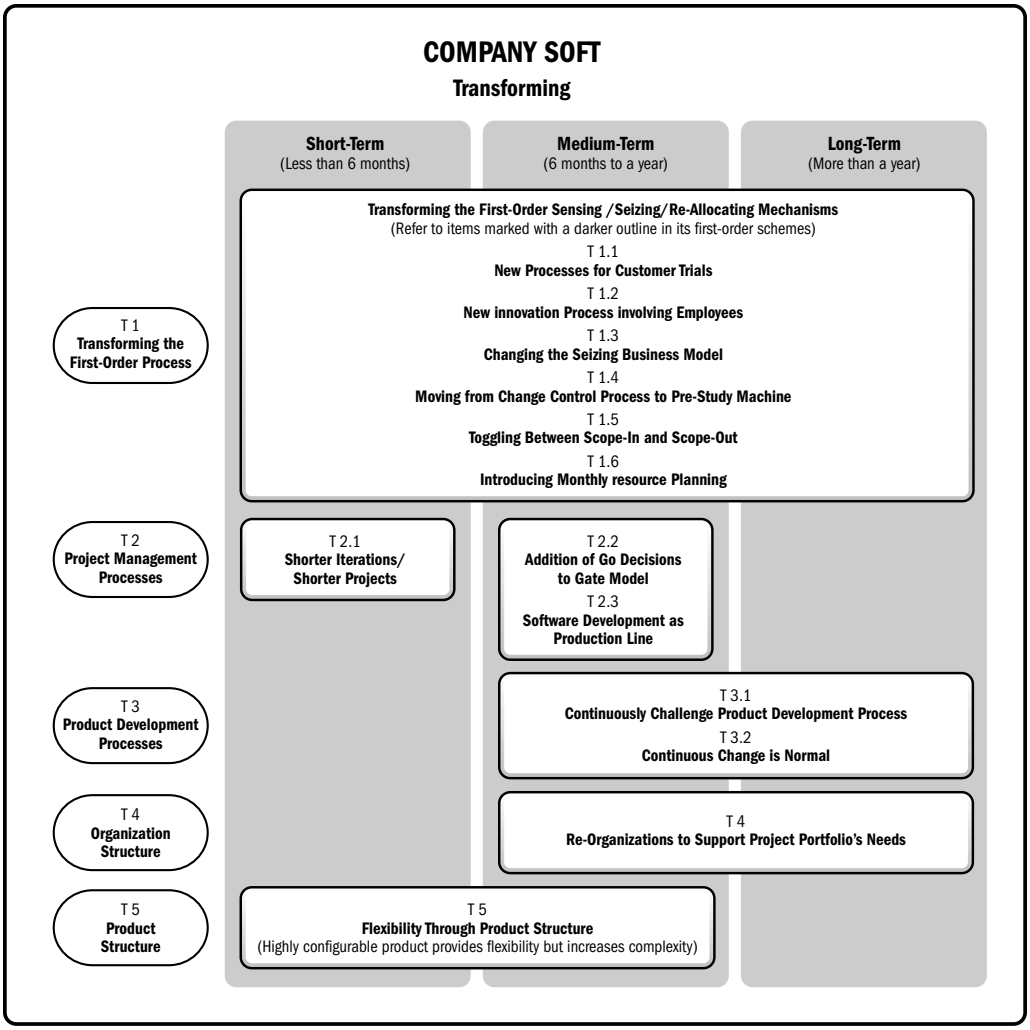

Figure 6-10. *Transforming* Mechanisms at *Company Soft*

- T1.5: *Transforming* the *reconfiguring* mechanisms—Toggling between scope-in and scope-out; and
- T1.6: *Transforming* the *reconfiguring* process—Introducing monthly resource planning.

***Transforming* the *Sensing* Mechanisms - New Process for Customer Trials (T1.1)**
Customer trials are considered strategic activities to gain key customers. These trials include the demonstration that test cases can be executed successfully and that the pass rate is very high. A new process was developed to support these activities. This required a number of deviations to existing processes, feedback loops to the scope management, and new escalation processes. This new process has to be kept as an exception and cannot become the normal software development processes but it is particularly well adapted to the very turbulent environment to which these trials projects are exposed.

Transforming the *Sensing* Mechanisms - New Innovation Process Involving Employees (T1.2)

Because *Portfolio Soft1* is very new, ideas for applications are continuously investigated. Because *Portfolio Soft1* wants to tap on the creativity of their employees, they put in place a contest in which employees could contribute ideas. This is likely to be a temporary process, which is still in the midst of being evaluated and improved.

Transforming the *Seizing* Mechanisms - Changing the Business Model (T1.3)

The business model is an important component of the *seizing* mechanism which is used as the decision criteria to select, prioritize, and group components into projects. When the interviewees were carried out at *Portfolio Soft2*, the whole PDU had just been restructured to supply components rather than platforms (the differences between the two are described in detail in section 4.1.3). The consequences of this change include reducing the size of the projects and a new grouping of projects. The level of integration and verification is strongly challenged. If the PDU delivers components instead of complete platforms, the level of testing can then potentially be greatly reduced. The advantages and disadvantages of this new approach are still being discussed internally. It has repercussions not only on the portfolio structure but also on the funding structure and the supply of the products to the different units.

This new business model is considered more flexible and better adapted to the requirements of the internal customers. A similar discussion is under way at *Portfolio Soft1*. They are wondering whether to release complete systems; which would mean that the different nodes are tested together or whether individual nodes should be developed. At *Portfolio Soft1*, despite the additional flexibility of the latter, it is believed (at least by the system group and the I&V group) that a complete integration is still required.

Transforming the *Seizing* Mechanisms - Moving from Change Control Process to Pre-Study Machine (T1.4)

The prestudy machine was introduced to provide some form of continuity in the analysis of new requirements feeding the different projects. It is believed that the issuance of change requests directly to projects results in multiple change requests bouncing between projects without a complete system view of the optimal location for a request. By providing a central point for the investigation of all feature requests and a process to analyze and decide upon these requests, it becomes easier to track and optimize the flow of new requests across the portfolio.

Transforming the *Reconfiguring* Mechanisms- Toggling between Scope-In and Scope-Out (T1.5)

The scope-in approach was introduced in *Portfolio Soft1* to reduce the amount of requirements for which a pre-study was performed but which was subsequently removed during feasibility or execution. A few weeks before the interviews were carried out, a very large contract was signed with a very important customer. This created a very large inflow of requirements for the specific project put in place for this customer. Consequently, scope-out had to be restored temporarily. This is not considered optimal for the project portfolio and the product management organization knows that the capacity of the organization is exceeded. It is also very difficult to prioritize among all these requirements because they are all considered

top-priorities for this particular customer. It is expected that *Portfolio Soft1* will revert to scope-in once this project is completed.

Transforming the *Reconfiguring* Process - Introducing Monthly Resource Planning (T1.6)

The resource planning process used to be executed every quarter. However, because the resource planning process took approximately one month to execute, the data quality was not considered sufficient for operational resource allocation decisions by the steering groups. The PMO manager was continuously being asked if resource capacity was available to start new projects. In order to respond, up-to-date and reliable data about the resource requirements and allocation had to be available. In addition, similar data was necessary when resources had to be reallocated when projects got delayed or required additional resources. Historically, the resource plan which was produced quarterly to the finance department through an internally developed web-based tool was also used for this purpose. However, these resource plans were getting rapidly obsolete (once some reallocation had taken place) and nobody really relied on them. The data were not deemed appropriate to respond to the reallocation requests.

A more frequent resource planning process was put in place with the appropriate tools and processes. In the last two years, the PMO director and the senior management have started to implement a monthly resource planning process. Consequently, both project managers and line managers continuously maintain the information up to date.

6.5.2 Project Management Processes (T2)

Shorter Iterations and Go Decisions (T2.1)

The *Company Soft* development process includes a number of phases: specification, design, coding, and testing. According to this process, the projects complete the specification for the complete project, which are then followed by design for the whole project, and then coding and testing. This is called a waterfall model. In recent years, this approach has been criticized as being too rigid and not allowing enough flexibility for change and opportunities to validate the requirements based on early releases of tested software components.

Most projects at *Company Soft* have now broken down their internal deliveries into a number of iterations. Updated software is delivered to the test organization approximately every four to six weeks. There is pressure to reduce the iteration cycles to even shorter durations. This is to increase predictability and to reduce the amount of change once the development of an iteration has started. A project manager at *Portfolio Soft1* describes the way her best development team plans its work with very short iterations as follows:

> *More mature teams develop calendars determine their capability based on available work-days. And then they plan iterations. They have a release plan of what they are planning to deliver. Some of the things have four weeks, some of them have two weeks. They started up with longer iterations and increments and have shortened it down because they have found out that it improves their productivity but more importantly their confidence level in the delivery dates.* (Project Manager – *Portfolio Soft1*)

Addition of Go Decisions to Gate Model (T2.2)

The introduction of shorter iterations in the development cycle requires a faster decision cycle and is not entirely compatible with the existing decision model, which only includes six tollgates for the entire project. In most cases, project managers have to decide to start the execution of the earlier iterations before the feasibility of the entire project is complete. To continue to follow the project management process under those conditions, projects managers and sponsors face a dilemma:

- either to wait until all the feasibility is complete to reach the next tollgate, in which case execution has to start without the proper tollgate, see option A in Figure 6-11; or
- to use the tollgate to authorize the start of the execution, in which case the feasibility is not entirely complete, see option B in Figure 6-11.

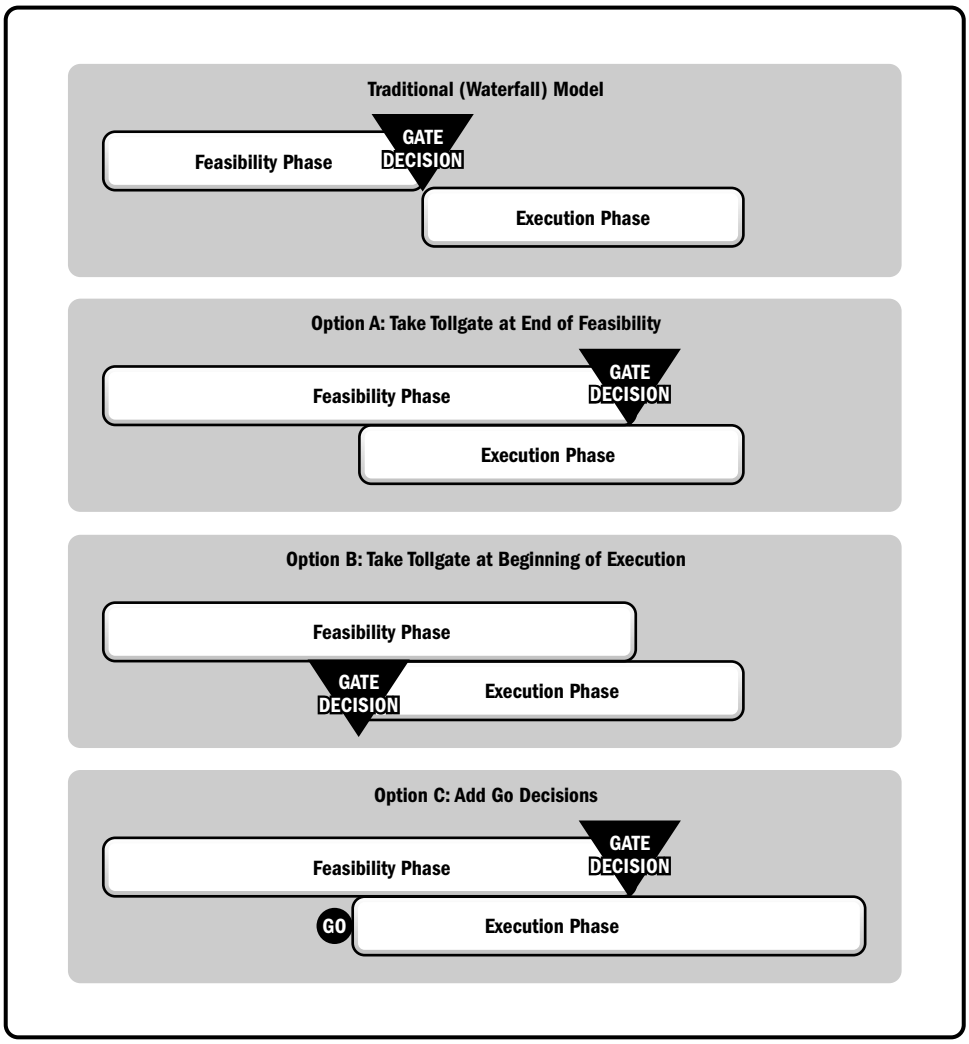

Figure 6-11. Addition of Go Decisions to the Gate Model

Company Soft introduced modifications to their project management model to alleviate this frequent R&D dilemma. Go decisions are added to the model to formalize the authorization of the start of some subset of the work even when the preparation for the entire project is not ready. This allows the project manager to prepare all the administrative aspects of the project (e.g., opening the financial accounts) for the approved iteration and start the monitoring and control activities accordingly. In Figure 6-11, this corresponds to the addition of a go decision to authorize a subset of the execution phase despite the fact that the feasibility is not entirely complete.

Software Development as Production Lines (T2.3)

The R&D component of *Company Soft* is clearly organized as a matrix organization with functional line managers responsible for the resource assignment, the development process, and the product maintenance and system architecture. The project managers are responsible for planning and tracking the scope based on assignments received from product managers, the time schedule, and the cost. These roles are clearly established at *Company Soft*. Although it generates the usual conflicts resulting from matrix organizations, there are sufficient mechanisms in place to resolve them. For example, resource allocation conflicts can be escalated through the PMO, product management, or the different steering groups. Software has been developed successfully over the decades using this multi-project environment in a matrix organization. Employees are used to working in projects and consider most of their work as project work.

As mentioned in section 6.2.2, there are a number of factors that put pressure on the project approach to transform it into a continuous process:

- a continuous process for requirement assessment;
- the scope allocation to projects through the RRB; and
- a push towards the continuous production of a fully tested product according to *agile* principles.

This latter point is based on the objective to reduce the number of parallel software tracks to be maintained. The goal is to have one version in the field (supported by the maintenance organization) and a single track under development. This approach makes the software development look like an assembly line where the manufactured good could be released at any point on the assembly line.

With the exception of the release activities, and looking back at the project structure displayed in Figure 6-6, the different iterations in a given project can indeed be conceived as a continuous flow of work managed by the same manager year after year. This approach defeats the notion of project as a temporary endeavor with a known end date. This becomes even more evident when the same team keeps working from one iteration to the next and that a larger number of go decisions replaces the number of gate decisions. Conceptually, software development becomes a production line rather than a temporary organization to deliver a given product.

The main justification for maintaining the project structure is, according to some interviewees, the need for a release to the customer. Once it is decided to release a certain version of the software, a number of activities must be carried out (for example documentation

production, release, and demonstration to a first customer, handover to the installation and support organization) and completed on a given date. The use of project management techniques becomes appropriate in this case.

6.5.3 Product Development Processes (T3)

Product Development Process Continuously Challenged (T3.1)

Two important objectives of *Company Soft* are faster delivery to the market and increased flexibility to adapt to changing requirements. To support both objectives, there are tremendous efforts put into the improvement of the software development process. The reference is made here, not so much to the project management process discussed previously, but to the methodology used by the software developers to design and program products once requirement specifications are received. Process improvement teams are constantly put in place to challenge ways of working.

In a turbulent environment, such as *Portfolio Soft1*, employees are asked, on one hand, to follow the processes to keep the efficiency high but on the other hand are also encouraged to challenge the processes and suggest improvements. Good practices and the knowledge gained from one process improvement pilot are spread across the different divisions of *Company Soft*. Through the contacts with consultants, tool vendors and communities of practices, practitioners are also well aware of innovations in the software development processes such as *agile*.

Continuous Change is Normal (T3.2)

The continuous change in the ways of working could be considered part of the corporate culture. Although there is a strong tradition in developing software and hardware products, it is customary to include some form of changes in ways of working in almost every project. This is in addition to other forms of changes such as the structural organization.

The approach taken by *Company Soft* is to use the ongoing projects as vehicles to deploy new processes and tools. Most project managers interviewed mentioned that some forms of improvements are being implemented in their project. This includes activities such as new accounting systems, new requirement tracking tools, new resource planning tools, new project management processes, and new software releases.

6.5.4 Structural Reorganization Supporting the Project Portfolio (T4)

As mentioned in sections 5.1 and 5.2, *Company Soft* is used to frequent structural reorganizations.

> *Of course there is always change in the organization. What remains are often the projects. The stable part is the project more or less. [...]it doesn't matter so much how the organization changes because you have your people and if they are working on that unit or this unit its does not matter because they are the same people and the project continues and the organizations support that project anyway.* (Project Manager – *Portfolio Soft1*)

The most disruptive type of reorganization is the transfer of design responsibilities between design centers. Even in these extreme cases, every effort is made to maintain project time schedules and project budgets despite modifications in the line organizations. Here is a comment from a project manager who was involved in such a design transfer:

> *We have had significant challenge in terms of the transfer of design to another site but we have not re-planned the project because of that. This has been the background activity. Transfer projects in the PDU have been handled by the line organization. As long as they can provide project resources that can keep the time plan there is no impact* (Project Manager – *Portfolio Soft2*)

This observation goes somewhat against the idea that projects are temporary organizations set-up by permanent organizations to execute some activities on its behalf as is proposed by Turner and Müller (2003) and the Scandinavian School of Project Management (Lundin & Söderholm, 1995; Packendorff, 1995; Sahlin-Andersson & Söderholm, 2002). In project-based organizations, such as *Company Soft,* temporary organizations to support projects are indeed created. These are structured around a project manager and a project team and are supported with processes, tools, and resources supplied by the permanent line organization. However, if project portfolios have a longer life than the line organization, it could be questioned which organization is more permanent.

Changes to the organizational structure are even considered the best way for the line organization to support the project portfolios. As the line manager of the system group describes it:

> *You want to have your organization structured in a way that is the most useful to your current project road map. You don't want to be in a situation where to start up a new project you require five resources from one organization and ten resources from another organization. So you want to have your organization structured and balanced with your product portfolio and that's something that we do. We could take a look at the organization structure that we have and say does this organization structure that we have today get us to where we want to be? And then sometimes we make organizational changes. We are just about to conclude one [. . .] The projects have different life cycles so there is always going to be some projects that are in the middle of organization changes.* (System Group Manager – *Portfolio Soft2*)

There are, of course, many elements involved in organizational change and the optimization of the performance of the project portfolio management might not be the only element considered by senior management in such changes. However, the modification of the structure of the organizations to support the project portfolios could be considered a good example of *transforming* to support PPM.

6.5.5 Flexibility Through Product Structure (T5)

Most of the mechanisms mentioned so far relate to *flexibility in the process.* When requirements are very uncertain, an option is to develop a product, which could meet all the foreseen possibilities. *Company Soft* tried to implement what Olsson (2006) calls *flexibility*

in the product where alternative demands are met with the same product. The products developed by both *Portfolio Soft1* and *Portfolio Soft2* follow this approach.

A first technique to provide the required flexibility is to offer a very large number of parameters to configure the product in a multitude of ways even without knowing in advance what the customer require. An analogy would be a manufacturer being uncertain about the required height of tables who would manufacture them with adjustable legs. Although this might seem like the appropriate approach for an enterprise like *Company Soft*, it also brings a number of problems, the most important being the increased level of complexity to install and configure the product, as mentioned by two interviewees:

> *Our product has a huge number of configuration possibilities and you have to be very skilled to set it up. It might be needed because it's going to operate in very different environments from customer to customer but what we have found out in fact is that it is way too flexible.* (PMO Manager – *Portfolio Soft1*)

> *We have perhaps too many parameters. We have an initiative called end to-end agility trying to limit the configuration possibility, which is totally endless today. It confuses rather than it helps. You should have configurations already defined and you should have limited configuration possibilities.* (Operations Development – *Company Soft*)

Because of the very high number of alternatives to configure, only specialized highly trained installers can offer the service to install the product. This increases the cost of installation. Another consequence is the difficulty to support the product considering the millions of different configuration alternatives.

A second approach used by *Company Soft* is the decomposition of the product into a number of independent nodes linked through standardized interfaces. Rather than developing and selling a complete system as one big block, the customer can choose the nodes and even purchase alternative nodes from competitors. There is a lot of discussion within *Portfolio Soft1* on the benefits and drawbacks of developing and releasing the nodes separately:

> *Ideally, you have feature deliveries per nodes to reduce the complexity and have less and less features based on multiple nodes [...] If you have multiple node kinds of features, this becomes a bit more complex of course, because then you have to coordinate between nodes.* (Development Unit PMO Manager – *Portfolio Soft1*)

Structuring the product into nodes provides a more flexible development environment but is also closely linked to the choice of business model as discussed in a previous subsection.

6.6 *Second-Order Seizing*

This section presents the different *second-order seizing* mechanisms used in the two portfolios at *Company Soft* to decide how to modify the *first-order mechanisms* and how to modify other organizational aspects affecting PPM. This section refers to the *second-order seizing* highlighted in black in the upper part of the updated conceptual framework of Figure 6-12.

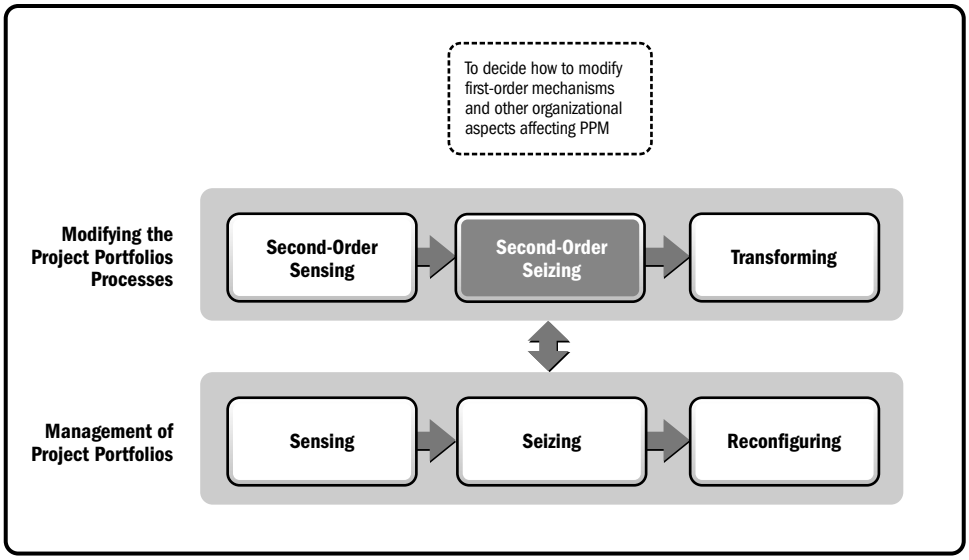

Figure 6-12. *Second-Order Seizing* Mechanisms in the Conceptual Framework

Figure 6-13 shows the three components of *second-order seizing* observed at *Company Soft*. They include the process improvement governance, setting targets, and selecting the *transforming* activities.

