Department of Marketing

New product development capability – A mechanism perspective

Antti Sihvonen

Aalto University

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Abstract

New product development has become one of the central ways in which companies change their day-to-day activities. To understand how these changes take place, dynamic capability perspective offers a view into how organizations match and even create market change. These capabilities are driven by underlying mechanisms that I examine in this study to shed light on how a specific form of dynamic capabilities, i.e. new product development capability generates change. To do so, this study provides a historical analysis of a Finnish meteorological instrument company Vaisala to map out how new product development capability drove change in the company during 1970s and enabled it to become a multiproduct firm.

The findings of this study explicate new product development mechanisms and how these mechanisms can explain new product development both on the project level as well as on the organizational level. I introduce and develop three categories of mechanisms that reveal how new product ideas are developed, how the projects are evaluated for commercialization and the impact that these projects have on the organization.

Subsequently, I explore how combinations of these mechanisms produce success paths on the new product development project level. I also investigate how the mechanisms enable us to understand changes in the organizational level that are driven by new product development. In doing so, I highlight how the capability can operationalize strategy, enable the realignment of the organization to its market and how exercising this capability contributes to the transformation of the organization into a multiproduct firm.

Overall, this study is among the few studies to provide an empirically grounded examination of the mechanism of dynamic capabilities and their internal functioning. Therefore, it provides empirical evidence on how the mechanisms of dynamic capabilities explain change in organizations. By doing so, the study draws attention to the abstract nature mechanisms-based theorizing in the field of dynamic capabilities and proposes a more nuanced understanding of mechanisms that explain these capabilities.

Keywords new product development capability, mechanisms, dynamic capabilities, historical research, event structure analysis, qualitative comparative analysis, critical realism

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1. Introduction

> "The events are many, but their universal idea and their inner connection are one. This nullifies the past and makes the event present. Pragmatic reflections, no matter how abstract, belong indeed to the present, and the stories of the past are quickened into present-day life. Whether such reflections are really interesting and full of life depends on the spirit of the writer." (Hegel 1837/1997, p. 8-9)

1.1 Background

Development of new products has become one of the central ways in which companies compete in the global marketplace. Despite this, new product mortality rates remain high and success is hard to come by. In this kind of environment, the organization's capability to develop new products (Salvato 2009) and organizational forms (Galunic and Eisenhardt 2001) becomes paramount.

Focus on organizational capabilities turns our attention to what an organization is able to do (Jacobides and Winter 2012). Specifically, a capability denotes an ability to perform a certain task, function or activity in a minimally acceptable manner (Helfat et al. 2007, p. 121). This perspective has garnered substantial interest from the academic community and it has been used in the fields of strategic management (Eisenhardt and Martin 2000; Teece, Pisano and Shuen 1997), organization theory (Salvato 2009; Vogel 2012) and marketing (Day 2011; Menguc and Auh 2006; Vorhies and Morgan 2005) to understand how organizations function.

In the organizational capability field, dynamic capability discourse aims to uncover how organizations are able to adapt to (and possibly create) changes in their business environment (Eisenhardt and Martin 2000; Teece, Pisano and Shuen 1997) in contrast to operational capabilities that depict the day-to-day activities of organizations (Winter 2003). The creation of new products has been identified as an important form of dynamic capabilities (Eisenhardt and Martin 2000) and this form, labeled as new product development capability, has received attention in the academic literature (Danneels 2002; Salvato 2009).

Despite the fact that many would argue for the importance of dynamic capabilities, the concept has been riddled with inconsistencies (Zahra, Sapienza and Davidsson 2006) such as whether these kinds of capabilities benefit organizations in less dynamic environments. The concept has also been accused of tautology due to focus only on explaining success post hoc (Williamson 1999). To mitigate these challenges, there is a growing interest in understanding how dynamic capabilities function (Danneels 2002; Helfat and Peteraf 2003; Salvato 2009) to better undergird the foundations of the concept.