The section describing the *transforming* mechanism mentions that improvement projects are often incorporated into the ongoing development projects. The decision to allocate

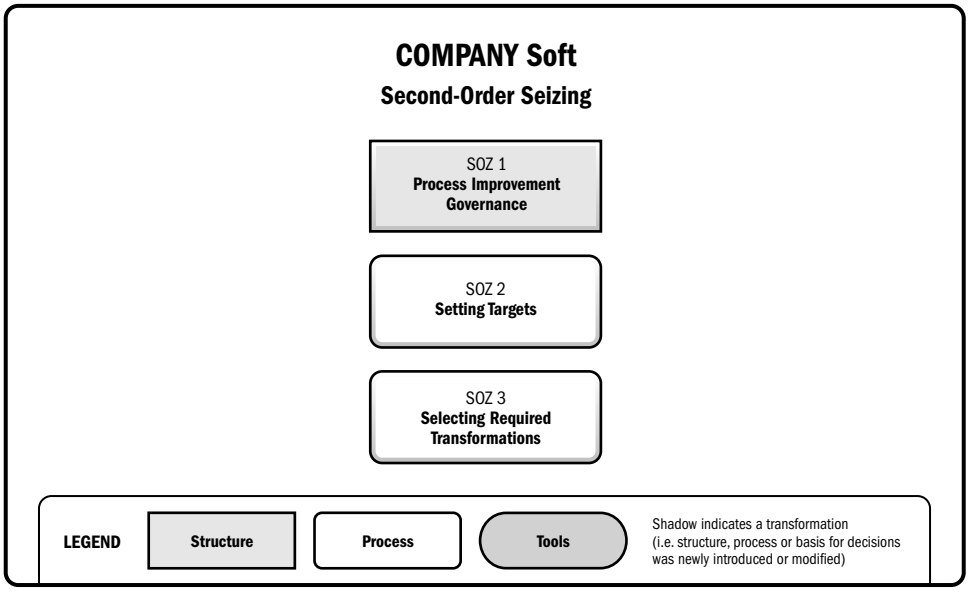

Figure 6-13. *Second-Order Seizing* at *Company Soft*

resources to improvement projects (as opposed to the development of new products) are taken in the same steering group. Decisions affecting very significantly the ways of working (for example, to use scope-in instead of scope-out) are also brought in front of the steering groups for approval.

In addition, a number of improvement projects are driven at corporate or DU levels. This ensures a more holistic view. For example, there are a number of initiatives to ensure that the revenues in the service organization are not negatively affected by the product development process of the PDUs.

6.6.1 Setting Targets (SOZ2)

Measurements are used to identify areas to be transformed. Some of the measurements are also used to set, sometimes aggressive, targets to the organization. The manager of the strategic planning department at *Portfolio Soft1* mentions:

> *We don't want small improvements like five percent which gets eaten away just by the salary increases, we were looking for something that can bring us easily into the range of 20 percent or more, so we had to really change a few things and we thought the best place to start would be the back end. How do we become more efficient in I&V? How do we shorten the time? It is still under deployment even though we started this a couple of years ago. We have really lots of good ideas, but we always underestimate the amount of time it takes to deploy it throughout the organization.* (Strategic Planning Manager – *Portfolio Soft1*)

6.6.2 Selecting the Required Transformations (SOZ3)

Transforming activities cost money and compete for valuable resources that could be allocated to other activities, such as the development of revenue-generating products. The different proposals generated by the operation developers must therefore be prioritized against other activities using the targets defined for the organization.

This regular selection and prioritization of improvement activities is not documented in the internal *Company Soft* PPM process. However, because these requirements compete for resources that could be allocated to the project portfolios, it is included here as a second-level mechanism, which corresponds to the decision, processes to alter the first-order mechanisms (or other *organizing mechanisms*).

6.7 *Second-Order Sensing*

Section 6.5 presents some of the *transforming* mechanisms that took place in *Company Soft*. This includes modifications to the first-order process of *sensing-seizing-reconfiguring* and the introduction of new structures, processes, or tools to support the PPM activities. This section presents the *second-order* mechanisms observed at *Company Soft* (see to the *second-order sensing* highlighted in black in the upper part of the updated conceptual framework of Figure 6-14).

Figure 6-15 displays the *second-order sensing* mechanisms covered in this subsection. The usual legend indicates if these are related to structure, processes, or tools.

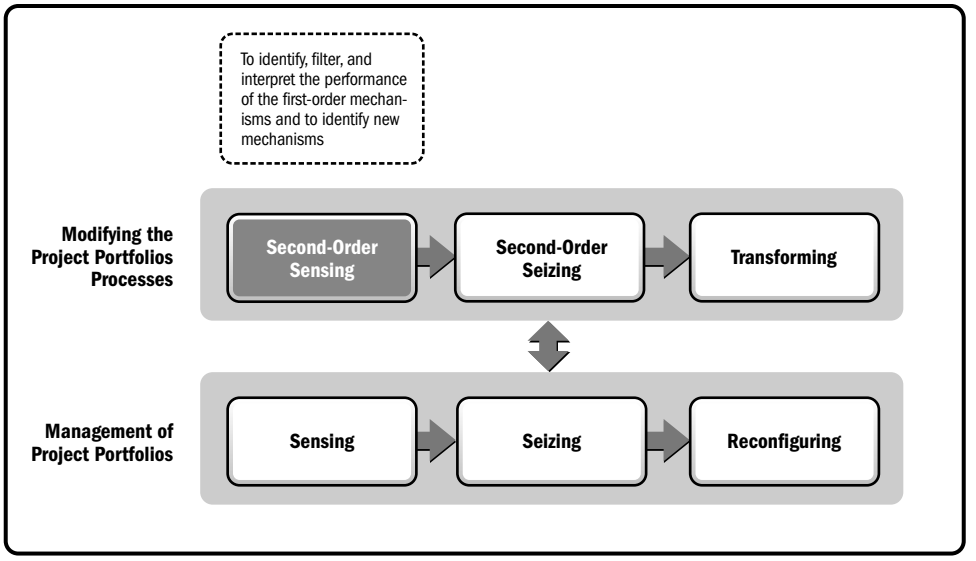

Figure 6-14. *Second-Order Sensing* in the Conceptual Framework

6.7.1 Dedicated People for Process Improvement (SOS1)

At *Company Soft*, a number of people are dedicated to process improvement. This includes different roles:

- discipline owners;
- operation development; and
- process improvement teams.

Discipline Owners (SOS1.1)

There are a number of key disciplines (e.g., configuration management, project management, software development, software testing) which are managed at corporate level. A full-time person is assigned as discipline owner. She is responsible for the documentation of the process, its improvement, and its deployment at corporate level. Project management and configuration management are examples of such disciplines.

The corporate project management model was developed in the 1980s and is still updated regularly. Special models were added for customer projects and for internal projects. In recent years, a new project portfolio model was developed and deployed as part of a broader program to select a project portfolio tool at corporate level. The development and maintenance of corporate level processes is a huge task that requires the involvement of representatives from the different divisions and departments of *Company Soft*.

Operation Development (SOS1.2)

In every DU and PDU, a role, called *operation development,* includes:

- the responsibility to assess the performance of the organization;
- to help the management team set and measure metrics and targets;

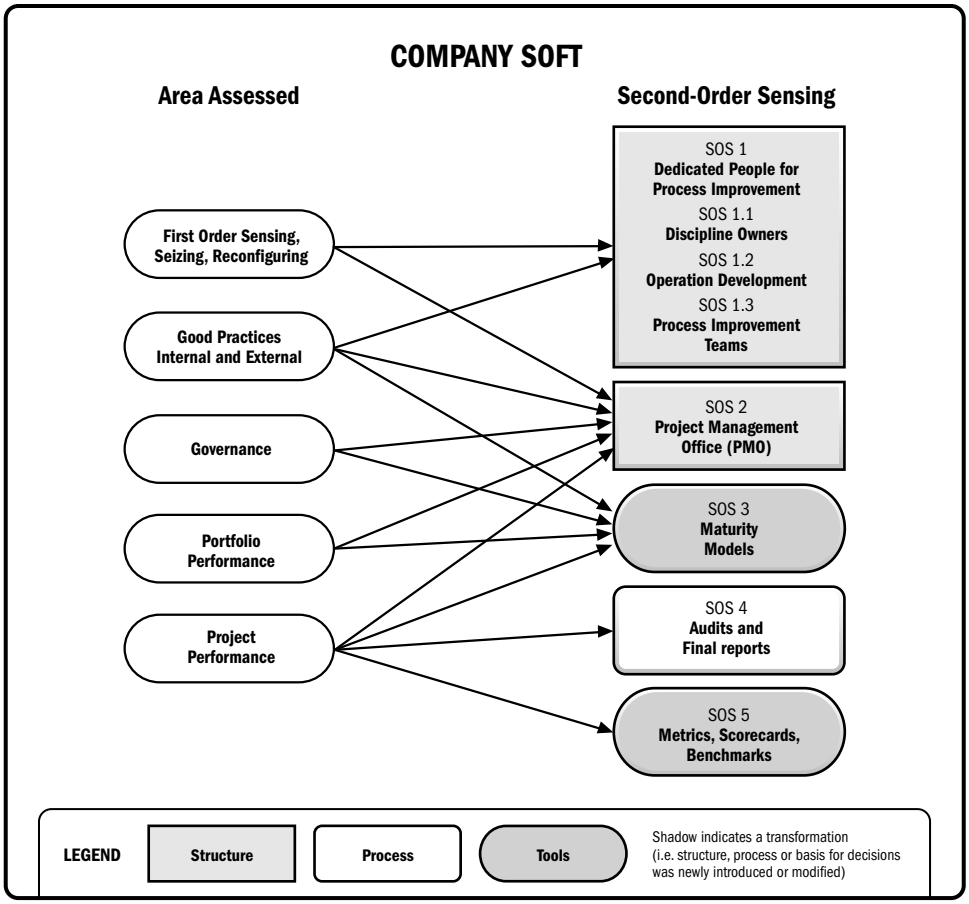

Figure 6-15. ***Second-Order Sensing*** **at** ***Company Soft***

- support the corporate improvement initiatives; and
- to launch and monitor improvement projects at DU or PDU levels.

The operation developers are considered important roles that influence the management of the units. They are members of the key steering groups and chair the improvement project steering group. In *Portfolio Soft1*, a group of five full-time people, and *Portfolio Soft2*, a group of two people, support the operation developer in these functions.

The operation developers put in place balanced scorecards, metrics, and other measurements to determine if the organization is meeting its objectives and they compare its performance with other organizations and with internal targets. Operation developers are responsible for coordinating audits and benchmark assessments (described under SOS5). A number of initiatives are launched to support the achievement of these targets (see SOZ2, in section 6.6.1). Another component of the operation developer role includes process innovation. Based on the targets set up by the organization (for example, to reduce product development lead-time by 50 percent), the members of the operation development network

come up with new ways of working which challenges the ongoing processes. Over the years, the continuous challenge of processes has become part of the culture.

Operation developers are interconnected across divisions via a network where they share information about their practices, pilot activities, and process improvements. For example, a department within *Company Soft* introduced and adapted some of the *agile* principles. Their experiences are now shared to other DUs using sharing techniques such as meetings and symposiums.

Process Improvement Teams (SOS1.3)
At the lowest level of the organization, process improvements teams are created to document and maintain local adaptation of processes developed at corporate level. The members of these teams are experts in their domain assigned per discipline. This is at a lower level than the operation developer and the discipline owner. Process improvement groups are often lead by the members of the operation development group.

Areas Assessed
The different people dedicated to process improvements are key elements to assess the first-order *sensing-seizing-reconfiguring* level of the project portfolio management process. They are also monitoring good practices within the organization and those being developed or piloted outside of *Company Soft* to incorporate them into their processes.

6.7.2 Project Management Office (SOS1.3)

The PMO is mentioned here as a *second-order sensing* mechanism mainly because it holds, among other things, the responsibility to ensure that the organization runs as smoothly and as efficiently as possible. This includes primarily how efficiently projects are managed but also covers many other supporting aspects such as the resource planning and allocation, the governance, portfolio management, value management, etc. Some of the *transforming* activities discussed in section 6.5 were triggered by direct observations made by members of the PMO. For example, the introduction of monthly resource planning cycles was justified by the inability of the PMO manager to respond quickly to demands from product management regarding the available resource capacity to handle additional projects. The quarterly resource planning cycles were deemed inappropriate for this function. Efforts were therefore put in place to deploy the necessary tools and procedures to provide accurate resource planning data on a monthly basis.

Senior management must evaluate the performance of their organization. This is done through some of the mechanisms discussed in this section supplying them with facts and opinions to help them take their decisions to transform the organization and the PPM processes.

The financial structure is another example of a sore point observed by the senior management at *Portfolio Soft2*. This resulted in numerous attempts at finding the optimal way to handle the financing of common products when multiple PDUs (facing turbulent environments) share the financing. There are no special mechanisms put in place to sense these issues but is a result of continuous observations by the management team.

Areas Assessed
As shown in Figure 6-15, the PMO serves as a very important *sensing* mechanism and provides important observations and interpretations related to the different areas being assessed: *first-order sensing-seizing-reconfiguring*, good practices internal and external (related to project management), governance, and project portfolio performance.

6.7.3 Maturity Models (SOS3)

Over the years, *Company Soft* has used a number of maturity models to assist them in evaluating their performance and their practices. This included ISO 9000 compliance and Capability Maturity Model Integration assessments.

In recent years, an initiative was launched in the R&D organization to raise the performance of the organization according to a modified version of the Product and Cycle-Time Excellence (PACE) model developed by the consulting firm PRTM. These models are described in detail in (McGrath, 1996, 2004) and are structured as five levels of maturity:

- **stage 0:** Informal project management;
- **stage 1:** Functionality focused project management;
- **stage 2:** Cross-functional project management (phase reviews, core teams, structured development);
- **stage 3:** Enterprise project management (enterprise project planning and control, networked teams, enhanced phase reviews); and
- **stage 4:** Advanced project management practices (integrated financial plans, distributed program management, co-development, and knowledge management).

Stages 3 and 4 in this model focus on portfolio excellence, which is the highest level of maturity, including such things as value chain analysis and suppliers' integration. *Company Soft* uses this maturity model to help sense the areas, which require improvement towards excellence in PPM. The different units filled in auto-evaluation questionnaires and a benchmarking comparison was done against other units and other firms in similar industries.

Areas Assessed
As shown in Figure 6-15, maturity models are used to assess governance, project and project portfolio performance. They are also used to provide a link to the commonly agreed on good practices in the industry.

6.7.4 Audits and Final Reports (SOS4)

Quality audits are periodically performed on the projects. Sometimes they are in preparation for maturity models assessment or ISO certification compliance. However, they are also used to identify improvement areas. Feedback is provided to the senior management and to the operation developers who recommend the best course of action. Audits can be requested when major issues are encountered by projects; however there were no references to such audit during the interviews.

Final reports are also produced by the project managers at the end of each project. Occasionally intermediate reports are also written at the end of significant phases of the

project. These reports are structured according to a standard template including, but not limited to the following areas:

- review models and methods used during the project;
- project performance, specification vs. outcome;
- actual value versus expected value;
- project result versus project goal;
- project outcome versus project specification;
- budget, planned cost versus actual cost;
- changes during the project and change management control;
- lead time; and
- lessons learned.

The final report is used in a number of ways. It provides feedback to project managers of subsequent projects regarding issues, which might need attention (i.e., things that worked well or not so well). The subsequent project manager would not only read the report but contact the previous project manager directly for inputs. Final reports are also used by the line organization to identify areas for process improvement.

Areas Assessed
As shown in Figure 6-15, audits and final reports are used to assess the individual project performance. They are also used to provide feedback to the process improvement teams and to the subsequent project organizations.

6.7.5 Metrics, Scorecards, and Benchmarks (SOS5)

Both *Portfolio Soft1* and *Portfolio Soft2* collect numerous forms of measurement. Senior management use what they called key performance indicators (KPI) to help them measure their performance against a number of aspects of the organizations. These measurements are also used as targets for improvement initiatives and sometimes tied to bonuses when targets are achieved.

One of the key metrics used is customer satisfaction. Because this is a lagging indicator, that is, the outcome is measured many months after the activities are executed, three additional internal indicators are defined at the DU level. These measurements are believed to correlate strongly with customer satisfaction. They are

- time to respond to customer requirements: this corresponds to the time between when a customer submits a requirement, i.e., when a market requirement description is written until a product decision is taken and the customer is informed of the decision (this could either be accept or reject requirement);
- ratio of the requirements accepted versus the total inflow of requirements; and
- the overall lead time from the time the market requirement description is issued until customer acceptance.

Additional measurements are collected in the different PDU. In *Portfolio Soft1*, there are two additional variants of the lead-time measurement such as the average number of

days of slippage across all of the projects based on the difference between the date approved at TG2 and the date of the actual acceptance.

Although the lead time is a constant preoccupation at *Company Soft*, the reliability of the time estimate seems to be of similar concern. One of the key targets related to customer satisfaction is accuracy of customer commitments measured as the percentage of projects meeting the delivery dates as planned at given gate decisions. The translation of the roadmap accuracy into customer satisfaction is summarized as follows by the product manager at *Portfolio Soft2*:

> *We measure the user satisfaction via the accuracy of the product roadmap and the product development plans aligned with the PDU capability. There are now many projects that are depending on this road map and customers hate when we cannot fulfill this or when we change our road map every month. They hate that and that causes a lot of problems so stability of the roadmap is essential.* (Product Manager – *Portfolio Soft2*)

As shown in Figure 6-15, metrics, scorecards, and benchmarks are, like quality audits and final reports, used to assess project and project portfolio performance. They are also used to provide feedback to the process improvement teams and to the following project organizations.

Chapter 7

PPM in *Portfolio Fin1* and *Portfolio Fin2*

This chapter describes the mechanisms put in place at *Company Fin* to cope with the uncertainty described in sections 5.3 and 5.4. It is structured according to the conceptual framework presented in Chapter 2. *Portfolio Fin1* and *Portfolio Fin2* are presented together in this section to reduce the amount of repetition due to similarities within a given company. When a mechanism only applies to one project portfolio, the header indicates it clearly.

7.1 *Reconfiguring*

This section presents the mechanisms used in *Company Fin* to reallocate resources and reconfigure the project portfolios based on the identification of opportunities of requirements for change. This section refers to the third box of the first-order level as highlighted in black in the lower part of the simplified conceptual framework of Figure 7-1.

Figure 7-2, summarizes the key components of *reconfiguring* observed at *Company Fin*. They are organized according to the time horizon (i.e., short-term, medium-term, or long-term) of *reconfiguring* actions. The following subsections describe each *reconfiguring* mechanism in detail. Mechanisms which have been newly put in place, recently modified, or transformed are highlighted with a bold border (and are discussed further in the section 7.5 on *transforming* activities)

7.1.1 *Reconfiguring* the Project Portfolio (R1)

The types of portfolio reconfiguration which occur at *Company Fin* include the following modifications:

- **Project split into two projects:** This occurs when a project is considered too large. Past experience (and consultant reports) showed that maintaining the project size under one million Canadian dollars is optimal for planning accuracy.
- **Project stopped:** There are a number of mentions of projects being stopped even after a large amount of money had already been spent.
- **New projects started:** In the short term, projects are rarely added to the ongoing approved projects. The context of *Company Fin* rarely requires the launch of emergency projects to respond to urgent needs. Based on the portfolio roadmap and the progress of the projects in the portfolio, new projects are gradually added according

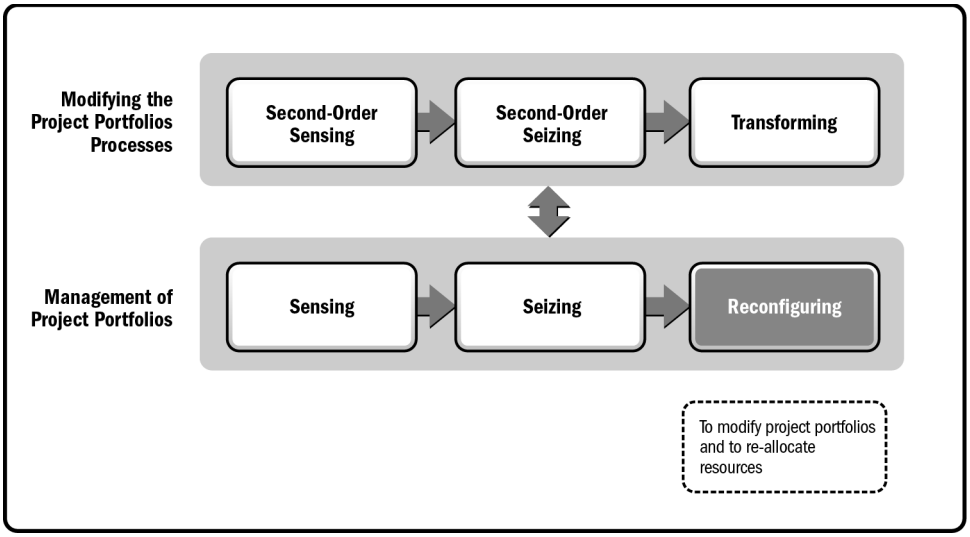

Figure 7-1. *Reconfiguring* Mechanisms in the Conceptual Framework

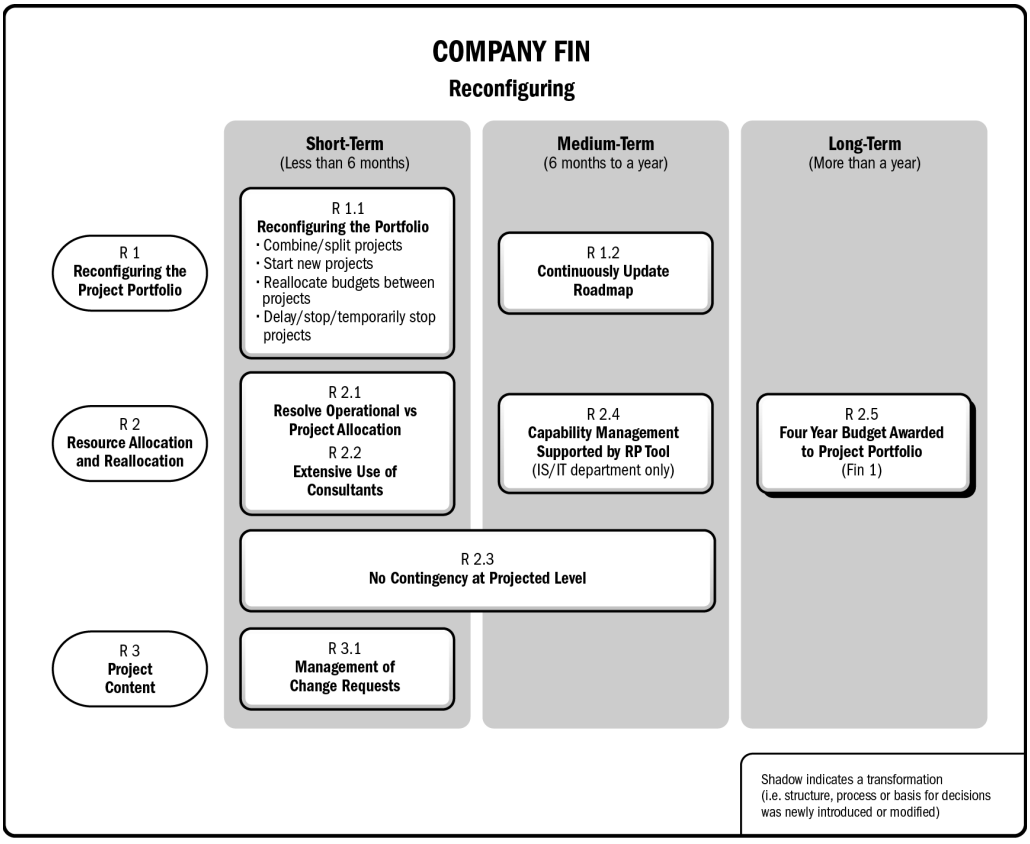

Figure 7-2. *Reconfiguring* Mechanisms at *Company Fin* Reconfiguring the Project Portfolio (R1)

to the availability of budget in the year and the availability of resources to work on projects.

- **Reallocate budgets between projects:** if a project requires a bigger budget, money can be transferred across projects within the constraint of the portfolio budget.
- **Project delays and cost overruns:** *Company Fin* has very strict budget constraints and limited access to resources to work on projects. When projects are delayed or cost overruns are expected, the project manager can request additional financing, try to reduce expenses, or move cost to later years.

Continuously Update Roadmap (R1.2)

When the portfolios are initially established, a cross-functional team estimates the work to be done and attempts to decompose it into a number of reasonably sized projects. The target size for projects is around one million CAD$. An analysis is then done on the best sequence of projects. According to parameters such as dependencies from other projects (e.g., if data generated by project A will be used in project B), duration of projects, and uncertainty of projects. Project roadmaps display all projects for the complete duration of the portfolio. Based on the roadmap, the portfolio budget is then broken down per year.

When projects start execution, the outcome of the projects helps determine the work to be done in subsequent projects. Sometimes, early estimates of ongoing projects must be increased and content has to be pushed to future releases. In other cases, projects are stopped because the requirements are no longer necessary, releasing resources to the following projects.

Once project managers get assigned to one of the future projects, more detailed planning information becomes available and tollgate dates are updated. As user needs are better defined and the norms better understood, the content of projects becomes more precise. For example, if a multi-project plan showed a tentative project being planned for the following year, the target tollgate dates would be shown as tentative. However, when project managers are assigned to the projects and the planning starts, the first tollgate is granted and later tollgates are moved according to new data collected during the planning phases. This rolling wave of project planning provides an ongoing basis for budget planning and for resource allocation. However, the project portfolio can never be completely planned in detail.

7.1.2 Resource Allocation and Reallocation (R2)

Resolving Operational versus Project Allocation (R2.1)

At *Company Fin*, the people assigned to projects in *Portfolio Fin1* and *Portfolio Fin2* are working on other non-project related activities, what interviewees at *Company Fin* called operational activities. For example, accountants responsible for producing the company's annual reports are temporarily lent to projects in *Portfolio Fin2* to help specify requirements. In most cases, the priority for these individuals is their operational activities especially when they are related to specific deadlines such as the production of the quarterly or annual reports. The portfolio budget can cover their cost and money is not an issue. The projects cannot always solve this problem with the hiring of consultants because of

the scarcity of the specific competence required for certain activities. A rare expertise is the knowledge of the norms but more importantly its interpretation considering *Company Fin*'s specific context. One solution that was found is to dedicate some of the key resources to projects (which sometimes involved physically transferring department or even building) and to temporarily replace them by more junior resources or consultants for their operational function.

Another consequence of the priority conflict between the operational and project activities, identified by the interviewees, is the stability of the resource assignments for the whole duration of the projects. In many cases, a person is assigned for a phase of the project and is replaced by another person on the next phase. This creates situations where newcomers have to be trained and brought up to date with the objectives and the status of the project.

Extensive Use of Consultants (R2.2)

Company Fin cannot rely exclusively on the operational resources to execute a large number of parallel projects. A large percentage of the project resources are consultants. In the case of *Portfolio Fin1*, the percentage of consultants in the projects reaches over 70 percent of the workforce. The use of consultants provides some of the necessary flexibility to adapt to the fluctuation in resource requirements of the project portfolios according to the fluctuations in capacity (number of hours) and competence over time. Many consultants worked for *Company Fin* for many years and moved from one project to the next according to the needs and phases of the different project portfolios.

At the time of the interviews, *Company Fin* has just gone through a rationalization of the number of consultants to reduce expenses at corporate level. This includes the reduction of hundreds of consultants over a period of two to three months. They try to replace consultants with internal resources while trying to minimize the impacts on the projects.

Contingency at Portfolio Level not at Project Level (R2.3)

An approach that is used in project management when there is a high level of uncertainty is to use margins of uncertainty to cover for potential cost overruns when unexpected events occur. However, project managers and portfolio managers claim that they are not allowed buffer to cater for uncertainty. They always have to issue change requests (or additional funding requests) whenever they expect their project cost to be exceeded. Similarly, they report to their steering group any delay that they consider significant, although they do not have guidelines on what constituted significant. A project manager mentions:

> *At Company Fin, we do not use project contingencies. We have a project which is very difficult to evaluate precisely and it would be nice to add a 15% buffer [. . .] but our projects are required to balance exactly to the cent with the budget. We issue change requests, afterwards, if there are demands for scope change or requests for additional funding if we are short of money because of inadequate planning. (*Project Manager *– Portfolio Fin2)*

A small amount of money is put aside as contingencies at the portfolio level and is kept in case some projects exceed their budget. This serves as a form of contingency for all projects. In other words, instead of every project keeping contingencies for uncertainty,

a common pool is maintained at the portfolio level. This makes variations between actual project costs compared to approve budgets very visible. Any variation has to be signaled by project managers. However, according to the PMO representative at *Portfolio Fin2*, this portfolio buffer is still very small:

> *The total portfolio contingency was approximately $USD200,000 for 13 and a half million dollars in total budget for all of thel projects. That's very little. So the directive to the project managers is: "No buffer." If you have needs, come back with a request (*PMO Representative – *Portfolio Fin2)*

Capability Management Supported by a Resource Planning Tool (IS/IT only) (R2.4)

The corporate IS/IT department is involved in a large number of the *Company Fin* projects. Contrary to the other operational groups, the IS/IT employees are almost always working in projects and are very familiar with both the IS/IT development processes and the project management model. A tool has been implemented to forecast the resource needs for the coming 12 to 24 months in terms of number of hours required for different disciplines (e.g., architects, programmers). For each person (employee or consultant), the tool describes the competences and the allocation to projects which are matched against the project needs. The tool is considered an absolute must to be able to forecast and assign hundreds of resources to projects across the different divisions of *Company Fin*.

It must be noted that this resource planning activity is only done in the IS/IT department, primarily because they are a department involved in a multitude of parallel projects. Other departments do not need such a tool to plan the resource assignment since their main resource demands are for operational activities, which by definition are more continuous.

Four Year Budget Awarded to Project Portfolio (*Portfolio Fin1* only) (R2.5)

Portfolio budgets are allocated according to calendar years rather than for the duration of the complete portfolio.[1] At the highest level, allocation of financial resources is cascaded down as *buckets* assigned to large project portfolios, which are then further broken down into smaller portfolios (or subportfolios or programs). Portfolio budgets are approved according to the calendar year.

The annual portfolio budget has consequences on the way project budgets are handled and resources allocated. For example if the project spends more or less money in a given year and would like to transfer a portion to the following year, this is rendered difficult by the constraint of the annual budget, which does not allow flow of money from one year to the other. In other words if money had been approved in 2008 for the portfolio it had to be spent in 2008 and could not be transferred to subsequent years and vice versa.

This is a recurrent theme, which had already been observed at *Util2008* and *Fin2008* during the study of summer 2008. It was observed during the preliminary research that portfolios were aligned with the quarterly and yearly financial budgeting cycles.

[1] Project portfolio budgets are also allocated on a yearly basis at *Company Soft*.

The budgeting cycles cut across portions of projects. Some projects might have started before the cycle and some will finish after the cycle. In *Portfolio Fin2*, the portfolio budgets were also allocated for given years with the possibility to move money between projects but without the flexibility to reallocate money from one year to the next. In practice, some form of flexibility exists. When portfolio budgets are prepared, at the end of the year, the planning always begins with the remaining portions of ongoing projects. However, if a project has not spent the money in a given year they cannot automatically use that money in the following year. It has to be reapproved as part of the following year portfolio budget.

One exception is the *Portfolio Fin1* for which the portfolio manager received approval for a four-year period:

> *At Company Fin we normally allocate budget on a yearly basis. At the beginning of 2005, or 2006, I sold the idea to get a multi-year budget and we are the only ones at Company Fin to have this. It allowed me to get a flow between projects during the year and between years as well. For example, I could delay the development of some scope to 2010, if there was an issue, for example, some ill-defined scope or if there were too many questions or if there was a conflict in resource availability. So instead of having to justify the transfer or to lose the budget, I could do it myself. (*Portfolio Manager – *Portfolio Fin1)*

This approach provides more flexibility and to some extent more power to the portfolio manager. The portfolio manager considers this important to be able to plan the portfolio over its entire life. She considers this budget allocation to be a very positive advantage and something she would strongly recommend when managing portfolios. However, based on her experience, this requires fighting against an established financial culture built around yearly cycles.

7.1.3 Project Content (R3)

Management of Change Requests at Portfolio Level (R3.1)

At *Company Fin*, the reallocation of scope across projects is managed with change requests issued at the project portfolio level. This is done to maintain a balanced budget at portfolio level. Money can be reallocated from projects that are under-spending to projects over-spending.

Company Fin is used to handling change requests at project level and the introduction of change requests and change control boards at portfolio level is natural. Ultimately, the money comes from the same budget, therefore the reallocation of scope between projects under a given project portfolio allows an optimization of the sequence of activities and a mechanism to reallocate resources.

There were a number of mentions, by the project managers, of scope being moved from one year to the next because the project budget for a given year is exceeded. If this change is handled within the project and can be handled within the total project budget, these re-allocations do not require portfolio change requests. If scope has to be moved to future projects, change requests are issued at portfolio level (see also discussion on change requests and change control boards under *seizing* in section 7.2.2).

7.2 Seizing

This section presents the *seizing* mechanisms used in the two portfolios at *Company Fin* to determine and decide on the *reconfiguring* actions discussed in the previous section. This section refers to the *first-order seizing* as highlighted in black in the lower part of the conceptual framework of Figure 7-3. *Seizing* includes *organizing mechanisms* for deciding changes to the project portfolio once a potential need for change has been sensed. The goals of the project portfolios studied are primarily to comply with legal or international norms. In this case, the departments receiving the solutions are responsible benefits of the project outcomes. As shown in Figure 7-4, the mechanisms can be grouped into three main categories:

- business analysts (SZ1);
- project scope management (SZ2); and
- project portfolio governance (SZ3).

These three components can be further decomposed into a number of structures and processes and are discussed in the following subsections.

7.2.1 Business Analysts (SZ1)

The projects in the two *Company Fin* portfolios develop a mixture of new processes, of new reports, and IS/IT solutions. Outputs are for internal end-users who have operational jobs to perform and have usually little experience with the software development and the project management processes. The end users are very knowledgeable in the current ways of working, for example, existing norms, but are not trained to translate the implications of the new norms into new requirements.

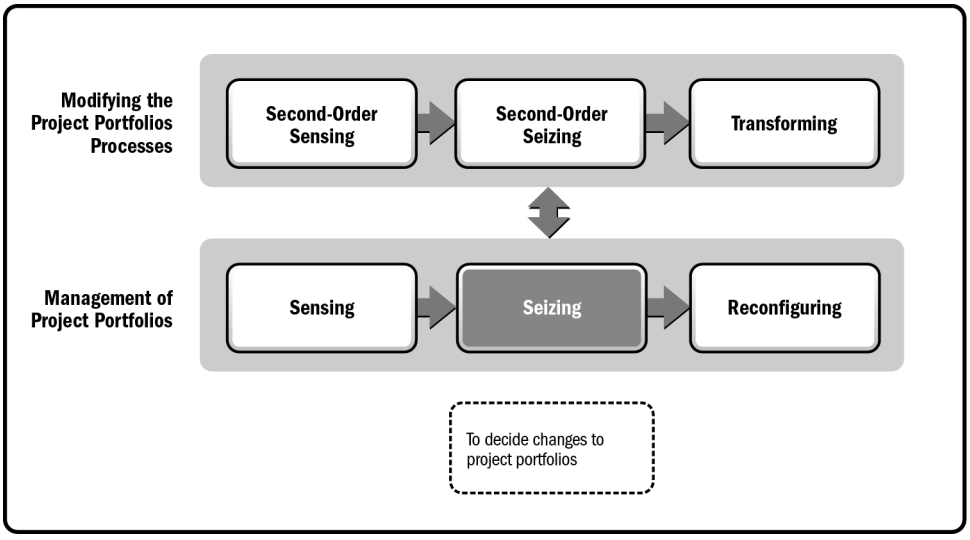

Figure 7-3. *Seizing* Mechanisms in the Conceptual Framework

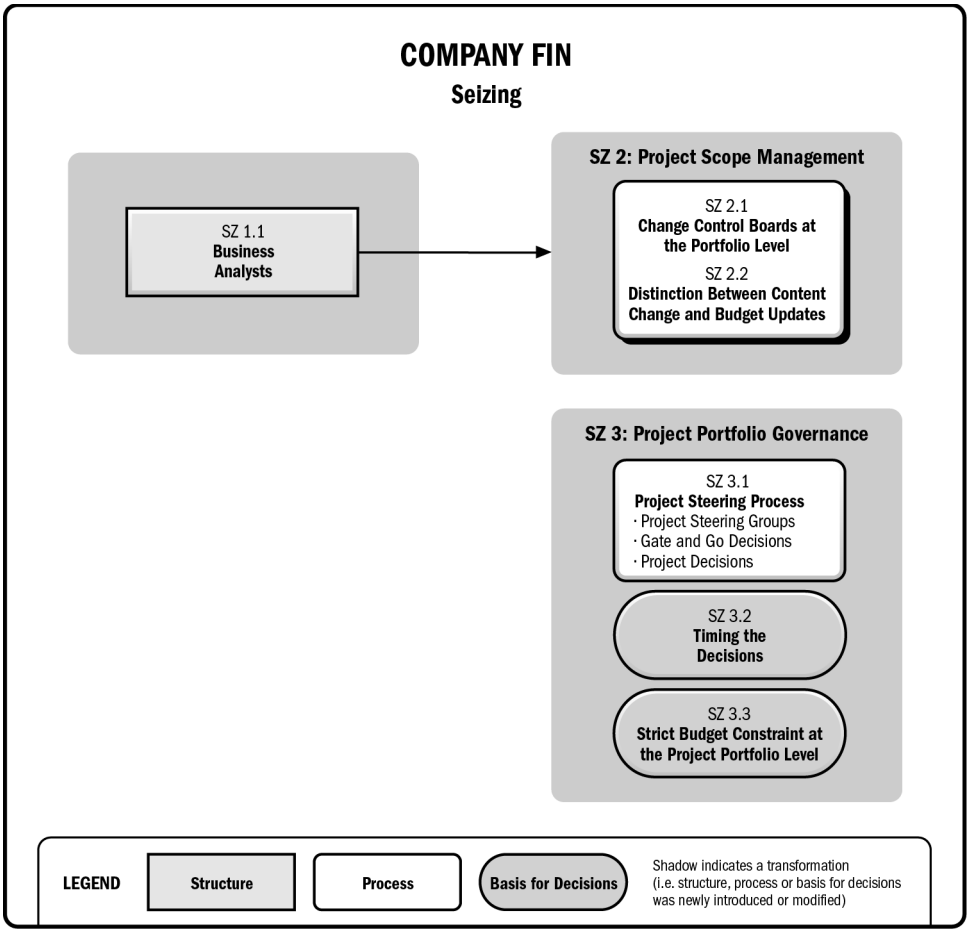

Figure 7-4. ***Seizing*** **Mechanisms at** ***Company Fin***

To assist the end-users in defining their requirements, *Company Fin* assigns professional business analysts. Business analysts must have a good understanding of the business and of information technology to understand and translate the needs of the users into software (and/or process) requirements. This is how a business analyst in *Portfolio Fin2* defines his role:

> *The business analyst role in this type of project consists primarily of collecting information, structuring it, normalizing it to make sure that users and software developers speak the same language. So he must understand the business side and the software development to ensure that the information is properly translated [. . .] Most often, this is done in workshops. The official route is workshops. But any other information gathered around a coffee, in a mail, any other collected information will help us understand the customer needs. (*Business Analyst – *Portfolio Fin2)*

As mentioned by this business analyst, workshops are commonly used to specify the requirements and decide on the priorities of the different requirements. Although ultimately,

the end-users have the final word when it comes to content, business analysts play an important role in identifying the requirements, in assessing how it should be translated into the terminology used by software developers, and in prioritizing between all the requirements.

Business analysts ensure that the content of the project is properly defined. This role is somewhat analogous to the product manager in new product development. Even though they do not have the responsibility for the profitability of a product, they still have to ensure that money is invested and that resources are allocated in the most beneficial way. For example, one of the business analysts at *Portfolio Fin2* mentioned that business cases had to be developed to support the development of certain aspects of the portfolio.

7.2.2 Project Scope Management (SZ2)

Change Control Boards at Portfolio Level (SZ2.1)

Project handle scope changes through their own change control boards. Two types of change requests can be issued and are analyzed by the members of the project change control board. *Company Fin* also introduced the concept of a change control board at the project portfolio level. They documented a process in which any demand that could not be addressed within the authority of the project (in terms of schedule and budget) would have to be escalated and approved at the portfolio level.

This function is not purely *seizing* and includes a strong *sensing* component (similar to the role of product managers at *Company Soft*) but *sensing* aspects of business analysts are covered in section 7.3. What constitutes *seizing* includes specifically the prioritization, selection, and allocation of the requirements identified during *sensing* to projects.

At the project portfolio level, the change requests are used to monitor the overall budget situation and to ensure that the sum of money spent on all projects (including actual costs and planned values) within a given year remain within the limits of the portfolio budget. There are a number of ways that budget overruns can be handled at the portfolio level: moving content to subsequent years, reducing content of some projects, or reducing the amount of people involved in activities.

Approvals of change requests by the project portfolio change control board are also used to document transfer of money between projects:

> *Sometimes requests for additional funding are negative. They are not always positive. For example., if I transfer the responsibility for a functionality from one project to another, one project will request additional funding but the other project must deduct the funding from his project. (*Assistant Portfolio Manager – *Portfolio Fin1)*

Such reallocation of money between projects according to the priorities defined by the portfolio is considered one of the key elements (and benefits) of project portfolio management.

Distinction Between Content Change and Budget Updates (SZ2.2)

Company Fin distinguishes between two types of project changes:

- *Change request* refers to a change of scope of the project in comparison to the approved (baseline) requirement specification.

- The *additional financing request* is issued when the project manager expects that the original project budget will be exceeded and that the project will require additional financing.

The two types of change requests allow *Company Fin* to differentiate the changes that are due to incorrect planning by the project team from the changes to the project content requested and approved by the sponsor. The two types of change requests are treated differently when collecting project performance and planning precision metrics. A project will not be considered over budget if the variation can be justified by approved change requests affecting the scope of the project. However, additional financing requests are measurement of the planning accuracy.

7.2.3 Project Portfolio Governance (SZ3)

Project Steering Process (SZ3.1)

The project portfolio governance at *Company Fin* is based on a hierarchy of four main committees:

- the prioritization council;
- the portfolio steering group;
- the portfolio management team; and
- the end-user committee.

The highest level, the prioritization council, decides the allocation of money between portfolios and meets around four to six times per year. On a yearly basis, portfolio budgets are allocated by this council for the next year.[2]

The portfolio steering group meets approximately monthly. It has representatives from the different components which will be receiving the outcome of the project portfolio. Ultimately, they are the senior executives sharing the sponsorship of the portfolio. They take decisions regarding portfolio escalation issues, portfolio budget follow-up, granting gates for individual projects.