To understand the functions of dynamic capabilities many scholars have turned their attention to depicting the mechanisms that could explain how dynamic capabilities function (Makadok 2001; Zott 2003) and change (Zollo and Winter 2002; Wang and Ahmed 2007). Mechanisms explain processes and how they lead into outcomes (Bunge 2004; Danermark et al. 2002; Steel 2004) and can therefore elucidate how dynamic capabilities function through them. While there have been a number of studies that focus on the mechanisms underlying dynamic capabilities (e.g. Zollo and Winter 2002; Zott 2003) they have been largely theoretical in focus and identified abstract mechanisms such as capability building (Makadok 2001).

With few notable exceptions (Tripsas 1997; Verona and Ravasi 2003), empirical studies on how dynamic capabilities function through mechanisms are still largely missing. To address this issue, the objective of this study is to shed further light on the mechanism of dynamic capabilities by focusing on new product development capability and how it functions through the associated mechanisms.

To achieve this goal I conduct a qualitative historical inquiry into a Finnish meteorological equipment company Vaisala that transformed itself in little over ten years (1969-1981) from being a producer of a single type of product into having four distinct product lines. In doing so, I try to understand the mechanisms underlying new product development capability and how this capability and the associated mechanisms enabled the creation of new products as well as broader changes in the organization.

1.2 Research questions

The purpose of this study is to propose an empirically grounded examination of how new product development capability functions through the associated mechanisms. Specifically, new product development can be understood as being constitutive of the organizational and strategic processes through which and organization develops new products. To understand this capability, mechanisms depict movement from initial conditions into an outcome (Bunge 2004; Danermark et al. 2002; Steel 2004) and thus provide explanations of how the capability functions. Beginning to understand the mechanisms that underlie this capability can bring us closer to understanding how organizations renew themselves through new product development and change from a

single product company into a multiproduct firm. To break down the research problem a number of research questions have to be laid out.

The first step in building an explanation requires postulating possible mechanisms that could explain the phenomena under research in this study, i.e. the successful development and launch of new products. In this study mechanisms of new product development capability are disseminated into three classes based on whether they relate to the creation of an initial product concept, evaluation of a product for commercialization or the launch and diffusion of the product into the organization. This covers the process of developing a product from initial idea into a launched product.

Postulating mechanisms necessitates identifying entities, activities and structures through which mechanisms are animated (loosely following Pajunen 2008) and which can explain component processes that contribute to the successful development of new products. Therefore, identifying the elements that can contribute to mechanisms and then identifying how these elements alone or in conjunction with each other can form mechanisms pertinent to new product development capability forms the first part of this study. Thus, each mechanism can be conceptualized as being a piece of theory explaining component processes of a larger system (Stinchcombe 1991), which in this study is the capability to develop new products. Deriving from these considerations, the first research question can be outlined as follows:

Research question 1: What kinds of mechanisms underlie new product development capability?

The first research question therefore seeks to identify constitutive elements of mechanisms and to postulate mechanisms pertinent to new product development capability. This gives us an understanding of the mechanisms that underlie the capability. The next step is to understand how these mechanisms can explain how the capability functions on the new product development project level. This enables us to understand success paths (Woodside, Ko and Huan 2012) that explain how sequences of mechanisms can explain outcomes, which in this study are the successfully developed products. We can then generate an understanding of how dynamic capabilities function as particular combinations of elements and patterns of relationships, as suggested by Loasby (2010). Based on these considerations, the second research question can be outlined as follows:

Research question 2: How can the mechanisms explain the successful use of new product development capability on the project level?

By understanding how the mechanisms explain new product development capability on the project level enables us to understand how the capability functions on the micro level. However, it is possible that the capability can also

relate to firm level changes. Therefore, the way in which new products are developed can be caused by organizational change, transform search activities (Rosenkopf and Nerkar 2001) and enable transformation into a multiproduct firm (Teece 1980; 1982). These firm level changes have been a central issue that the dynamic capability discourse has sought to explain (Eisenhardt and Martin 2000; Teece, Pisano and Shuen 1997; Rindova and Kotha 2001). Therefore, it is also necessary to examine firm level changes that the capability could induce. Based on these considerations, the third research question can be outlined as follows:

Research question 3: How can the identified mechanisms explain the successful use of new product development capability on the firm level?