The portfolio management team has a lot of autonomy and can decide on the best utilization of resources within the constraints of the portfolio budget. They meet regularly (every second week) to follow-up on the status of projects and address any escalation issues from the project managers. The portfolio management team also follows up on portfolio budgets and other performance indicators using a dashboard. Finally, they review change requests and additional financing requests at portfolio level.

The fourth committee is the end-user committee, composed of representatives of the main receivers of the portfolio outcome. They meet every second week and are responsible for ensuring that the content meets the end-user expectations. They also resolve any prioritization issue regarding scope that might have been escalated by business analysts or project managers.

Timing the Decisions (SZ3.2)

When there is a high level of uncertainty about the exact delivery of a project a key issue becomes the decision to execute or not certain parts of the projects. There are two opposite

[2] Despite the fact that *Portfolio Fin1* obtained approval for a four year budget (as discussed in R3.5 in section 0) they still had to get confirmation for budgets on a yearly basis.

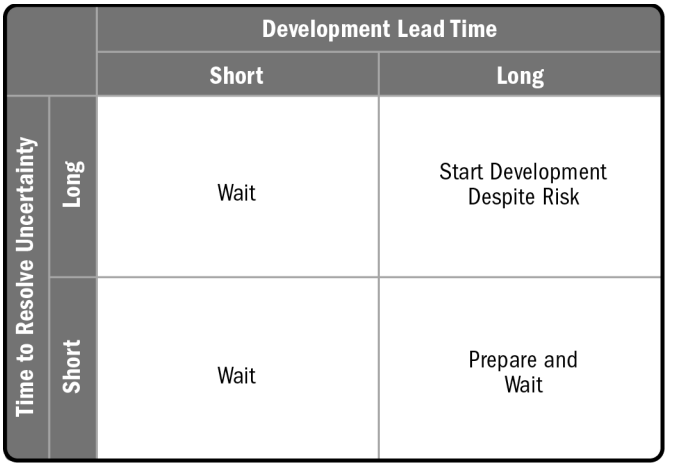

Figure 7-5. Decision Based on Lead Time and Uncertainty

options: (a) to wait until the uncertainty is resolved to start the development or (b) to start the development before the uncertainty is resolved. There are a number of examples in *Portfolio Fin2, which* uses the timing of the decision as a strategy when the uncertainty is very high. The wait versus start decision is based on two main elements: the project development lead-time and the time to resolve the uncertainty as shown in Figure 7-5. There were three occurrences mentioned at *Portfolio Fin2* where the time to resolve the uncertainty was expected to be very long and therefore forced the organization to start the project before the uncertainty was resolved. In this case, if the project would have waited, the remaining lead time to complete the project would have been too short to complete the project in time.

According to an employee in the PMO, this typically occurs when technology development is involved:

> *We try to estimate when we will receive an answer. Depending on the expected response time, we look at the time required to implement the changes. I would say that when it involves technology, since we have a development cycle, it takes time, and there is a lot of people involved on this. We have to begin earlier. It is different with norms affecting only business processes. (*Member of PMO – *Portfolio Fin2)*

A second case occurred where the project almost completely developed a product despite a very high level of uncertainty regarding the actual need to comply with a specific norm. It was decided to complete the execution but put the project on hold until the uncertainty was resolved. The accountant responsible for the interpretation of the impacts of the norms on the organization is involved in this decision and mentions:

> *At some point, they developed the solution completely. They designed it in its entirety knowing that that they might not need it. But they were so far in the design phase that they said: We will complete the design and if the project starts again in 2010 we will be able to use it if necessary. (*Accountant – *Portfolio Fin2)*

In a third case, *Portfolio Fin2* started the project execution despite the conviction that the accounting norm did not apply to them. In parallel, they spend a lot of energy fighting the authorities to be exempted from this norm while in parallel. This development was just in case they would lose their case. They ended up spending more than one million dollars in development but could have spent four times as much if they had completed the project as originally planned as described by the sponsor:

> *There was one norm that we did like at all. We spent months trying to get exempted from this norm. We managed to get exempted from the help of our auditors. Sometimes we wondered: "We have to do it, we don't have a choice." This was nonsense for everybody. After having prepared our arguments, we went to London [. . .] Development had started and we spent maybe one million for nothing. We had estimated the project at 4,5 million and we left one million in the gutter.* (Sponsor – *Portfolio Fin2)*

Strict Budget Constraint at Project Portfolio Level (SZ3.3)

As discussed in section 6.2.3, for *Company Soft*, a very strict constraint at portfolio level appears to be the portfolio budget. Throughout the interviews with the people involved at *Company Fin*, it became clear that the project portfolio budget is indeed always untouchable. In all portfolios, the overall yearly budget for a given project portfolio is considered fixed and non-renegotiable. Portfolio budgets are approved at a very high level in the organization after long analysis and negotiations in the money allocation between portfolios or product areas.

This means that when budgets for individual projects within the portfolio are exceeded in comparison to the plan, some re-balancing has to be done to remain within the portfolio budget. This takes one of the following two forms:

- reassignment of money from one project to the other while staying within the overall portfolio budget; or
- delay some projects (or some parts of projects) to the following year.

The project budgets and the roll-up of all project budgets to portfolio level become particularly important at the end of the year. If the money is not spent in a given year, it does not mean that it will be carried over to the following year for a given project even if it is required to complete a project. Project managers are thus pressured to spend the money exactly in the year they have planned to spend it.

7.3 *Sensing*

This section presents the different *sensing* mechanisms which are put in place in the two project portfolios at *Company Fin* to identify the changes in the environment and translate them into potential new (or changed) requirements for the projects. This section refers to the *first-order sensing* highlighted in black in the lower part of the updated conceptual framework of Figure 7.6.

Sensing refers to structures, tools, and processes to sense, filter, and interpret changes and uncertainty. The objectives of the *sensing* mechanisms are to identify the changes in

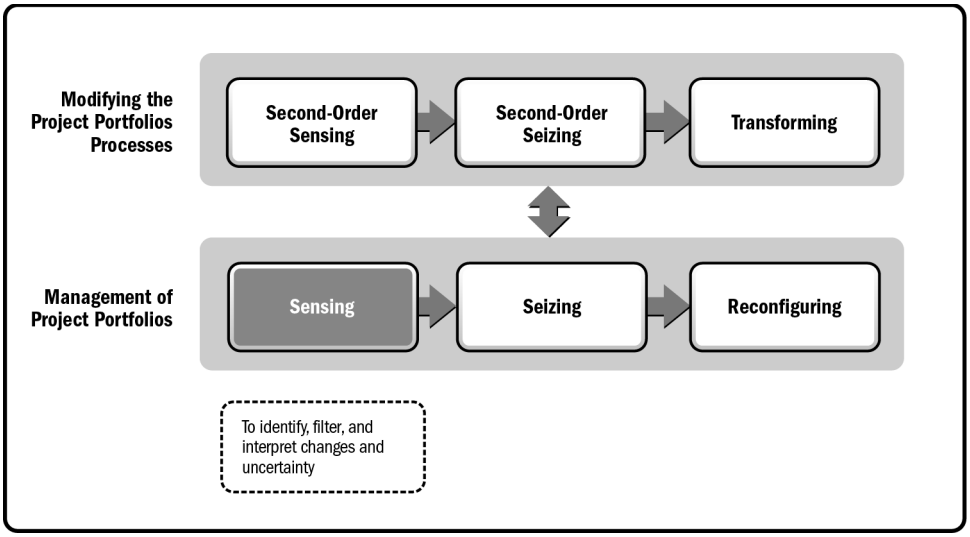

Figure 7-6. *Sensing* Mechanisms in the Conceptual Framework

the environment and translate them into potential new (or changed) requirements for the projects. In the PPM context of *Company Fin*, this includes the proactive assessment of the evolution of the norms, how competition interprets the norms, and the match between the products being developed and the customer needs. The *sensing* mechanisms are linked to the *seizing* mechanisms, which are used to decide on the resulting reconfigurations of resources in the project portfolios. Figure 7-7 shows the relationship between the sources of uncertainty and the *sensing* mechanisms at *Company Fin*.

Mechanisms which have been newly put in place, recently modified, or transformed are highlighted with a bold border. These modifications to the *sensing-seizing-reconfiguring* result from transformation decisions that are discussed further in section 7.5.

7.3.1 Dedicated Role for Monitoring Norm Updates (SS1)

The main source of uncertainty at *Company Fin* is related to the regulating bodies continuously updating the norms. An even greater source of uncertainty is its interpretation by the firm itself (as discussed in sections 5.3 and 5.4). To ensure that changes to the norms are captured as early as possible, both *Portfolio Fin1* and *Portfolio Fin2* assigned somebody to be responsible for regularly monitoring the updates of the norms.

For example, in the case of *Portfolio Fin2*, an accountant is dedicated full-time as watchwoman[3] to follow the evolution of the new accounting norms and legislations. She subscribes to all the publications related to the evolution of the accounting norms, to the ongoing discussions in the official forums, and the directives from the regulatory bodies. Based on the documentation, she produces a weekly summary report and sends it to all the stakeholders who might be affected in *Company Fin* (not just *in Portfolio Fin2*).

[3] In French, interviewees used the word *vigie*.

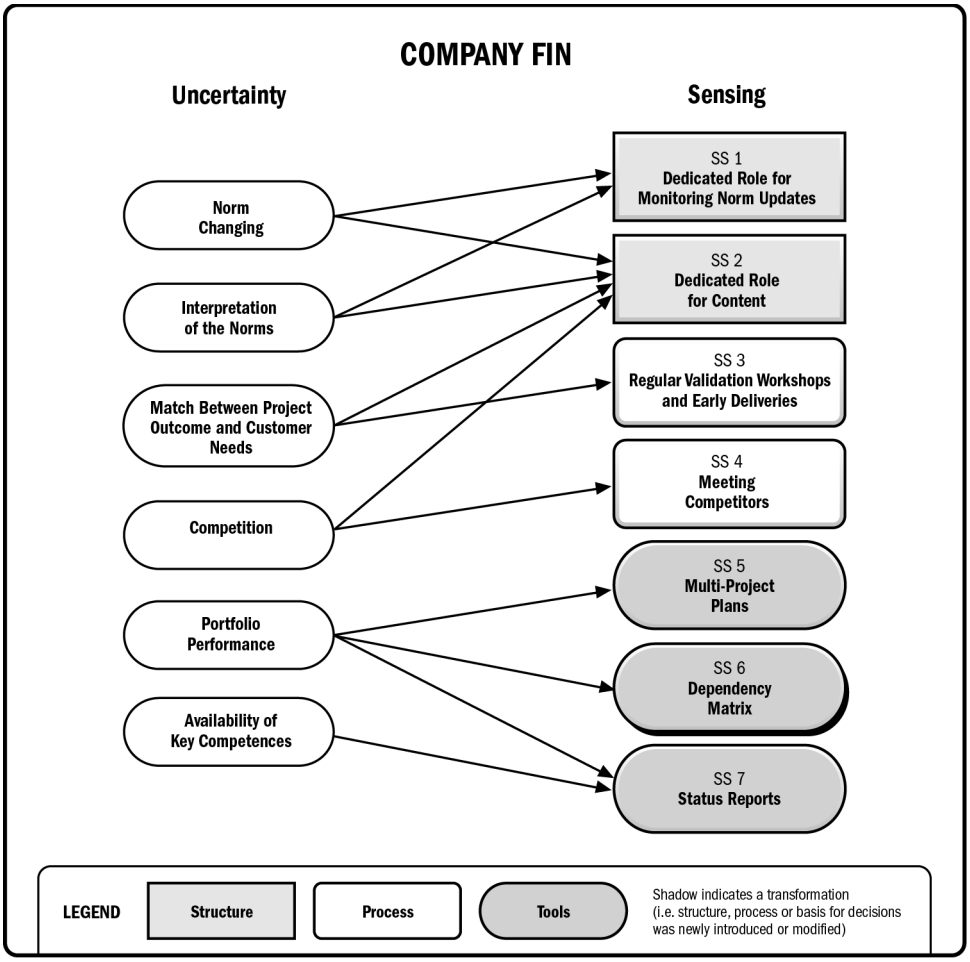

Figure 7-7. *Sensing* Mechanisms at *Company Fin*

There is an additional person specifically dedicated to the *Portfolio Fin2* who interprets the weekly report from the *watchwoman* to assess if upcoming changes in the norms result in impacts and change requests to *Portfolio Fin2* projects. This function is a full-time staff function reporting directly to the portfolio manager and per se is contributing to all the projects in the portfolio. When potential changes to the portfolio are identified, he gets in contact with the business analyst responsible for the content of the project to translate the changes in the accounting norms into the necessary requirements and change requests on the ongoing projects.

Links to *Seizing*

In the case of *Company Fin*, the specification of the requirements is done by the end-users with the help of the business analyst. Both of these project members require the analysis from the people monitoring the changes to the norm to determine if there are impacts to the projects. If this is the case, they translate them to project or portfolio change requests. They are then assessed by the decisions boards.

The *sensing* mechanisms are used by business analysts to identify the requirements (somewhat like a radar screen) and to serve as filtering functions (like funnels for ideas). The key element of these functions is to first assess that changes are occurring, and their importance against already approved scope.

7.3.2 Dedicated Role for Specifying Project Content (SS2)

In *Portfolio Fin1* and *Portfolio Fin2*, the customers are the internal users who are impacted by new processes, practices, and tools. The end-users normally have the last word with respect to the actual requirements. However, because they also have an operational position in the organization and do not always have a lot of experience on how to translate their needs into software requirements, business analysts are assigned to projects to interface with the customers. Business analysts are assigned to all projects and some projects have full-time business analysts dedicated to their project. They are responsible for organizing workshops, to gather, specify, and validate the project requirements.

These activities are very intense in the early phases of the projects (identification and design) but continue throughout the complete project life cycle. Business analysts monitor sources of changes and ensure that they are identified and captured in due time.

Both *Portfolio Fin1* and *Portfolio Fin2* also introduce a new role called integration business analyst. They are responsible for overseeing the requirements at the portfolio level to minimize duplications and conflicts between projects. This is deemed necessary because of the large number of projects and their dependencies. The integration business analyst is more senior and has a complete view of the content of the project portfolio. The integration business analyst could be considered as the business analyst assigned at the project portfolio level.

Links to *Seizing*

As mentioned before, it is not always clear how to dissociate the *sensing* and the *seizing* functions when it comes to determining how a given structure or process is put in place in a complex organization such as *Company Fin*. Because business analysts are heavily involved in both functions, they are an example of dual *sensing-seizing* functions. This explains why they are also described in both sections. Business analysts are not only involved in assessing the trends in the interpretation of the norms and customer needs (through the *sensing* functions) but they must also translate them into project requirements through the *seizing* mechanisms of product portfolio management mechanisms (SZ1) discussed in section 7.2.

7.3.3 Regular Validation Workshops and Early Deliveries (SS3)

Both *Portfolio Fin1* and *Portfolio Fin2* use regular workshops led by business analysts with business representatives (i.e., the end users) to identify the requirements for the processes and tools to be developed. These workshops are not only carried out during the early phases of the projects but continue throughout the projects to refine the requirements, to validate the designs, and identify potential enhancements. A business analyst mentioned that occasionally workshops might result in major surprises. Requirements that would otherwise have been completely missed in earlier phases suddenly appear in later discussions during the workshops.

Workshops also serve as an opportunity to continuously meet the end users and to informally gather their needs outside the official meetings. A business analyst in *Portfolio Fin2* mentions:

> *The official channel is workshops but we try to detect any information gathered around a coffee or in emails. One of the qualities of a good business analyst is to be empathetic to the customer, to understand his needs that he does not always express clearly in workshops. (*Business Analyst – *Portfolio Fin2)*

At *Company Fin*, prototyping is used to validate the interpretation of the norms by stakeholders in the early stages of the projects. The objective is to reduce subsequent rework and reach agreement and decisions on the project scope. There are different approaches used. At *Portfolio Fin1*, presentation slides are used to provide the look-and-feel of the application very early in the feasibility phase. At *Portfolio Fin2*, layouts of reports are produced to allow validation by end users.

In one of the *Portfolio Fin1* projects, a paper-based process is developed and implemented prior to the development of the tool-based solution. This allows the users to get used to the process and to provide input on the information required. In some cases, slideware[4] is produced to demonstrate how the system would look. An enhancement of this approach is dynamic modeling where they can simulate the different entries in the system.

Links to *Seizing*

The *sensing* of the customer needs through regular workshops and meetings generates requirements that are treated in the same manner as any other requirement by the business analyst (SZ1.1) and then processed for decision through the governance boards. They are evaluated, categorized, and prioritized via the product scope management mechanisms (SZ2) described in section 7.2.

7.3.4 Meeting Competitors (SS4)

Portfolio Fin1 and *Portfolio Fin2* have to comply with new regulations which are interpreted by Canadian financial authorities. Because these norms are new, there is considerable margin for interpretation which can occasionally be negotiated with the authorities. One of the approaches used in both portfolios at *Company Fin* is to try to assess how competitors (i.e., similar firms in the financial services industry) address controversial or ambiguous issues. This is sometimes done by hiring consultants or specialized firms, which implemented the same norms for competitors in the financial sector.

An alternative is to meet the competition directly to discuss and agree on a position to negotiate with the authorities as mentioned by a business representative:

> *I met other financial institutions to find out what they were doing. When regulating bodies do not know exactly what they want, we consult each other. So, for example, to evaluate the regulating requirements, another bank informed us of their approach towards the regulating bodies. (*Business Representative – *Portfolio Fin1)*

[4] The term *slideware* comes from a combination of the words *slide* and *software* and refers to a presentation of the functionality to be developed. This is a technique used to mock up the user interfaces and the output to generate discussions with users.

Links to *Seizing*

Like the three other *sensing* mechanisms presented earlier, meeting the competition is another technique to help interpret the norm and translate it into requirements which must be prioritized against other requirements through the *seizing* mechanisms by the business analyst (SZ1.1) and then decided upon by the governance boards. They are then evaluated, categorized, and prioritized via the product scope management mechanisms (SZ2) which are described in section 7.2.

7.3.5 Multi-Project Plans (SS5)

Company Fin uses multi-project plans for both *Portfolio Fin1* and *Portfolio Fin2*. Multi-project plans show the list of ongoing projects with a short descriptor, its estimated cost, and a high-level plan with key milestones, decisions points, and deliverables. The plan includes future, not yet approved, projects.

Multi-project plans are used to plan deliveries with the end-users, the auditors, the regulatory bodies, and to calculate yearly budgets for the project portfolios. When projects are approved, a target budget is approved and is included in the portfolio budget. For future projects, for which the gate decision is not yet granted, a target level is estimated. When projects are in the early phases, margins of uncertainty are included in the estimate. This can be as high as 680 percent in early phases of projects.

This is considered a *sensing* mechanism because it is used to monitor the portfolio performance and to identify corrections that need to be made on the portfolio in reaction to variations. Up to this point, the uncertainties handled by the *sensing* mechanisms fall into the category of *foreseen uncertainty*. However, uncertain portfolio performance due to the inability to accurately plan projects should be classified as *variations*, i.e., comes from many small influences and yields a range of values on a particular activity (De Meyer et al., 2002). The *variations* have to be monitored and managed on a continuous basis. Although it might be argued that project portfolio performance is controlled by the organization, it still carries a significant amount of inherent *variation*, which must be monitored and controlled.

Links to *Seizing*

Multi-project plans are used as boundary objects and are reviewed in the project steering groups. They also get updated based on steering group decisions. They serve as a reference to monitor the status of projects through the status reports discussed in section 7.3.7.

7.3.6 Dependency Matrix (SS6)

Portfolio Fin1 produces dependency matrices. This is a special technique to formalize and document dependencies between the projects. Each project identifies the impacts of their projects on other projects. When change requests are issued, the dependency matrix is used to assess if there are impacts on other projects. Based on the analysis of the dependencies, the project manager informs the portfolio manager and/or the other project managers of the consequences of approving (or rejecting) the change requests.

There is also a monthly update of the dependency matrix done by the project administrators to ensure that it is maintained up to date. The dependency matrix is also used in *Portfolio Fin2* but because the portfolio size is much smaller, it is used less frequently.

The dependency matrix was introduced in *Portfolio Fin1* because of the size and complexity of the portfolio and the large number of dependencies between the projects. This tool can be considered both a *sensing* mechanism (because it helps identify impacts on projects) and to some extent a *seizing* mechanism (because it helps to take action on the resource allocation based on these impacts).

Links to *Seizing*

The level of dependencies between the different projects almost always results in some knock-on effects on other projects, either because the project outcome (e.g., data collected in a database) would not be available in time for subsequent projects or more often because resources would be held longer than expected in the delayed projects. The dependency matrix is therefore used to identify the consequences of changes (under *sensing*) and assist in the governance decision making (under *seizing*).

7.3.7 Status Reports (SS7)

At *Company Fin*, there are numerous levels of project portfolio status reports:

- multi-project status overview,
- project status reports at steering groups; and
- written project reports (weekly and monthly) to senior management and to the corporate PMO.

Project managers present the status of their project to the different steering groups, using a presentation template displaying: achievement since last report, planned activities in the coming time period, escalation issues and risks. In addition, the corporate PMO provides an external assessment on the status of the portfolio in terms of portfolio budget compliance and deliveries according to schedule. A number of metrics are also defined to measure the performance of the portfolio. The status reports are presented as *sensing* mechanisms because they are tools to monitor the performance of projects faced with very high levels of uncertainty.

Links to *Seizing*

In both portfolios, the steering bodies are put in place to decide on a number of issues related to the project portfolio performance. There is also a separate meeting with user representatives to ensure that the project deliverables meet their needs. Some of these boards are also put in place to monitor the performance of the portfolio via the project performance. This takes the form of regular meetings (either biweekly or monthly) where each project manager reports issues, delays, cost overruns, major scope changes.

7.4 Links between Uncertainty and *Sensing* Mechanisms

Dedicated people monitor changes to the norms (SS1) to assess and interpret potential changes, which might impact *Company Fin*. Because the norm approval follows a

well-established process involving many stakeholders, this gives enough time to determine future upcoming impacts. The much higher volume of changes to the norms in *Portfolio Fin2* compared to *Portfolio Fin1* justifies the allocation of a full-time person (SS2) to this specific *sensing* function.