Together these three research questions enable me to first to build an understanding of the mechanisms that can contribute to the exercise of new product development capability. It is then possible to examine how the capability functions on the level of new product development projects and finally how the projects relate to larger changes on the organizational level. This should yield an overarching understanding of how new product development capability functions through the identified mechanisms. Answering these questions can enable me to contribute on one hand to understanding how dynamic capabilities function on the process level (e.g. Danneels 2002; Eisenhardt, Furr and Bingham 2010) and on the other hand create understanding how the capability functions on the firm level (Helfat et al. 2007; Rindova and Kotha 2001). Next I will provide an outline of this study to introduce the main issues I will consider in each of the subsequent chapters.

1.3 Outline of the study

The argument of this thesis is developed through eleven chapters. These chapters are intended to build on the previous ones and therefore successively build an argument for the centrality of understanding mechanisms of new product development capability. Overall, I hope that the outline provided here will help the reader in following the arguments developed in this thesis.

Following this short introductory chapter, chapter 2 builds a theoretical foundation for this study. My aim is to first introduce organizational capabilities and new product development, and thereafter build a conceptualization of new product development capability by drawing from the two previously mentioned perspectives. Therefore, the chapter leads into defining new product development capability, explicating the role that knowledge and decision-making have on it and finally outlining how the capability is actualized through ideation, evaluation and outcomes.

Chapter 3 builds directly on the premises of the previous chapter to outline a theoretical framework. This leads to the presentation of theoretical framework that is used in studying mechanisms in the empirical part of this study.

Chapter 4 continues from the preceding discussion by providing an explication of the methodological procedure through which it is possible to postulate and theorize about mechanisms. The chapter begins by outlining the underlying epistemological and ontological assumptions of this study. Thi is followed by a depiction of a research process for uncovering mechanisms and an explication of the procedures through which this research process will be actualized.

In chapter 5 we finally move to the empirical part of this study. It outlines a historical narrative of the Finnish high-technology company Vaisala from 1969 to 1981, during which the company grew from a single product line into a multiproduct firm. The narrative is divided into an overall company history narrative, separate narratives for each of the central new product development projects and narratives on the emergence and change of the product lines. This lays out grounding for the subsequent analyses and provides the reader with an overall understanding of the events that took place during the period of inquiry.

Chapter 6 begins to answer the first research question by analyzing central new product development projects to uncover recurring activities of new product development. This is first done by the identifying of entities, activities and their influence on new product development, followed by dissolution of the period of inquiry into its component parts. Then, an analysis of the activities pertinent to each new product development project will be done. The analysis yields an array of recurring activities that the company uses in new product development.

After identifying central recurring new product development activities, chapter 7 postulates mechanism from the activities and their configurations. This enables me to answer the first research question pertaining to the kinds of mechanisms that are present in new product development and to provide a theoretical grounding for each of the mechanisms.

Chapter 8 draws together the identified mechanisms to examine how they function on the NPD project level. By doing so, I examine how the new product development mechanism in conjunction with each other formulate success paths which are the manifestations of the new product development capability on the project level. Therefore, this chapter aims to answer the second research question.

Chapter 9 furthers the analysis by examining new product development capability on the firm level. By doing so, we can understand how new product development affects organizations on the aggregate level and the factors that affect the change of the capability itself. This chapter therefore aims to answer the third and final research question.

Chapter 10 provides a discussion of the findings in the light of extant theory and therefore draws together the preceding two chapters. In doing so, my aim is to explicate what the capability enables organizations to accomplish and

how this study can contribute to the mechanism-related discussion in the field of dynamic capabilities.

Finally, chapter 11 draws the presented arguments together and concludes the discussion on the mechanisms that underlie new product development capability. This is accompanied by a discussion of the limitations of the present study, as well as of the possible avenues for future research. But now the journey awaits.