The regular validation workshops (SS3) serve as early warning to the projects if requirements might not be met to the end-user satisfaction. It is also an effective way to identify new requirements or misunderstood requirements. The main source of uncertainty in this case is also due to the interpretation of the norms. Meeting the competition (SS4) helps understand how regulatory bodies might impose the implementation of certain aspects of the norms.

A multi-project plan (SS5) is a mechanism put in place to address the *variation* resulting from the potential inaccuracies of planned projects. The dependency matrix (SS6) is also used to determine the consequences of changes to projects (due to change in scope or inaccurate planning) on other projects in the portfolio. Multi-project plans (SS5) and dependency matrix (SS6) are used in conjunction with status reports (SS7) to continuously monitor progress against project portfolio plans.

7.5 *Transforming*

In section 2.4.2, the concept of *transforming* is presented as the higher-order activities of improving the PPM activities. This refers to the following two broad categories of actions:

- modifying the *sensing-seizing-reconfiguring* mechanisms used in the first-order level; and
- introducing new structures, processes, or tools to support the PPM activities but not directly resulting in changes to the *first-order sensing-seizing-reconfiguring* mechanisms.

Transforming is the third element in the second-order sequence of the conceptual framework as highlighted in black in Figure 7-8. Figure 7-9 summarizes the *transforming* mechanisms observed at *Company Fin*. The row T1 entitled *Transforming the First-Order Process* includes modifications to the first-order *organizing mechanisms*. This includes the modification of existing processes or the introduction of new processes marked in bold in Figure 7.6 for *sensing*, Figure 7-4 for *seizing*, and in Figure 7-1 for *reconfiguring*. Transformations did not always involve the modification of the first-order mechanisms but were sometimes introduced to modify other aspect affecting management of the project portfolio. *Transforming* mechanisms have been classified as follows:

- project management processes (T2);
- product development processes (T3); and
- organization structure (T4).

The codes T1 to T4 refer to the different rows in Figure 7-9 and are used to facilitate cross-references in the following sub-sections. Each header includes the reference to the relevant code.

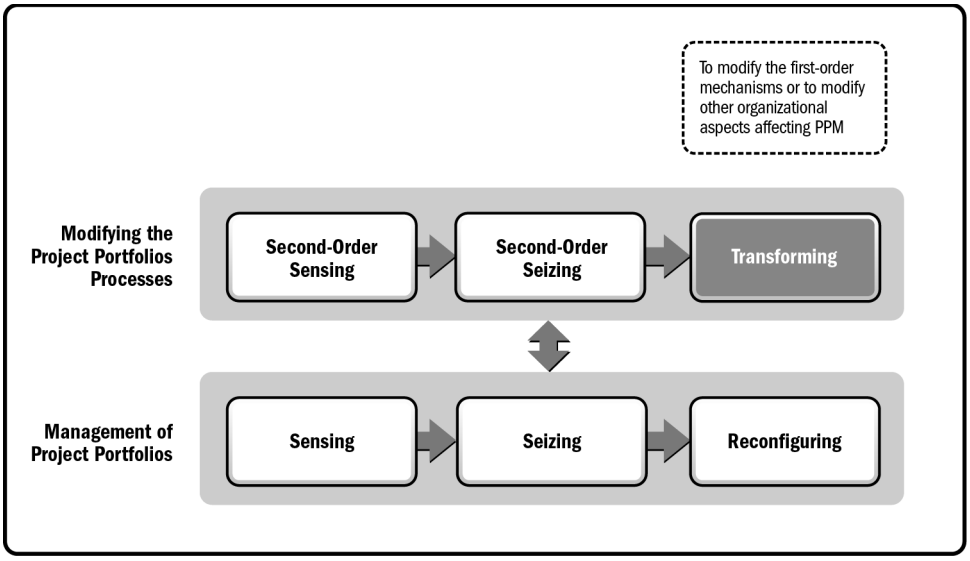

Figure 7-8. *Transforming* Mechanisms in the Conceptual Framework

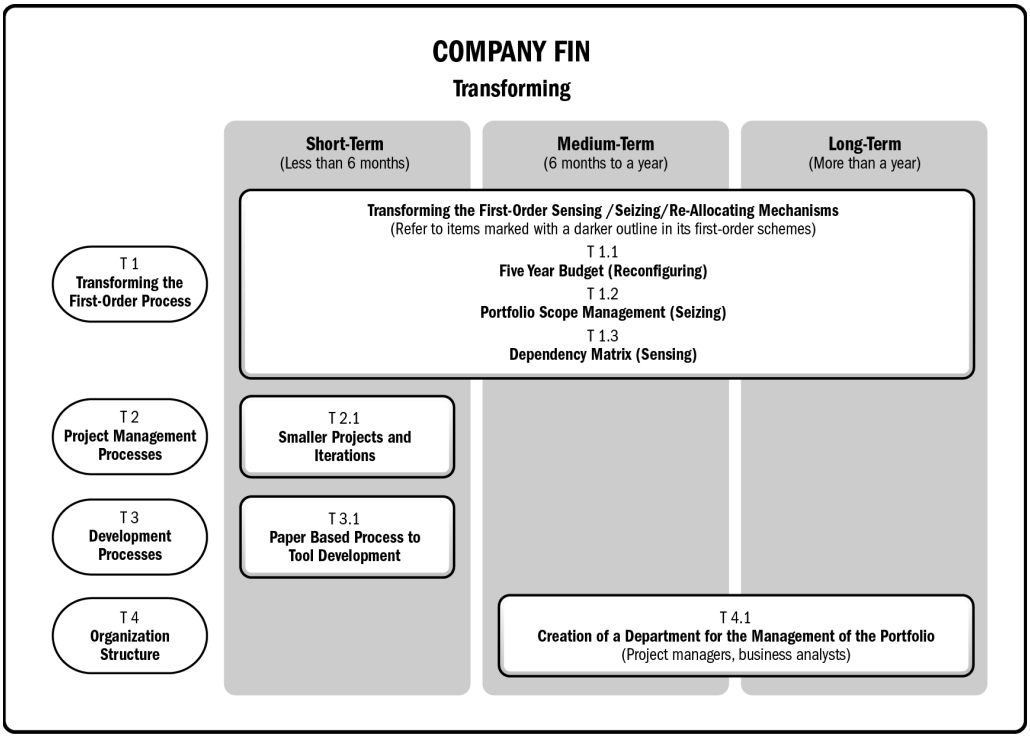

Figure 7-9. *Transforming* Mechanisms at *Company Fin*

7.5.1 Transforming the First-Order Mechanisms (T1)

There are cases where the first-order *Sensing-Seizing-Reallocating* mechanisms were newly implemented in one (or both) *Company Fin* portfolios. Such mechanisms are clearly marked in bold in the figures to indicate that they have been newly introduced or modified. These new modifications of the *first-order sensing-seizing-reallocating* mechanisms are treated here as *transforming* mechanisms and include:

- T1.1: five year budget (*Reconfiguring*);
- T1.2: portfolio scope management (*Seizing*); and
- T1.3: dependency matrix (*Sensing*).

Transforming the *Reconfiguring* Mechanisms: Four Year Budget (T1.1)

At *Company Fin*, Project proposals are analyzed and prioritized by the steering groups, once a year, for the following year. These yearly cycles were not deemed appropriate, by the *Portfolio Fin1* portfolio manager for the planning of the entire portfolio. She requested a four-year budget for more or less the equivalent of the duration of all projects part of the portfolio. This long-term budget allowed the portfolio management team to better plan the sequence of projects and the allocation of resources. It also provided senior management with the estimated cost and duration of the entire portfolio, not just for the following year. According to the portfolio manager, this is the first time in the history of *Company Fin* that such longer-term budgets were allocated. This was after long debates and battles by the portfolio manager. Despite this four-year budget, yearly forecasts still have to be submitted and monitored.

Transforming the *Seizing* Mechanisms: Portfolio Scope Management (T1.2)

Change requests at project level are used at *Company Fin*. The concept of change requests at portfolio level was also introduced to monitor and control changes at a higher level. Project managers are not allowed to include contingency reserves in their plan and are forced to report any expected deviations once the project is under execution. This allows the portfolio manager to be informed on any deviations from the plans, even when they are very small.

Transforming the *Sensing* Mechanisms: Dependency Matrix (T1.3)

At *Portfolio Fin1*, the number of dependencies between projects is extremely high. The management comes up with mechanisms to help them assess if the changes in one project would have consequences on other projects. The evaluation and documentation of the dependencies by each project and its integration into a dependency matrix was introduced to support the interpretation and assessment of uncertainty and changes on other projects.

7.5.2 Project Management Processes (T2)

Smaller Projects and Iterations (T2.1)

The software development process at *Company Fin* follows a waterfall model, which includes a number of consecutive phases: identification, feasibility, design, execution, deployment, and post implementation. Project managers are pressured to follow this standard process

imposed at corporate level. The projects cannot be decomposed into smaller iterations (as suggested by *agile* methodologies, for example). One of the project managers at *Portfolio Fin2* mentioned that she tries to introduce such a concept by splitting her project into topics (i.e., subsets of the functionality to be delivered). Each of those topics then goes through the complete development phases in short cycles. According to the project manager, the regular development process is inappropriate for her project because of the high level of uncertainty:

> *I try to plan small iterations per topic. It would not be feasible otherwise. If I would do complete phases: feasibility, design, execution, it would be very difficult to manage because it changes too much. (*Project Manager – *Portfolio Fin2)*

This iterative approach is not entirely supported by the IS/IT department which prefers the elaboration of a more complete design phase prior to execution. The approach is tolerated in the feasibility phase where different iterations are used to specify different features. However, single gate decision is still used when the feasibility study of all features are completed.

Another approach, which is used in both portfolios at *Company Fin*, is the decomposition of the portfolio into projects of a maximum of one million Canadian dollars. This guideline is based on past experience and consultant reports that showed that above this size, projects at *Company Fin* cannot be managed with a high degree of accuracy.

7.5.3 Product Development Processes (T3)

Use of Paper Based Process (T3.1)

The typical development process for new tools and processes includes the requirement specification followed by validation workshops and prototypes. One of the projects within *Portfolio Fin1* was introducing a completely new process, which included many changes in the ways of working in the hundreds of branches where the tools and processes are planned to be deployed.

The business person responsible for gathering and specifying the requirement was concerned that such tool deployment in an uncertain environment would be very costly, and would result in a high volume of change requests (because it would be very hard to capture all requirements). They therefore decided to pilot the process using a paper-based process. Although this approach is very unusual for business analysts and IS/IT developers, it was used to deploy the process and get feedback on the requirements at low cost.

7.5.4 Organization Structure (T4)

Creation of a Department for the Management of the Portfolio (T4.1)

Both portfolio managers interviewed at *Company Fin* are reporting directly to senior vice-presidents. They created the equivalent of PMO for the portfolio, which includes all the sub-portfolio managers, some of the project managers assigned to projects in the portfolios, and portfolio support functions such as business analysts. In the case of *Portfolio Fin2*, the person responsible for monitoring the changes in the norms is also reporting to the portfolio manager. The members of these groups are co-located on the same floor of the same building.

This temporary structure created to manage the project portfolio ends up having a longer life than the original organization which created it. Both portfolios experienced a number of changes in the senior executives of *Company Fin* and multiple structural re-organizations. The portfolio management structure remained intact after these re-organizations, only the governance structures changed.

7.6 *Second-Order Seizing* and *Second-Order Sensing*

At *Company Fin*, since there are few *transforming* activities, there is no specialized *second-order sensing* or *second-order seizing* procedures or mechanisms put in place to translate into actions the change requirements identified. All *transforming* activities are decided upon directly by the project portfolio management team that has the authority to introduce and implement, as they see fit, the necessary changes to the ways of working.

Chapter 8

Cross-Case Analysis

This chapter compares the findings from the four cases to identify if patterns emerge. Section 8.1 compares the different changes and uncertainties observed in the four portfolios. This is followed, in section 8.2, by a summary of the common *organizing mechanisms* observed in all four portfolios. Although the exact implementation of these mechanisms differs slightly, they show sufficient similarities to suggest that these mechanisms are likely to be observed in other project portfolios. *Portfolio Soft1* is facing a much more turbulent environment than the three other portfolios. There is a limited set of findings which differ significantly for this case which could probably be explained by this higher level of uncertainty. These unique occurrences are presented in section 8.3.

8.1 Comparing Changes and Uncertainties

During the interviews, a number of sources of uncertainties were identified and are described in see section 4.1. Table 8-1 summarizes the different types of uncertainty and change described by interviewees in the four portfolios. All four portfolios display a high level of uncertainty in the project scope specification.

The environment of *Company Soft* can be considered a much more turbulent environment than *Company Fin*. In the case of *Company Soft*, the source of uncertainty comes from the development of totally new products and their introduction into new markets. In such a context, even the customers cannot easily specify their needs.

At *Company Fin*, the source of uncertainty is primarily related to the interpretation of the norms. This is partly due to the norms being changed by the regulating bodies but an even greater source of uncertainty is its interpretation by the firm itself.

Table 8-1 includes a mixture of changes in the environment affecting the project portfolio but also includes a number of internal changes (such as new development processes) which are implemented in response to external uncertainty. For example, at *Company Soft,* there are numerous mentions of process and organizational changes. These internal changes can be considered responses by the organization to external uncertainty.

As mentioned in section 1.2.4, Leifer et al. (2000) suggest that project uncertainties can generally be classified in four broad categories according to their sources: technical uncertainty, market uncertainties, organizational uncertainties, and financial uncertainties. Table 8-2 maps the different types of uncertainties mentioned during the interviews according to the four categories. The market uncertainties are the most significant in all four cases. This includes matching the product with customer requirements, competitor's offering

Table 8-1. Comparison of Types of Uncertainty and Changes in the Four Cases

		Soft 1	Soft 2	Fin 1	Fin 2
Scope	Spec of New Product	+			
	Need for Customization	+			
	New Customers/Market	+			
	Evolving Priorities		+		
	Norm Changing			+	+
	Interpretation of the Norm			+	+
Internal	Changes in Processes	+	+		
	Financing Structure		+		
	Structural Re-Organization	+	+	+	+
	Key Competences			+	+
	Business Model	+	+		
	Project Performance	+	+	+	+
	Budget Reduction			+	
External	Technology	+	+		
	Third-Party Suppliers	+			

evolution, new customers, new market, and new applications. Financial uncertainty is observed primarily in *Portfolio Soft2*. Uncertainty regarding resource availability is a concern at *Company Fin*.

A fifth category of uncertainties, *planning accuracy*, is added to the categories proposed by Leifer et al. The planning of project activities, especially in the context of software

Table 8-2. Mapping the Sources of Uncertainty

	Soft 1	Soft 2	Fin 1	Fin 2
Technical	3rd Party Product	3rd Party Product		
	Technology	Technology		
Market	Match Product with Customer Needs	Match Product with Customer Needs	Match Product with Customer Needs	Match Product with Customer Needs
	Competitor's Offering	Competitor's Offering		
	New Customers			
	New Market			
	New Applications			
			Content of Basel Agreement	Content of New Accounting Regulations
			Interpretation of Basel Agreement	Interpretation of New Accounting Regulations
Organizational			Availability of Resources	Availability of Resources
Financial		Funding Structure		
Planning Accuracy	Portfolio Performance	Portfolio Performance	Portfolio Performance	Portfolio Performance

development, is difficult to perform with a high degree of accuracy and is often subject to changes during execution. The uncertainty in planning accuracy is caused by variability associated with estimates of project parameters. It is also related to the level of interdependencies between projects. For example, if a project team estimates that a project will take six months and will cost US$200,000 despite all the planning and forecasting technique, real durations and costs might differ by some margins due to issues encountered during project execution.

The sources of uncertainty seem to have led to similar *organizing mechanisms* across the four portfolios. These similar mechanisms are described in the following section.

8.2 *Organizing Mechanisms* Replicated in All Four Project Portfolios

This section summarizes the *organizing mechanisms* that are common to all four portfolios. Although the exact implementation of these mechanisms differs slightly, they show sufficient similarities to suggest that they are likely to be observed in other project portfolios. This includes *organizing mechanisms* to manage scope, the assignment of a dedicated role for scope management, the use of multi-project plans and roadmaps, the monitoring of portfolio performance, striving for shorter projects and iterations, strict portfolio yearly budgets, and a limited use of reserves for uncertainty. Table 8-3 compares these mechanisms, which are described in more detail in this section.

8.2.1 Managing Scope

Table 8-3 shows that project scope is the most important source of uncertainty in all four portfolios. This results in a number of *organizing mechanisms* being put in place to translate these sources of uncertainty into the required changes in the project portfolios. The approaches used in the portfolios differ slightly but the purpose remains the same.

Table 8-3. Organizing Mechanisms Replicated in All Four Project Portfolios

Characteristics	Company Soft		Company Fin	
	Portfolio Soft 1	Portfolio Soft 2	Portfolio Fin 1	Portfolio Fin 2
Managing scope	Pre-study machine requirement request board scope-in	Pre-study machine requirement request board	Change control boards at project portfolio level Two types of changes requests	Change control boards at project portfolio level
Dedicated role for scope management	Group of product managers		Business analysts and integration business analyst	
Multi-project plans and roadmaps	Multi-project plans and roadmaps		Multi-project plans and roadmaps	
Managing dependencies between projects	Managed without tools by project management teams	Informal	Dependency matrix	Informal
Monitoring portfolio performance	Metrics mainly at project level standard project reporting Integrated reporting		Metrics mainly at project level standard project reporting Integrated reporting	
Shorter projects and iterations	Targets projects less than one year and iterations less than 6 weeks agile development		Target projects less than 1 million CAD$	
Strict portfolio yearly budgets	Yearly budget approved 18 months rolling forecast		Yearly budget approved. Portfolio budget approved for 4 years.	Yearly budget approved
Reserves for uncertainty	No reserves at project level; limited reserves at portfolio level		No reserves at project level; limited reserves at portfolio level	

In *Company Soft*, this takes the form of the Pre-Study Machine and Requirement Request Board described in section 6.2.2. Combining the prestudy into a single process common to all projects allows them to manage the inflow of requirements. This is combined in a *Scope-In* approach, i.e., starting projects with project scope smaller than project capacity allowing future opportunities to include additional content.

Company Fin prefers to use change control boards at project portfolio level. At that level the change requests are used to monitor the content of project deliverables while monitoring the overall budget situation.

The key point is that, in the four portfolios studied, some processes and structures were put in place to monitor and control project scope across the portfolio. This allows them

- to control the inflow of requirements and its allocation to projects;
- to ensure impact analysis on all projects is performed;
- to avoid change requests being submitted and potentially rejected in multiple projects; and
- to constantly provide a mapping between the requirements and the different projects developing artifacts against these requirements.

8.2.2 Dedicated Role for Scope Management

The specification of the scope of the different projects is a complex task and in all four portfolios this task is delegated to specific roles: product managers in the case of *Company Soft* and business analysts in the case of *Company Fin*. Neither the sponsors nor the project managers have the responsibility of specifying project content.

In *Company Soft*, the scope responsibility is shared among many people. For example, in *Portfolio Soft1*, there are over 50 product managers within a product management department. Product managers are responsible for specifying the requirements and for sending *assignment specifications* to the projects, that is, the details of what the projects have to deliver in terms of scope, target date, and target budget. Important portfolio management functions are the planning, coordination, and alignment of the project scope which must be balanced against the organization capacity and capability.

In *Portfolio Fin1* and *Portfolio Fin2*, business analysts are assigned to all projects to interface with the customers. Business analysts monitor sources of changes and ensure that they are identified and captured in due time. Portfolios at *Company Fin* also introduced a new role, called integration business analyst, responsible to oversee the requirements at the portfolio level to minimize duplications and conflicts between projects. This is deemed necessary because of the large number of projects and their dependencies. Integration business analysts have a complete view of the content of the project portfolio. They ensure that project scope is properly addressed by projects: avoiding requirements being forgotten and ensuring that requirements are not duplicated across projects.

For the product development organization at *Company Soft*, product managers represent the customers. They play a very active role at specifying the project content within the constraints of the portfolio budgets. However, they are not considered part of the project but remain outside the project somewhat like an *orderer*. In comparison, the business analysts

at *Company Fin* play a similar role in interfacing with the internal customers to specify the requirements but are active members of the project.

8.2.3 Multi-Project Plans and Roadmaps

In all four portfolios, multi-project plans and portfolio roadmaps are used to represent project portfolios at a high level. Roadmaps are used to depict the planned key deliverables over time and especially deliveries to customers. Multi-project plans are more detailed. In such plans, each project is represented on a single line with significant milestones. Additional information is included about the projects such as the budget, the amount of money spent, the level of risk, the customer.

It was observed multi-project plans are never baselined. These plans contain both ongoing approved projects and future projects, which are only tentatively planned. The latter plans must be confirmed through some form of gating approval once the planning is more precise. The latest versions of the multi-project plans are used as references and are continuously being updated with additions, modifications to projects, granting of tollgates, newly planned targets dates, etc. This is a living document analogous to the rolling-wave planning discussed in section 1.5.6.

8.2.4 Managing Dependencies Between Projects

Because the level of dependencies between projects is extremely high, the evaluation of the impacts of project deviations on other projects becomes more problematic. *Portfolio Fin1* formalizes and documents dependencies between the different projects. Each project must identify the impacts of their projects on other projects in a dependency matrix. This tool is used to manage the impacts of variations in one project to other projects. The dependency matrix is introduced in *Portfolio Fin1* because of the size and complexity of the portfolio and the large number of dependencies between the projects. This allows the project managers and the steering bodies to determine impacts of any change or deviation in one project on other projects.

There is always a high level of dependency between projects but these dependencies take different forms. In the case of *Portfolio Fin1*, many projects contribute to a common deliverable. Different components of a single tool are delivered through separate projects. The dependencies are so high that the demarcation between the concept of program and portfolio is unclear in this case.

In *Portfolio Fin2* and *Portfolio Soft2*, such dependency matrices are not considered necessary because the portfolios are small. Dependencies can be managed informally by the project managers because they know the interconnections between projects. Although the portfolio size and the number of dependencies are high, *Portfolio Soft1* did not implement any specific tools or techniques to manage dependencies, apart from the resource planning tools to manage resource dependencies.

8.2.5 Monitoring Portfolio Performance

The two firms have implemented some form of metrics to assess the performance of the projects (for example, cost precision and time planning precision) within the portfolio. For example, the portfolio manager of *Portfolio Fin1* is able to claim that project planning

precision is 97 percent in a given year. Apart from these project metrics, there are very few indicators to measure portfolio performance.

Considering that project management is about doing the projects right and portfolio management is about doing the right project, it is not clear that measuring an average of the project performance translates directly into portfolio performance. A more appropriate indicator of project portfolio performance would measure how well the portfolio contributes to a given enterprise's strategy.

Both firms are still seeking good measurements of the project portfolio. For example, *Portfolio Soft2* tries to assess the performance of their portfolio by asking the customers for feedback about their perception related to the project roadmap planning precision:

> *This is what we call roadmap accuracy. Secure user satisfaction into the accuracy of the product roadmap and product decision plans aligned with the PDU capability. There are now many projects that are depending on this roadmap and customers hate when we cannot fulfill this or when we have a new roadmap every month and it differs. They hate that and that causes a lot of problems. So stability of the roadmap is essential. (*Product Manager - *Portfolio Soft2)*

Some form of standard is also implemented for project reporting to the steering bodies and central PMOs. This ensures a comparison between projects and a presentation of the performance of all projects in the portfolio. The portfolio budget is also followed using standard accounting tools implemented at corporate level.

8.2.6 Shorter Projects and Iterations

There is pressure in all four portfolios to decompose the portfolio into projects under a given size. At *Company Fin*, a directive specifies that projects must be less than one million dollars. Similarly, the objective is to keep projects shorter than one year in *Company Soft*.

Company Soft breaks down its internal deliveries into a number of iterations. This facilitates the planning and the control of the intermediate deliverables (in comparison to the waterfall approach, which is based on a single deliverable at the end of the project). Because *Company Soft* has learned that it is pointless to try to plan projects in detail over a long period due to the expected number of change requests, the projects are no longer planned as waterfalls. The recent trend has been to evolve towards development processes analogous to *Agile* with short projects and short iterations. Although the project delivery sequence is determined in advanced, like train schedules, the exact content of the different deliveries remains tentative and is planned progressively.

Small projects are less complex and thus easier to manage but they require more project management overhead. In counterpart, bigger projects require less project management overhead but are generally more complex and harder to manage. The four portfolios attempt to find the project size, which will balance overhead cost and project complexity according to the maturity of their respective organization.

Both firms see a correlation between the project size and the ability to deliver. The shorter and smaller the projects, the more confidence they have in achieving good planning

precision. Having projects under the portfolio umbrella allows them to specify such guidelines. If projects exceed these targets, they can then split them into smaller components.

8.2.7 Strict Portfolio Yearly Budgets

A very common theme in the project management literature is the ability to negotiate between three core aspects of the projects: cost, time, and scope (and/or quality). Project managers attempt to meet all three requirements but could be given some latitude to modify or exceed one of the variables to comply with the other two. In the case of portfolio management, it appears that one of the variables, the yearly project portfolio budget, is always a strict constraint, which cannot be negotiated. Portfolio budgets are approved at a very high level in the organization. After long analysis and negotiations, the money is allocated to portfolios or product areas. Portfolio budgets are normally allocated on a yearly basis. This follows the financial cycles of the organization, which are not modified to cater for the longer-term needs of project portfolios.

This means that when budgets for individual projects within the portfolio are exceeded compared with the plan, some rebalancing has to be done to remain within the portfolio budget. This takes one of the following two forms:

- reassignment of money from one project to the other while staying within the overall portfolio budget; or
- delay of some projects (or some parts of projects) to the following year.

The project budgets and the roll-up of all project budgets at the portfolio level become particularly important at the end of the year. If the money is not spent in a given year, it does not mean that it will be carried over to the following year for a given project even if it is required to complete the project. Project managers are thus pressured to spend the money in the year they have planned to spend it. There are a number of ways that budget overruns are handled at the portfolio level such as reducing content of some projects, reducing number of people involved in activities (e.g., review meetings with stakeholders), and resubmitting for approval of content in subsequent years.

Exceptionally the *Portfolio Fin1* budget was approved for a four-year period. This approach provided more flexibility, allowed better planning of the project over a longer time, and increased the number of *reconfiguring* options. Although, the portfolio manager is not constrained to plan only one year in advance, she still has to submit proposals and get approvals for the yearly budget for the portfolio. This yearly budget has to fit within the four-year plan envelope but also has to be in line with other portfolio budgets approved for each year. Once the yearly budget is approved, there is little flexibility to transfer money between years. However, in practice some form of flexibility exists. If a project spans over two budget years, it has to be included in the portfolio budget of year 1 and in the portfolio budget of year 2. If a project gets delayed and cannot spend its planned money during the planned year, money must be transferred to other projects within the portfolio and additional money sought for that delayed project in subsequent years. In practice, ongoing projects are planned first when establishing a project portfolio for a given year.

8.2.8 Using Reserves to Cater for Uncertainty

Surprisingly, in all four portfolios, project managers claim that they are not allowed to include buffers to cater for uncertainty. They are expected to plan their projects as precisely as possible and have to issue change requests (or additional funding requests) whenever they consider their project cost to be exceeded.

Consequently, the project managers must balance their efforts between two practices. They must first try to plan as accurately as possible before getting their budget approval to avoid subsequent re-approvals. However, if the planning is not accurate, they are forced to report and request additional funding which must be taken from other projects (by delaying them for example) or by using the money in the management reserve. This observation is further discussed and compared to the literature in section 9.2.3 of the discussion chapter.

8.3 Differences in *Organizing Mechanisms* in Highly Turbulent Environments

The previous section describes the mechanisms, which have been observed across all four portfolios. Although the number of cases observed is small, the commonalities between the cases are indicative of potential mechanisms that are likely to be observed more generally in other project portfolios.

In the description of the *organizing mechanisms* in Chapter 6, it is apparent that *Company Soft*, and more specifically *Portfolio Soft1* is facing a much more turbulent environment than the three other portfolios. The *organizing mechanisms* are more numerous, the effort put in managing uncertainty is much more omnipresent and systematic.

As shown in Table 8-4, in addition to the more turbulent environment, the key characteristics of *Company Soft* that could explain the specific mechanisms observed are these:

- the project portfolios are put in place to develop new products; use of internal resources only in a matrix organization;
- most people are totally dedicated to project work; and
- management of project portfolio which develops new products which are part of their core business.

This section discusses some of the mechanisms, which stand out as distinctive for portfolios facing such highly turbulent environments. This includes:

- the amount of *transforming* activities;
- key differences in *second-order* mechanisms;
- the number and type of *sensing* mechanisms;
- the implementation of sophisticated resource planning tools and processes; and
- constant reorganizations.

8.3.1 Amount of Transforming Activities

There is a high degree of *reconfiguring* in all four portfolios investigated. However, there is a noticeable difference in the *second-order mechanisms* between the two firms studied. Employees at *Company Soft* continuously challenge existing structures and processes and

Table 8-4. Differences in *Organizing Mechanisms*

	Characteristics	Company Soft		Company Fin	
		Portfolio Soft 1	Portfolio Soft 2	Portfolio Fin 1	Portfolio Fin 2
Organizational Context	Industry	Software development		Software development	
	Main portfolio output	Complete systems including documentation and support	Software platforms	Processes and tools	
	Level of uncertainty for portfolio management	Extremely high level of uncertainty	High level of uncertainty	High level of uncertainty	High level of uncertainty
	Resources	Internal (matrix)		Mix of internal and external	
	Size of project portfolio (number of concurrent projects)	Approximately 50 projects	Approximately 25 projects	Approximately 50 projects	Approximately 25 projects
	Customer	External customer	Internal organization	Internal organization	
Organizational Mechanisms	Transforming	Separate second-order sensing and seizing mechanisms		No separate second-order sensing and seizing mechanisms	
	Second-order sensing and seizing mechanisms	Separate second-order sensing and seizing mechanisms		No separate second-order sensing and seizing mechanisms	
	Sensing mechanisms	Largest number and most active of sensing mechanisms	Limited number of sensing mechanisms	Limited number of sensing mechanisms	
	Balancing	Monthly resource balancing using sophisticated tool capability planning		Resource planning not a main preoccupation at portfolio level	
	Re-organizing	Frequent re-organizations justified by the product life-cycles		Frequent re-organizations despite project portfolios	

are encouraged to suggest improvements in the ways of working. This corresponds to *transforming* mechanisms, that is, second-order capabilities to improve or to build new first-order competences.

Company Soft not only has continuous resource reallocation within the project portfolios but also has a large amount of ongoing transformations. Continuous changes in the ways of working, the structure, and the tools are part of the corporate culture. For example, there is tremendous effort put into the improvement of the software development process used by the developers. Process improvement teams are in place to constantly challenge the ways of working. Employees are asked, on the one hand, to follow the process to keep the efficiency high but on the other hand are also encouraged to challenge the processes and suggest improvements.

The approach taken by *Company Soft* is to use the ongoing projects as vehicles to deploy new processes and tools. This includes improvement activities such as: new accounting systems, new requirement tracking tools, new resource planning tools, new project management processes, and new software release management strategies.

In comparison to *Company Soft*, the number of transformations put in place by *Company Fin* is much smaller. The project managers and the developers tend to follow the processes developed and deployed at corporate level. They do not see making changes to these processes as their role and even fear to be blamed if they do not adhere to the established ways of working.

Figure 8-1 summarizes the level of *reconfiguring* and *transforming* observed in the four portfolios. In Quadrant 3 and 4, project portfolio management involves a high degree of *reconfiguring* to adapt to changing requirements. However, in portfolios with more

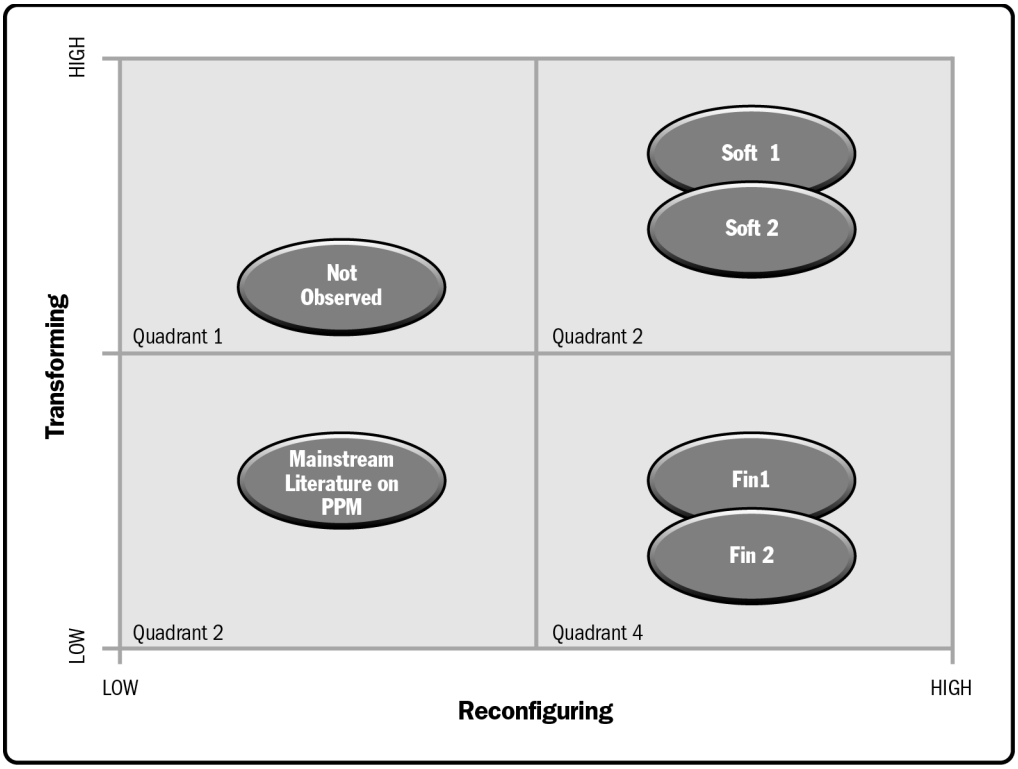

Figure 8-1. Intensity of *Reconfiguring* and *Transforming* in Cases Studied

turbulent environments such as *Portfolio Soft1* and *Portfolio Soft2*, a much higher degree of *transforming* mechanisms is also observed (see Quadrant 3).

Company Soft, a firm facing more turbulent environments, not only reconfigures more often but also implements more *transforming* mechanisms. This translates into organizations where nothing can be taken for granted: not the functional organizational, not the process used for development, and not even the resources assigned to work on the projects. This creates a restless organization where everything can be challenged and improved in order to adapt the organization to changing environments.

Although constant *reconfiguring* of the project portfolio is a common theme in this report, processes to address reconfiguration are rarely mentioned in the project portfolio literature, and standards, represented by Quadrant 2 where both *reconfiguring* and *transforming* are low.

Quadrant 2 displays environments where both *transforming* and the *reconfiguring* activities are low. This is representative of the mainstream literature on PPM, which rarely mentions such mechanisms. Portfolios with the characteristics of Quadrant 1 have not been observed and are never mentioned in the literature. A hypothesis might be that these portfolios would be observed when the projects are stable but the organization decides to change the routines in search of improved performance or to increase their legitimacy through isomorphism (DiMaggio & Powell, 1983; Meyer & Rowan, 1977).

8.3.2 Second-Order Sensing and Seizing Mechanisms

The dynamic capability model used to analyze the data was split into two levels to distinguish the mechanisms leading to *reconfiguring* from the mechanism leading to *transforming*. This is particularly relevant to *Company Soft* that implemented specific and clearly identifiable *second-order sensing* and *seizing* mechanisms. As mentioned in the previous section, *Company Soft* constantly introduces new processes, new ways of working, and continuously manages process improvements.

Second-order seizing is done by process improvement steering bodies, which evaluate the performance of the different processes according to a number of specified targets. Improvements are also proposed and implemented using a network of process improvement teams at different levels of the organization. For key areas, discipline owners are assigned to lead the process improvement teams. The senior management of the DU and PDU always includes a role called *operation development* that has the responsibility to assess the performance of the organization and to launch and monitor improvement projects at DU or PDU levels.

In comparison, *Company Fin* does not have any specific *second-order sensing* or *second-order seizing* procedures or mechanism to identify and decide the changes to put in place. All *transforming* activities are decided directly by the project portfolio management team who has the authority to introduce and implement the necessary changes in the ways of working as they see fit.

A key difference between the two organizations is that *Company Soft* considers the performance of their project portfolio as a component of their core business. They therefore have very strong incentives to deliver products that are the best in their field in a very competitive environment. In counterpart, the portfolios studied in *Company Fin* are considered support functions to ongoing operational activities. They are put in place to develop new tools and processes to comply with international norms. The projects are managed over and above ongoing operational activities.

8.3.3 Higher Level of Uncertainty: More Sensing Mechanisms

As expected, the higher level of uncertainty observed at *Company Soft* justifies the establishment of a larger number of *sensing* mechanisms than in *Company Fin*. Multiple *sensing* mechanisms are put in place at *Company Soft* to interpret the sources of uncertainty related to new customers, new technologies, new products, and new applications. This includes a mixture of structures, processes, and roles such as a dedicated role identifying requirements, a system management group to monitor the evolution of technology, early demonstrations to customers, special process for customer trials, and innovations through employee contributions.

The portfolio scope is constantly being modified and updated and, as such offers a very different picture from the PPM described in the portfolio literature where the content of individual projects is well known and the goal of portfolio management is to select among projects. On the contrary, special mechanisms are put in place for managing project scope at portfolio level. In *Portfolio Soft1*, they even introduced a special body, the requirement request board, to control the flow of feature requests. This RRB can rapidly assess the

amount of work and determine the best project to develop each feature based on the status of the ongoing projects in the portfolio.

Projects are also *scoped-in* rather than *scoped-out* to reduce the amount of rework or rejected requirements once the projects have started. All these mechanisms are put in place to make sure that opportunities are captured as the environment evolves.

8.3.4 Balancing Using Sophisticated Resource Planning

Resource balancing is crucial at *Company Soft*. For many interviewees, portfolio management and resource balancing are more or less synonymous. Managers refer to *capability management* and *pipeline management*, i.e., the ability to allocate and reallocate people to resources to project but more importantly the capability of the organization to develop the competences to undertake additional projects. *Company Soft* has put in place a monthly resource planning process using sophisticated tools to plan and monitor the allocation of the resources to the projects. They have also developed an internal web-based tool to support this process. This means that data is continuously being kept up-to-date by project managers and line managers. This allows all the governing functions to base their decisions on more reliable resource data while continuing to provide the necessary data for the quarterly financial forecast. Another benefit is the ability to openly share the data about the resource demand and supply across the organization.

The focus on resource planning might be because they are structured as a matrix organization. In comparison, at *Company Fin* resource planning tools are only used in the IS/IT department because this is one of their rare departments where resources are allocated to numerous projects as a matrix-like organization.

8.3.5 Re-Organizing to Support Portfolios or Despite Portfolios

Reorganizations, transfers to different design centers, closing down units to create new ones, and merging departments are part of the corporate culture at *Company Soft*. *Company Soft* has a history of re-organizing their line organization every 12 to 18 months. Frequent reorganizations are observed in both *Portfolio Soft1* and *Portfolio Soft2*. Although the impacts of these reorganizations have not been analyzed in detail, interviewees had a tendency to accept this type of change as normal and to downplay their impacts. None of the interviewees mentioned that re-organizations had significant negative impacts on the projects. Even in the cases of the transfer of design responsibilities to another design center (which is considered the most disruptive type of reorganization), project schedules and project budgets are expected to be maintained.

Re-organizations are included as a type of change in Figure 5-1, because they are considered a source of change for the project managers. However, they are really under the control of the organization itself and are not really due to uncertainty in the environment. Rather than being considered a source of uncertainty, they should rather be classified because of the *organizing mechanisms*.

Company Soft strives to have the organization structured and balanced according to product portfolio. Changes of the organizational structure are therefore considered a way for

the line organization to better support the project portfolios, for example by grouping all the resources working on a given product in the same department or in the same design center.

Structural re-organizations at *Company Fin* are almost as frequent as in *Company Soft*. However, there are a number of key differences observed between the two firms. Because, in *Company Fin*, most resources are not dedicated full time to projects, new structures affect both the projects and the operational activities of the resources. Slowdowns in projects are observed during the reorganization periods because

- people wonder where they will be reallocated in the organization;
- changes in management might impact resource assignments to projects; and
- previous decisions might be challenged due to changes in management structure.

One of the key differences between the two firms is that re-organizations in *Company Soft* are justified by the product life cycles. When the development of new products is initiated, a new structure is put in place and is expected to grow. When the product reaches maturity, the organization is expected to decrease in size and resources are expected to be reallocated to other development activities. This includes the transfer of some activities to low-cost countries, centralization/decentralization of some activities, and reduction of R&D activities. In the case of *Company Fin*, the focus is planning resources to support operations. Additional resources required to support the needs of the projects are most often covered by hiring external consultants.

Chapter 9

Discussion

This chapter discusses the implications for theory and practice of the results presented in the previous chapters. It first provides a discussion of findings related to the use of dynamic capabilities as a conceptual framework. This is followed by some reflections on how project portfolios are managed in dynamic environments in comparison to the literature. Some of these reflections are translated into propositions that could be investigated in future research.

9.1 Dynamic Capabilities

The experience gained using dynamic capabilities as a conceptual framework, provides some suggestions for a better understanding of dynamic capabilities for researchers and practitioners. As discussed in Chapter 2, the initial sequence *sensing-seizing-transforming/reconfiguring*, which is the basic model of dynamic capabilities, was used to collect data and to structure the interviews. During data analysis, it had to be enhanced in order to capture the reality that was being observed. The conceptual framework drawn from the literature was modified by these:

- making a distinction between the terms *reconfiguring* and *transforming* (see discussion in section 9.1.1);
- introducing the idea of second-order mechanisms operating at different levels of the organization and in different timeframes (see section 9.1.2); and
- refining the definitions of *sensing* and *seizing* in the context of PPM.

9.1.1 Reconfiguring versus Transforming

The conceptual framework for this research was initially composed of three main concepts: *sensing*, *seizing*, and *reconfiguring/transforming* (as presented in Figure 2-1) according to Teece et al.'s framework (2007, 2009). During the classification of the different mechanisms observed in the four portfolios, it became clear that there were at least two orders of changes occurring in the organizations and that it would be useful to distinguish and treat these two concepts separately despite that Teece et al. used the terms *reconfiguring* and *transforming* interchangeably.

Based on these observations, the following proposition is suggested:

Proposition 1: The terms *reconfiguring* and *transforming* refer to two different concepts which should be clearly defined as part of the dynamic capability framework.

In the context of PPM, the term *reconfiguring* is defined as the *organizing mechanisms* to modify the project portfolio and to allocate human and financial resources within the portfolio. This includes *organizing mechanisms*:

- to change the project portfolio structure, including any changes in the project configuration (new projects, new subportfolios, termination of projects) and project scope prioritization;
- to modify the project scope and project interdependencies; and
- to change the allocation of financial and human resources to the projects in the portfolio.

This is useful to represent the continuous process of organizing in the face of constantly moving environments. One of the main challenges is to translate uncertain product requirements into project scopes that could be launched, planned, and monitored. Knowing that the requirements are uncertain and bound to change, firms put in place mechanisms to redefine scope and reallocate resources quickly and efficiently when opportunities or challenges occur.

Transforming is defined as the *organizing mechanisms* to modify the first-order mechanisms or to modify other organizational aspects affecting PPM. This includes:

- modifying the first-order *sensing-seizing-reconfiguring* mechanisms used in PPM; and
- introducing new structures, processes, or tools to support the PPM activities.

9.1.2 Second-Order Sensing and Second-Order Seizing

Collis (1994) and Winter (2003) define second-order capabilities as the competence to build new first-order competences or to improve the activities of the firm. Collis's higher-order capabilities can be considered dynamic capabilities. They relate to the modification and the creation and extension of the resource base. The second-order of dynamic capabilities involves three groups of processes defined as *second-order sensing, second-order seizing,* and *transforming:*

- *Second-order sensing* includes the processes to assess PPM performance. This requires the *sensing* of the performance of the first-order dynamic capability (in this case the project portfolio management,) as well as the identification of new practices, which might be identified outside of the organization (see Figure 2-3).
- *Second-order seizing:* Once changes are identified as necessary by the *sensing* processes, the organization decide the changes that must be put in place in addition to how and when they should be deployed. This includes corrective actions, new routines, structures, or tools to improve the performance of PPM and be better aligned with the changing external conditions.
- *Transforming*: improving the *sensing-seizing-reconfiguring* mechanisms used in the first-order dynamic capability or the modification of the supporting environment.

In the case of *Company Soft*, higher degree of transformations resulted in specific *second-order sensing* and *second-order seizing* mechanisms described in sections 6.6 and 6.7. This is translated into specific roles for monitoring the performance of the PPM activities and

trends in the environment, and specific steering boards to decide on improvement projects. In the case of *Company Fin*, the second-order level activities were carried out but by the same people carrying out the first-order activities. In other words, the second-order dynamic activities are performed by the same people as the first-order mechanisms.

There exists also a third order of dynamic capability related to the portfolio selection itself. Budgets and human resources are allocated to project portfolios at the highest levels in organizations based on vision, mission, and strategies. Changes in external environments have direct consequences on these decisions. This strategic level of dynamic capability corresponds to the level, which is most often discussed and depicted in the literature on dynamic capabilities, but was not investigated in this research.

9.1.3 Lessons on Using the Dynamic Capabilities Model to Study PPM

The experience gained in this research showed that the dynamic capabilities framework is well suited to study PPM processes in uncertain environments. It allows the observation of the processes according to a different lens than the usual project management processes. A number of difficulties, which were encountered during data collection and analysis, are discussed in this section.

Organizing mechanisms might overlap between *sensing* and *seizing*. For example, the product management role to identify and prioritize requirements appears in both areas as per the following definitions:

- *Sensing* refers to *organizing mechanisms* to identify, filter, and interpret changes and uncertainty which might affect the project portfolio; and
- *Seizing* is defined as *organizing mechanisms* for deciding changes to the project portfolio once a potential need for change has been sensed.

When the categorization of the *organizing mechanisms* was ambiguous, the mechanism was included in both categories with a short description in the *sensing* mechanisms to describe the links to the *seizing* mechanisms. However, there are a sufficient number of mechanisms that could be assigned easily to a specific category: either *sensing* or *seizing*. This justified keeping both groups separate. The classification of the *reconfiguring* and *transforming* mechanisms such as the resource planning or capability planning was rarely problematic.

The original intention was to try to map relationships from the sources of uncertainty through the *sensing*, *seizing,* and *reconfiguring*. It was found that while the connection between *sensing* and the source of uncertainty can be established, most often the *seizing* and *reconfiguring* are broader and rely upon multiple *sensing* mechanisms.

Finally, interviewees could easily relate to the concepts of dynamic environments or of project portfolio management. However, the terms *sensing* and *seizing* used in the dynamic capabilities framework were not familiar to them. The translation of their familiar activities into the categories of *sensing, seizing,* and *reconfiguring* are not always straightforward although they were very useful to analyze PPM processes in dynamic environments. Among other things, they allowed the identification of a number of processes, roles, and structures directly related to PPM.

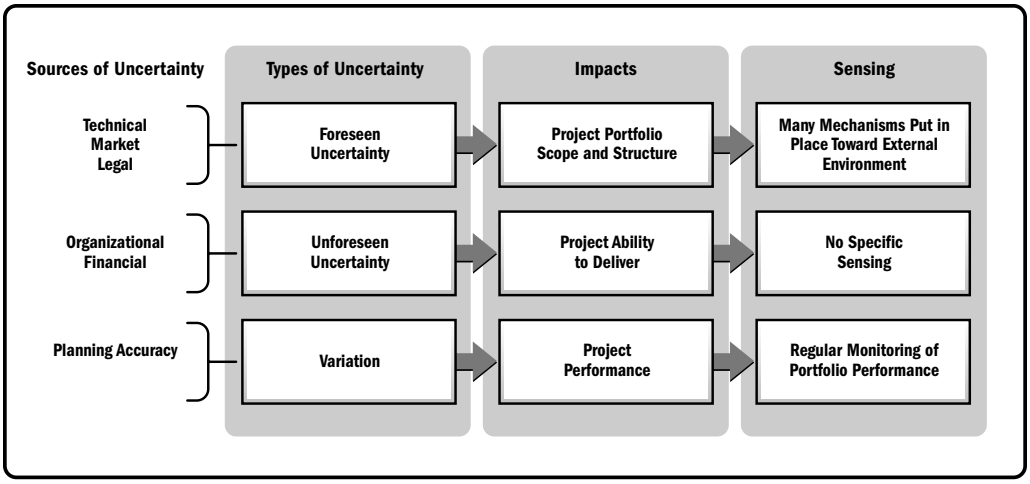

Figure 9-1. Mapping Sources of Uncertainties to *Sensing*

9.2 Project Portfolio Management in Dynamic Environments

This section summarizes some of the implications of the findings of this research on PPM practices. Some attention is given to potential contributions in comparison to existing portfolio management literature. The section is structured into three subsections discussing: uncertainty management, project portfolio, and project portfolio management.

9.2.1 Uncertainty Management

Sensing Sources of Uncertainty in PPM

Figure 9-1 classifies the sources of uncertainty observed in this research according to the typology of De Meyer[1] et al. (2002). The connection between the sources of uncertainties, their potential impacts on the portfolios and the need for *sensing* mechanism is also shown.

Most mechanisms described in this research address *foreseen uncertainty,* that is, when the uncertainty is identifiable and the projects have stable goals. Technical uncertainties and market uncertainties bring uncertainty regarding project portfolio scope for which many *sensing* mechanisms are put in place. This type of uncertainty can lead to contingent actions, which in the cases observed resulted in processes and structures to mitigate the impacts of the uncertainties on the performance of the organization.

Although organizational uncertainties and financial uncertainties can lead to frequent changes in the project portfolios, they are actually *unforeseen uncertainty* analogous to the unknown-unknowns. *Sensing* mechanisms appear to be less necessary in this case.

Finally, uncertain performance due to the inability to accurately plan projects is classified under *variations.* This comes from many small influences and yields a range of values on a particular activity. Although project portfolio performance is under the control of the

[1]See a description of De Meyer et al.'s classification in section and in Appendix B.

organizations, it still carries a significant amount of inherent variation, which has to be monitored and managed on a continuous basis.

In summary, *sensing mechanisms* are primarily put in place to sense the foreseen technical, market, and legal uncertainties while monitoring and control mechanisms are put in place to control the variations due to inaccuracy in planning.

Uncertainty Management versus Risk Management

In this research, an *uncertainty management* perspective is adopted instead of *risk management*, a more established practice in the project management community. Although project managers and portfolio managers interviewed claim that they face risks and use the traditional risk management tools and techniques, they are also exposed to an environment which is constantly changing.

Risk management was added to the second revision of *The Standard for Portfolio Management* (Project Management Institute, 2008b) and includes four processes:

- identify portfolio risks (process 5.1);
- analyze portfolio risks (process 5.2);
- develop portfolio risk responses (process 5.3); and
- monitor and control portfolio risks (process 5.4).

As discussed in section 1.2.4, *risks* are associated with events, which might or might not happen. Risk management is the proactive activity to either prevent or mitigate the negative impact of such events. In dynamic environments, the concept of risk does not seem to be adequate. For example, in the project portfolios studied, the uncertainty related to scope was mentioned regularly as the main challenge. This cannot really be considered a risk. It is much closer to what Duncan (1972) defines as uncertainty, that is, "the inability to predict accurately what the outcomes of a decision might be" (p. 317). Using uncertainty management instead of risk management draws attention to the need to understand and manage variability in the inputs to the project portfolio activities as opposed to the concept of events that might or might not happen.

Although risk management is appropriate in many portfolios, the concept of uncertainty and uncertainty management was considered more appropriate in the four portfolios studied. Arguably, they were particular cases having to deal with a high degree of uncertainty and complexity that leads to the following proposition:

Proposition 2: Uncertainty management is more appropriate than risk management when project portfolios must be managed in constantly changing environments.

Portfolio Scope Specification

It was observed that the project content specification is the responsibility of an individual other than the sponsor, the portfolio manager, the project manager, or the functional line manager. This is a role which is considered very important by all interviewees but which is rarely mentioned in the project management literature maybe because it is implicitly assumed that the scope of individual projects is not an important source of uncertainty. It was

also observed that, in dynamic environments, PPM is not limited to the project selection and prioritization but includes the mechanisms to allocate content to projects (i.e., project scope management mechanisms are implemented at portfolio level).

Scope specification is not only performed by clearly defined roles but also by bodies specifically created for this purpose. In the portfolios observed, the level of uncertainty is considered sufficiently high to justify the implementation of specific roles, organizational structures, and processes to address scope specification (as discussed in sections 8.2.1 and 8.2.2). Based solely on the results of this research, it is not clear if separate roles for scope management are due to the high level of uncertainties related to project scope or whether these roles would also be found in other contexts.

9.2.2 Project Portfolios

This research brought additional understanding of images that are used to describe project portfolios. This section compares some of the images commonly used in the literature to the images used by interviewees. While the notion of a project as temporary endeavor (and/or organization) is intrinsic in the definition, it was also observed that project portfolio, in dynamic organizations, tend to be established for longer periods than the line organizations that created them in the first place.

Images of Project Portfolios

Images and metaphors are very useful techniques to describe reality. This was used successfully to describe complex phenomenon in organizations (Morgan, 1986) and individual projects (Winter & Szczepanek, 2009). To describe multi-project environments, Eskerod (1996) proposes two metaphors:

- The Great Wall of China, which represents stable multi-project environments, where every brick is known to contribute to an overall goal.
- The dragon, which represents more dynamic multi-project environments, is fighting for survival, constantly moving, and hard to control.

A more common image for project portfolios is its representation as funnels to illustrate the project selection process as shown in Figure 9-2. The metaphor of the funnel is very strong and is widely used in the project portfolio management community. It assumes that a large number of ideas are generated. A number of screening processes are put in place to judge the validity and potential of the ideas for projects. The principle of the funnel is to reject ideas with a poor potential as early as possible in the process. Occasionally, this might mean putting some ideas or some projects on hold temporarily, until some conditions are changed.

In the portfolios studied, and especially in *Portfolio Soft1*, the processes of project selection and termination are almost inexistent. The question is not so much which project to select but which functionality to develop in each project. A project road map is produced upfront with some vague idea of the project content. This is like publishing a train schedule (as shown in Figure 9-3). The size of the trains, the departure time, the arrival time are published. At the time of departure, the exact content of the wagons is not entirely specified and opportunities are left opened to add content on the train almost until reaching destination.

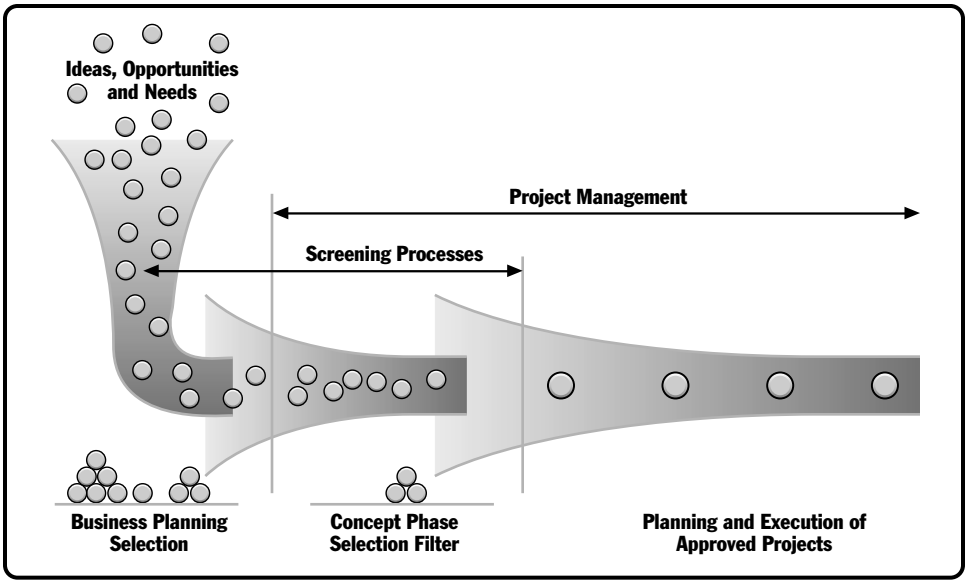

Figure 9-2. Examples of Project Portfolios as Funnels

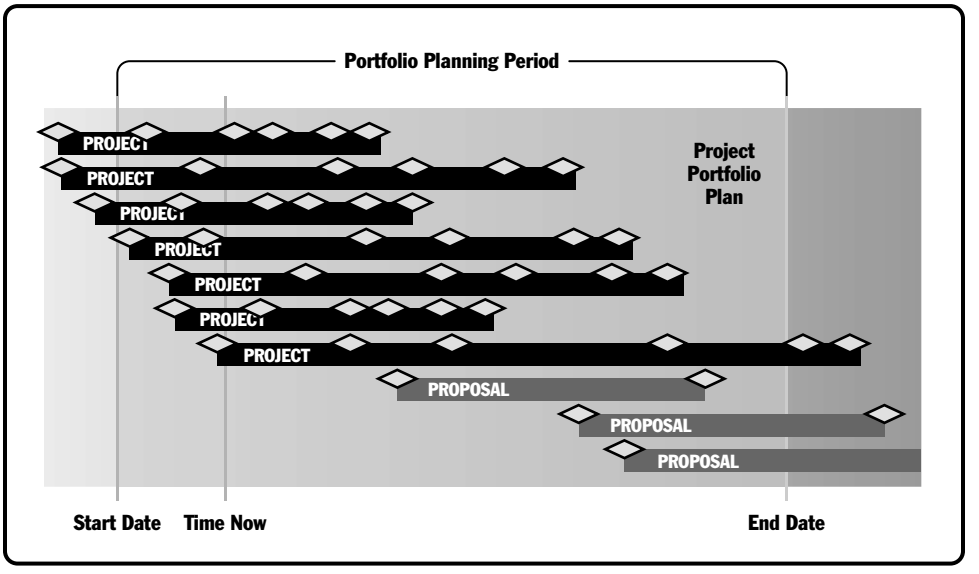

Figure 9-3. Representing Project Portfolios as a Train Schedule

(Source: Internal document at *Company Soft*)

The image of a train schedule seems to be used in project-based organizations when the resource supply available to work on projects is known upfront and defines the project capacity over a given period. Defining the sequence of projects upfront, regardless of its content, makes it easier to plan and allocate resources to projects. It also facilitates the communication with customers. Product managers develop a product plan showing the main product releases at a high level. The project organization matches the product plan with a multi-project plans that include key target dates and project size. The schedule of each individual train (i.e., project) is published once the level of confidence has reached the appropriate level while the multi-project schedule always includes some projects for which dates will be planned and confirmed later.

Both images, the funnel and the train schedule, are not mutually exclusive. Even in organizations using the image of a train schedule, some of content selection and prioritization also exists upstream in the process flow (as shown in the proposed image in Figure 9-4). For example, in *Company Soft*, ideas get evaluated and translated into requirements (with business cases) in the product management processes preceding the project portfolio management processes. This means that filtering, in a funnel-like process does exist in this environment as well. However, compared to the generally accepted image, it is not the

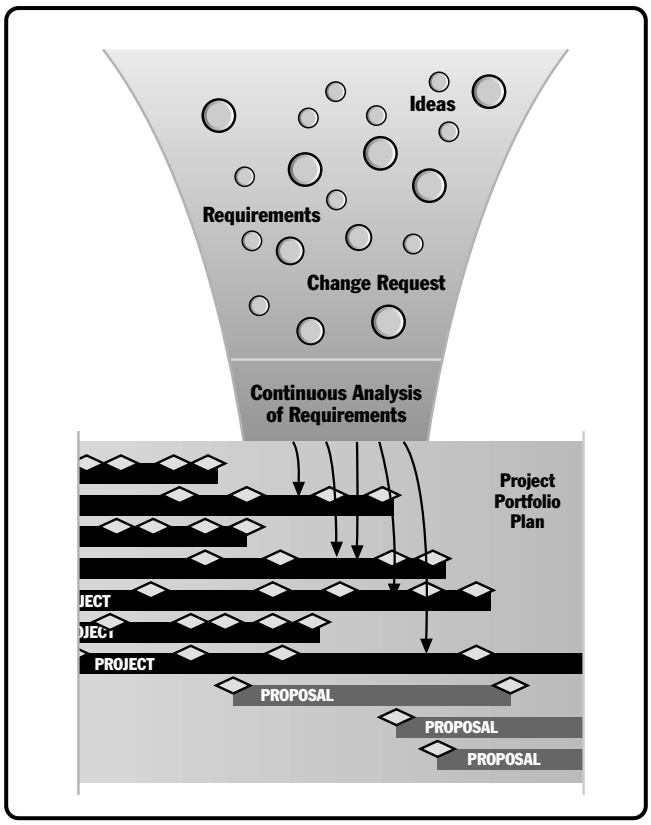

Figure 9-4. Combining the Funnel and Train Schedule Images

project that gets selected or rejected but specific functions and/or requirements. The right project where to include the requirements also need to be decided.

Project Portfolios as Permanent Organizations

Projects and programs have been described as temporary organizations set-up by a permanent organization (Andersen, 2006; Lundin & Söderholm, 1995; Lundin & Steinthorsson, 2003; Packendorff, 1995). In project-based organizations, temporary organizations structured around a project manager and a project team are indeed created. They are supported with processes, tools, and resources supplied by the permanent organization. The concept of a project as a temporary organization has brought interesting insights in many contexts and Turner and Müller (2003) have also tried to extend this concept to project portfolios. One premise of this school of thought is that a permanent organization does exist. However, Jelinek and Schoonhoven (1993) observed that in high-tech firms, such as Hewlett-Packard, Motorola, and Texas Instrument, which are challenged with renewal of their products through constant innovation, changes in formal organizations occur every six to twelve months to adapt to changing environments. These changes are deliberate and are part of a strategy to formally reorganize frequently.

Consequently, project portfolio management has to cater to the effects of organizational changes on their portfolio. In the firms observed, the portfolio management structure remained intact after these re-organizations but the governance structures had to change. It is not surprising that organizations facing turbulent environments would tend to re-structure their organization to adapt to changes. The surprising fact is that the project portfolio would have to consider the changes in the structural organization as an additional source of uncertainty not as a source of stability. These observations also challenge our conception of what should be considered permanent in the contexts of project-based organizations.

9.2.3 Project Portfolio Management

Complex Governance

The governance structure put in place at *Company Soft* is extremely complex and the portfolio governance responsibility is spread among a multitude of intertwined bodies and groups each responsible for a subset of the governance process. More specifically, in *Portfolio Soft1,* there are numerous boards each having a specific role with respect to PPM. Decisions are not concentrated in a single steering committee but are spread across a network of committees.

To make steering decisions, a number of aspects must be taken into consideration such as resource availability, impact on projects, systems integrity implications, strategic alignment of decisions and priorities against other alternatives. The large number of steering and management groups might only be indicative of the size and complexity of the *Portfolio Soft1*. This proliferation of steering groups might also be caused by the involvement of a large number of departments located in multiple sites.

In comparison, the governance structure at *Company Fin* is much closer to what is normally described in the literature. It is composed mainly of three management bodies: one representing stakeholders, one monitoring and approving budgets and one at the highest level taking the business decisions.

Project Management Tools and Techniques at the Portfolio Level

Section 1.5 presents a list of mechanisms commonly observed when projects are managed in dynamic environments:

1. Environment manipulation: Making dynamic static
2. Emergent planning approaches
3. Scope control
4. Controlled experimentation – Probing the future
5. Life cycle strategies
6. Management coordination and control
7. Soft approaches (Leadership styles, communication)
8. Planned flexibility: Flexibility in product and in process
9. Boundary-spanning activities

During the course of this study, all of these approaches (with the exception of mechanism 1 and mechanism 7) were observed at the portfolio level for all four portfolios. Examples can be found for each category in Chapters 6 and 7. The first exception *making dynamic static* was not specifically observed. Project managers and portfolio managers know that things will be changing and made little attempt to keep them static. Changes are not considered undesirable exceptions; they are expected and built into the processes and the organizational systems. It might be argued that striving for smaller projects is one such technique of making the environment static for the (short) duration of the project. However, such techniques can also be classified as *scope control*. Mechanism 7 was not specifically investigated.

In addition to the flexibility in process, *Company Soft* implements *flexibility in the product* where alternative demands can be met with the same product. A first approach to provide the required flexibility is to offer a very large number of parameters to configure the product in a multitude of ways even without knowing in advance what the customer might require. A second approach is the decomposition of the product into a number of independent nodes linked through standardized interfaces. The first approach has the drawback of increasing the product complexity while the second increases the overhead in terms of testing and integration. Building flexible products helps addressing unexpected events, once they occur. Flexibility in product also caters for uncertainty in the product specification, that is, if it is unclear if a customer wants a blue or a red widget, allowing the color to be selected at the last minute alleviates the necessity to decide upfront.

In addition to the tools and techniques of project management practices, a few tools, and techniques have also been developed specifically to support PPM. Examples where activities are brought up at the portfolio level to gain efficiency are:

- reduction of contingency at project level and use of contingency money at portfolio level;
- introduction of a common board to analyze and plan project content;
- creation of portfolio level change control board to assess impacts of demands on all projects; and
- common reporting templates and roll-up of cost tracking at portfolio level.

Contingency and Management Reserves
Two types of reserves (or buffers) are normally used when planning uncertain projects:

- "*contingency reserves* are to address the cost impacts of the risks remaining during risk response planning" (Mulcahy, 2009, p. 237); and
- "*management reserves* are any extra funds to be set aside to cover unforeseen risks or changes to the project. to an amount a contractor may include in a project" (p. 237).

A recommended good practice (Gido & Clements, 2008; Kloppenborg, 2009; Project Management Institute, 2008a) is to assign contingency reserves to cover the potential cost of *known-unknowns* while management reserves are kept to handle *unknown-unknowns*. In the case of the PPM practices observed in the four portfolios, some small amount of money is put aside as margins at the portfolio level in case some projects exceed their budget or to handle any unforeseen events but the projects are expected to plan without contingency reserve. Uncertainty in all four portfolios was absorbed primarily by delaying projects or reducing project scope. Financial reserves were managed primarily at portfolio level rather than at the project level. It would be interesting to investigate if this practice is widespread or not.

Feedback Loops and Portfolio Adjustments
There are three feedback loops in *The Standard for Portfolio Management* (Project Management Institute, 2008b), shown in Figure 1-2, one after *balance portfolio* in the *aligning* process group and two in the *monitoring and controlling* process group. Once the portfolio is authorized, the rebalancing of the portfolio can only occur based on the *review and report of portfolio performance* and when there is a significant *business strategy change*.

Significant business strategy changes are very rare and would bring the complete portfolio into question, potentially even bring it to a close. Although a large number of events and changes were analyzed in this research, such dramatic strategy changes were not.

Regular adjustments to the portfolio are performed frequently due to changes in the environment. In this case, the business strategy itself is likely to remain the same but its translation into the project portfolio would have to be modified to cater for new external conditions.

Such adjustments are mentioned in the PMI standard in a section called *communicate portfolio adjustments* but the activities involved in producing these adjustments are not defined. This could include tools and techniques such as the establishment of a portfolio level change control board and change control process. This could also involve the use of scenarios to assess impacts of changes on the ongoing portfolio. Finally, the standard for portfolio management should consider continuous assessment of changes and uncertainty as an intrinsic part of the process not as an exception. This could include some of the *sensing, seizing,* and *reconfiguring* presented in this report.

Human Resource Management
Human resource management is one of the knowledge areas of the *PMBOK® Guide* (Project Management Institute, 2008a) but it is completely absent from *The Standard for Portfolio Management* (Project Management Institute, 2008b) and is rarely mentioned in the literature on project portfolios. Based on the observations made in this research, the continuous

balancing of supply and demand of the human resources is an important process of PPM. The standard currently includes a section on balancing the portfolio but its main focus is on the selection of the best mix of projects (i.e., balancing risks, returns, complexity) to achieve strategic goals.

For PPM, human resource management goes beyond the allocation to individual projects. It might include some of these items:

- comparing the resource demands of all projects in the portfolio with the available resources;
- estimating the total cost of human resources and matching it with the portfolio budget;
- identifying if external resources are required; and
- ensuring the competence is adequate, short term and long term. On a longer term, this might include some new capability development, transfers of competencies, or shutting down of some areas.

It was observed that in dynamic environments, human resource management mechanisms were present in *sensing*, *seizing* and *reconfiguring* mechanisms. At *Company Soft*, this activity is formally executed on a monthly basis and requires an enormous amount of efforts from management.

Additions of New Components

The high-level illustration of the portfolio management processes of *The Standard for Portfolio Management* (Project Management Institute, 2008b), shown in Figure 1-2, shows a process flow that assumes that a list of a number of components (projects, programs, and other work) is available and must be prioritized, balanced, and authorized. Once this is done, the monitoring and controlling processes are activated. This is typical of most project portfolio frameworks, which do not really cater to the inclusion and assessment of new project requests once the project portfolio is authorize. The sequence *Identify-Categorize-Evaluate-Select* is not really appropriate in this case. What was observed in the four portfolios, when new project requests are submitted, is an assessment of the consequences of the addition of this new project. This takes the form of scenarios being created and analyzed for consequences on other projects, access to resources, and risks because such additions of components is constrained by the yearly budgets and the limited access to resources. The inclusion of additional components is not considered exceptional but built-in the project portfolio management process.

9.3 Concluding Remarks on Discussions

This chapter discussed some of the findings in comparison to the literature reviewed in Chapter 2. This includes some observations related to the use of dynamic capabilities as a conceptual framework and some of the practical implications when it is used to collect empirical data.

This is followed by some reflections on PPM in dynamic environments; more specifically on the management of uncertainty and the implementation of sensing mechanisms

and on the use of uncertainty management instead of risk management. Some of the observations lead to propositions, which could be, investigated in future research. A new image of the project portfolios is proposed in addition to a number of tools and techniques, which should be considered in the project portfolio standards and other frameworks describing PPM. The next chapter concludes this report with a summary of the contributions, the limitations of the research, and suggestions for future research.

Conclusion

This research investigated portfolio project management (PPM) in dynamic environments using dynamic capabilities as a framework. The objective was to attempt to answer the following research question: *How is uncertainty affecting project portfolios managed in dynamic environments?* The goal was to explore it through the qualitative study of four portfolios in two firms. It proposes some contributions to the understanding of the mechanisms put in place by organizations having to manage project portfolios while facing constantly changing environments and also suggests some improvements to the dynamic capability framework.

Contributions

This section summarizes some of the theoretical and empirical contributions made in the fields of PPM and in the dynamic capability theory. This research provided sufficient material to contribute in at least four areas:

- to develop ways to operationalize the concepts in the dynamic capabilities framework;
- to suggest improvements to the dynamic capabilities theory;
- to analyze the relationships between the sources of uncertainty in dynamic environments and the *organizing mechanisms* put in place by organizations; and
- to provide a better understanding of the management of project portfolios, more specifically of the operational activities involved once portfolios are authorized and launched.

Using Dynamic Capability at the Operational Level

The literature on dynamic capabilities addresses the firm's ability to maintain a competitive advantage and adapt to rapidly changing environments. However, as discussed in section 1.6, most publications on the topic are theoretical and try to assess what are these capabilities, how they contribute to the firm's performance, and how to put them in place. These publications target senior executives having to decide on strategic actions at a very high level of the firms, for example, acquisition of capabilities through purchases of companies, or creation of new divisions to develop new products. A contribution of this research is to demonstrate that this framework can also be used to analyzed more operational levels of the organization, in this case to study PPM.

As described in detail in the previous chapter, the four project portfolios studied in this research involve the frequent reconfiguration of resources to adapt to environmental changes while maintaining alignment with the firm's strategy. Although the definition of dynamic capabilities was intended to be used at a higher level of the organization, it can

be argued that PPM fits perfectly, the following definition proposed by Teece et al. (1997): "dynamic capabilities as the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (p. 516).

In the context of PPM, "the ability to integrate, build, and reconfigure internal and external competences" (p. 516) could refer to the strategic activity of allocating budgets to project portfolios. In addition, the dynamic capability could also include the regular allocation and reallocation of resources to project activities within the portfolio once the portfolios are decided upon. This is depicted through the numerous examples of *sensing*, *seizing*, and *reconfiguring* activities presented in Chapters 6 and 7.

The dynamic capabilities definition proposed by Eisenhardt and Martin (2000) opens the door to the inclusion of more operational routines within the concept of dynamic capabilities. In this definition, they include both the *organizational and strategic routines*:

> The firm's processes that use resources – specifically the processes to integrate, reconfigure, gain and release resources – to match or even create market change. The organizational and strategic routines by which firms achieve new resources configurations as markets emerge, collide, split, evolve, and die. (p. 1107)

In the same vein as Teece et al., Eisenhardt and Martin (2000) referred to the "new resource configurations" (p. 1106) as one of the goals of dynamic capabilities. Similarly, the main argument proposed by this report is that to implement dynamic capabilities in an organization, the reallocation of resources at a high level of the organization is not the only option. It can also mean the implementation of routines to continuously monitor and reconfigure the allocation of work to the firm's resources. The balancing and re-balancing of resources in a project portfolio, especially in a project-based organization, provides a good example of such continuous optimization. As observed in this research, organizations facing dynamic environments can then put in place *sensing* and *seizing* mechanisms, which lead to continuous reallocation of resources, using project portfolios as the vehicle.

Contributions to Dynamic Capability Theory

The experience gained using dynamic capabilities as a conceptual framework, provides some suggestions for a better understanding of dynamic capabilities for researchers and practitioners. The initial sequence *sensing-seizing-transforming/reconfiguring*, which is the basic model of dynamic capabilities, was used to collect data and to structure the interviews but was enhanced during data analysis in order to capture the reality that was being observed. In this report, a distinction is made between the terms *reconfiguring* and *transforming*. The observations gathered using the dynamic capability framework to collect data on project portfolio management indicated that many orders of capabilities existed in firms facing very turbulent environments. Not only were there frequent *reconfiguring* of resources from one project to another but there were also frequent introduction of new processes, and modification of processes indicative of *transforming* mechanisms.

A second contribution is the use of the concept of second-order mechanisms operating at different levels of the organization and in different timeframes in the context of PPM. The *sensing* and the *seizing* mechanisms leading *reconfiguring* and to *transforming* are not the same. *Second-order sensing* includes the processes to assess PPM performance as well

as the identification of new practices that might be identified outside of the organization. *Second-order seizing* include deciding on corrective actions, new routines, structures, or tools to improve the performance of PPM and be better aligned with the changing external conditions.

Analysis of the Relationships between Sources of Uncertainty and Organizing Mechanisms
This report analyzes the relationships between sources of uncertainty in dynamic environments and the mechanisms put in place by organizations to minimize their impact and to capitalize on opportunities. This empirical data is relevant to practitioners who must put in place structures, processes, and tools to support the management of project portfolios. The description of such mechanisms is a useful point of departure for use in other settings where applicable.

Better Understanding of Project Portfolio Management
In recent years, the topic of project selection seems to have dominated the literature on PPM. This includes tools and techniques to rank projects or optimize resource allocation under certain constraints. Although choosing the right projects is of the utmost importance, this research has shown that the ongoing monitoring and controlling of PPM process is also rich as an object of study. One of the objectives of this research was to provide a better understanding of the operational activities involved once portfolios are authorized and launched.

Managers involved in the daily planning and control of project portfolios spend great efforts in maintaining optimal resource allocation and at ensuring that the project efforts are not wasted due to uncertainties. In addition, planning the project scope is a continuous activity involving tremendous efforts and resources. Managing project portfolios involves creating structures, introducing new processes, introducing new business models, which goes beyond project selection. These activities are not static. The environment is often constantly changing and the projects being managed in constant flux and in need of constant oversight, support, and alignment.

Summary of Contributions
Table 9-1 summarizes the contributions made from this research. It indicates the target audience, the foundations targeted, and the conferences and publications where they are documented.

Limitations

Any research has limitations. Because of the limited time and resources allocated to a research, the topic was kept relatively focused. This infers that a number of items were left out of scope. The specific limitations of this research include:

- **The research is based on a limited number of cases:** From a sample of only four cases, it is not possible to generalize the findings to other project portfolios. In counterpart, every attempt was made to describe the cases in sufficient details to allow the readers to determine if the findings would be applicable to other cases observed in the future.

- **The research is exploratory:** The ambition of this research was to explore a field for which very few empirical studies exist. Although it contributes to a better understanding of the management under high uncertainty, there was not attempt at developing or demonstrating a new theory.
- **The research was retrospective not longitudinal:** Organizations are not static and evolve over time. This means that what was in existence one year prior or six months prior might no longer be in place at the time of the interviews. A study carried out on-site for the complete duration under study would have provided a different appreciation of the actual processes, decisions, and interactions when changes occurred. However, longitudinal studies are very costly in both time and money. A retrospective method was used as an alternative, but retrospective studies rely on recollection of events by interviews with all its limitations. Triangulation with rich historical data from the companies and across interviewees was used to increase accuracy.
- **Measurement of performance, measurement of turbulence:** The assessment of the level of dynamism facing the organizations studied felt somewhat arbitrary. This was based solely on the subjective evaluation by the interviewees. It would have been preferable to have some metrics to gauge the level of uncertainty, the level of turbulence, and the performance of the organizations.
- **Selection and prioritization:** The project selection and prioritization have been the main focus in PPM publications. However, they were not covered explicitly in this research. The portfolios under study had already been authorized and the main focus was the processes involved in the monitoring and controlling of these portfolios once they had been approved. However, the governance was described in the case studies as part of the context.

Future Research

As is often the case in this type of research, many additional questions have been raised during the course of this study. Exploratory work, like this, paves the way for additional research around the following topics:

- **Governance of project portfolios:** This study reveals that project portfolio governance is much more complex than what the existing literature depicts. Portfolios are managed by large groups of intertwined individuals, decision bodies, and line organizations. Decisions are made under time pressure and are generally complex while rarely made with complete and rationale background data. This brings up many questions related to governance: how are decisions made? On what basis? How does portfolio governance relate to corporate governance? To project governance?
- **Third-order dynamic capabilities not covered in study:** The study was limited to the first two orders of dynamic capabilities and did not include how portfolios are selected, prioritized, and authorized. In the PPM context, there exists a third level of dynamic capability related to the portfolio selection. Budgets and human resources are allocated to project portfolios at the highest levels in organizations based on vision, mission, and strategies. The choice to invest in one portfolio or another is strategic and is dependent on the changes identified in the environment.

Table 9-1. Summary of Contributions from this Research

Target Audience	Foundations	Main Contributions	Publications
Theoreticians and Academics	Dynamic capabilities	Using dynamic capability at operational level rather than at strategic level	
Theoreticians and Academics	Organizational theory	Analogies between sensemaking and dynamic capabilities	Petit, Yvan. 2009. "Project Portfolio Management in Dynamic Environments: Organizing for Uncertainty", at APROS, (6-9 December 2009), Monterrey, Mexico.
Theoreticians and Academics	Dynamic capabilities	To distinguish between reconfiguring and transforming To use framework with second-order sensing and seizing	Petit, Yvan, and Brian Hobbs. 2011. "Project Portfolio Management in Dynamic Environments: A Contribution to Dynamic Capability Theory", at Strategies for a Multi-Polar World: National Institutions And Global Competition, (6-9 November 2011), Miami, FL (Forthcoming)
Practitioners	Dynamic capabilities	To analyze the relationships between the sources of uncertainty in dynamic environments and the organizing mechanisms put in place by organizations	Petit, Yvan, and Brian Hobbs. 2010. "Project Portfolios in Dynamic Environments: Sources of Uncertainty and Sensing Mechanisms", at PMI Research Conference, Washington, D.C.
			Petit, Yvan, and Brian Hobbs. 2010. "Project Portfolios in Dynamic Environments: Sources of Uncertainty and Sensing Mechanisms". Project Management Journal, September, p. 46-58.
Theoreticians and Academics	PPM	To provide a better understanding of the management of project portfolios, more specifically of the operational activities involved once portfolios are authorized and launched	Petit, Yvan, and Brian Hobbs. 2010. "Project Portfolios: Trains Not Funnels", at EURAM, (19-22 May 2010), Rome (Italy).
Theoreticians and Academics	PPM		Petit, Yvan, and Brian Hobbs. 2011. "Project Portfolios in Dynamic Environments: Organizing for Uncertainty", at IRNOP 2011, (19-22 June 2011), Montreal, Canada.
Theoreticians and Academics	PPM		Petit, Yvan, and Brian Hobbs. 2012. "Project Portfolios in Dynamic Environments: Organizing for Uncertainty". International Journal of Project Management, (Forthcoming - June 2012).
Practitioners	PPM		Petit, Yvan, and Brian Hobbs. 2011. "The Project Portfolio Change Management Process in Dynamic Environments", Newtown Square, PA, Project Management Institute (Forthcoming).

This is often the level at which dynamic capabilities are discussed. The third order also includes the evaluation of the performance and improvements to the second-order capability. This research studied a number of portfolios which were already established for a number of years and for which a budget, a vision, and a mission had been approved. The process leading to the establishment of these portfolios was not formally investigated in detail. A broader study including such third-order mechanisms might offer additional insights.

- **Project portfolio typology:** Based on the observation that the characteristics of portfolios differ greatly, it would be useful to investigate the parameters that have impacts on its management. Typologies have been found to be useful in classifying projects to determine, among other things, the management tools and techniques, and the management styles that are most appropriate in each case. Some authors have attempted to propose classification systems for projects which might result in project typologies (Besner & Hobbs, 2010a, 2010b; Crawford et al., 2005; Shenhar & Dvir, 1996, 2007). One of the objectives of these typologies is to identify the key characteristics that might have impacts on the choice of project management tools and techniques

and on the characteristics of the project manager to be chosen and assigned to lead projects. It is now commonly accepted that a single approach to manage all types of projects does not exist. Projects differ and might require different approaches depending of the context (Engwall, 2003). When it comes to project portfolios, the attempts at describing and classifying different typologies are very rare and somewhat timid, with only some attempt to distinguish different control mechanisms according to different multi-project environments (Dahlgren & Söderlund, 2010). In this research, the sample was very small, but the project portfolios in the two firms observed displayed some differentiating characteristics that would be worth investigating further.

- The project portfolio concept applies to a broad range of domains, from pharmaceutical to constructions, from new product development to IS/IT, from software products to manufactured goods. Portfolios can be composed of thousands of projects from which to select or can be composed of a handful of large programs. All these portfolios face different challenges and put in place different mechanisms. The four portfolios identified and presented in this report represent only a small sample of the different parameters that could be used to characterize project portfolios into typologies. Some of the findings from this research could be used as a starting point to try to define a project portfolio typology.
- **Larger sample and measuring instruments (performance, turbulence):** This qualitative study provides data that would benefit from being strengthened through quantitative studies on a larger sample. This could help understand the different types of environments in which project portfolio must be managed, what their sources of uncertainties are and what mechanisms are put in place in these different environments; questions that this study could not answer. A more quantitative research on portfolios would also require the development of measuring instruments for performance and turbulence. Such quantitative investigations have already been started at the Berlin University of Technology, by the research team of Dr. Hans Georg Gemünden.
- **Organizational project management:** The study of project portfolio management fits in the broader category of organizational project management which is a management topic for which many areas remain to be explored: what is the role of PMOs with respect to project portfolios, what are the consequences of structural re-organization on portfolios, does organizational management of projects improve performance?
- **Agile development process in a portfolio environment:** In the software industry new development methods, such as *agile*, have been introduced to cater to uncertain scope. The consequences of these new models for project management techniques have not been explored extensively but could be very useful to help develop project management practices. Their impact has primarily been studied at the project level. The present research has shown that this also has effects at the portfolio level; a topic which should be investigated further.

As can be observed, much remains to be investigated to better understand how to manage in dynamic environments. Considering that "uncertainty appears as the fundamental problem for complex organizations, and coping with uncertainty, as the essence of the administrative process" (Thompson, 1967, p. 159), it is hoped that this report contributes, although humbly, to a better understanding of the topic of *organizing for uncertainty*.

List of Acronyms

APM	Association for Project Management
DU	Development Unit
IFRS	International Financial Reporting Standards
IS/IT	Information System/Information Technology
OGC	Office of Government Commerce
PDU	Product Development Unit
PMI	Project Management Institute
PMO	Project Management Office
PPM	Project Portfolio Management
R&D	Research and Development
RBV	Resource-Based View
TG	Tollgate

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APPENDICES

Appendix A Comparison of Definitions of Portfolio
Appendix B Characterizing Uncertainty in Projects
Appendix C Comparison of Dynamic Capability Definitions
Appendix D Overview of Documents Collected
Appendix E Interview Guide
Appendix F Details of Interviews
Appendix G Description of Decision Boards at *Company Soft*

Appendix A

Comparison of Definitions of Portfolio

Table A-1. Comparison of Definitions of Portfolio

Notions Included in PPM Definition	Dye and Pennypacker 1999	Cooper 2001	Levine 2005	APM 2006	Rajegopal 2007	PMI 2008b	OGC 2008b
Centralized						+	
Coordinated							+
Management	+		+	+	+	+	
of Project Portfolios (or Groups of Projects)	+	+	+	+	+	+	
Processes and Sub-Processes						+	+
To Achieve Strategic Business Objectives	+		+		+	+	+
Decisions		+					+
Taking into Account Resource Constraints				+			
Most Effective Balance							+
Constantly Revised		+					

Table A-2. Comparison of Definitions of Project Portfolio Management

Notions Included in PPM Definition	Dye and Pennypacker 1999	Cooper 2001	Levine 2005	APM 2006	Rajegopal 2007	PMI 2008b	OGC 2008b
Centralized						+	
Coordinated							+
Management	+		+	+	+	+	
of Project Portfolios (or Groups of Projects)	+	+	+	+	+	+	
Processes and Sub-Processes						+	+
To Achieve Strategic Business Objectives	+		+		+	+	+
Decisions		+					+
Taking into Account Resource Constraints				+			
Most Effective Balance							+
Constantly Revised		+					

Table A-3. Comparison of Project Portfolio Management (PPM) Processes

Process Groups	Sub-Processes	Archer and Ghasemzadeh 1999/2004	Rajegopal 2007	APM 2006	PMI 2008b	OGC 2008b
Aligning	Identification	Pre-Screening	+ (Building Registry)		+	+ (Understand)
	Categorization		+		+	
	Evaluation	+	+	+	+	
	Selection	+ (Includes Screening)	+	+	+	
	Prioritization		+	+	+	+
	Risk Management				+	+
	Portfolio Balancing		+		+	+
	Authorization		+		+	+ (Plan)
Monitoring and Controlling	Reporting and Review	+	+	+	+	+
	Strategic Change				+	+
	Adjustment of the Portfolio	+		+		

Table A-4. Comparison of Processes covered by Project Management Institute (PMI) and Office of Government Commerce (OGC)

PMI 2008b	OGC 2008b
Aligning Process Groups	**Portfolio Definition**
Identify	Understand
Categorize	Categorize
Evaluate	
Select	
Identify Risks	
Analyze Risks	
Prioritize	Prioritize
Develop Risk Response	
Balance Portfolio	Balance
Communicate Portfolio Adjustments	
Authorization	
	Plan
Monitoring and Controlling	**Portfolio Delivery**
Monitor and Control Portfolio Risks	Risk Management
Review and Report Portfolio Performance	Management Control Financial Management Resource Management
Monitor Strategic Change	
	Benefits Management
	Stakeholder Engagement
	Organizational Governance