2. Theoretical background

The aim of this section is to outline the theoretical background of this research. In doing so, I first define organizational capabilities, their constitutive elements and forms. Thereafter, I discuss new product development as the context of study and how studies in this field have theorized the phenomenon. Building on this discussion, I then define new product development capability, the process through which it is actualized and its central components.

2.1 Organizational capabilities

Leitmotif of the capability perspective is the focus on what an organization can actually do (Jacobides and Winter 2012) and therefore providing a rationale for the existence of firms. To untangle this, the purpose of this subsection is to define the concept, review extant literature, define what types of capabilities there are and what kind of mechanisms have been postulated to underlie them.

2.1.1 What are organizational capabilities

A capability denotes an ability to perform a task, a function or an activity in a minimally acceptable manner (Helfat et al. 2007, p. 121). Therefore, a capability signifies what an instance is able to do successfully – what an organization or unit of an organization is capable of doing. Therefore, the capability perspective provides one possible answer to the question why companies exist by noting that they exist due to their ability to perform certain tasks. This task orientation results into heterogeneity and specialization between companies (Jacobides and Winter 2012). These notions should give us an ample starting point for defining what organizational capabilities constitute of, what kind of capabilities there are and how they have been operationalized in extant research.

Depending on the author, the constitutive elements of organizational capabilities can be defined either as routines (Nelson and Winter 1982; Winter 2003; Zollo and Winter 2002) or as simple rules (Eisenhardt and Martin

2000; Bingham, Eisenhardt and Furr 2007; Rindova and Kotha 2001). This follows the analysis of Peteraf, Di Stefano and Verona (2013) on how the dynamic capability discussion has developed. To understand these elements, I gauge them one-by-one to present an initial understanding of the possible constitutive elements of capabilities.

The routine-oriented discussion draws its roots from the seminal book by Nelson and Winter (1982) titled "The Evolutionary Theory of Economic Change". They define routines as "regular and predictable behavioral patterns of firms" (ibid., p. 14). Routines emerge in organizations to efficiently handle different kinds of tasks and activities. If we backtrack routines to their smallest component, they are reducible to the skills and habits of the individuals (Nelson and Winter 1982, p. 73; Winter 2013).

Routines can be disseminated into a structure of the routines and performance of the routines (Feldman and Pentland 2003). Therefore, routines provide agents a structure in which to realize the intended outcomes of the routine. However, routines can embody significant variation in the way in which they are actualized. Therefore, routines function as interplay of structure and agency, where the structure is reproduced and changed through actions. Routines can be codified in the operating procedures of the company (Zollo and Winter 2002) or they can depict a learned pattern of how an organization responds to a certain situation. These patterns reveal the ways in which organizational members perceive the efficient ways of address recurring issues.

The other perspective to the constitutive elements of organizational capabilities focuses on simple rules that are delineated from heuristics. This perspective draws its roots from a seminal work of Eisenhardt and Martin (2000) on defining what are dynamic capabilities. Simple rules can be conceptualized as simple heuristics that are articulated rules-of-thumb which are shared by multiple participants of an organization (Bingham, Eisenhardt and Furr 2007) and focus on central organizational processes (Eisenhardt and Sull 2001). They have a common structure and are centered on opportunity capture (Bingham and Eisenhardt 2011). Whereas routines provide detailed guidance on how well specified problems can be addressed, heuristics provide common guidance to solve a set of similar problems with only moderate structure and detail (Eisenhardt, Furr, Bingham 2010; Rindova and Kotha 2001).

Heuristics develop through succession in which organizations first develop lower order heuristics that are followed by the development of higher order heuristics (Bingham, Eisenhardt and Furr 2007; Bingham and Eisenhardt 2011). Lower order heuristics relate to the capture of a single opportunity and include selection heuristics that guide which opportunities the company will pursue and procedural heuristics that guide how the company will pursue these opportunities (Bingham, Eisenhardt and Furr 2007; Bingham and Eisenhardt 2011; Eisenhardt and Sull 2001). Higher order heuristics relate to how the organization links multiple opportunities together. These higher order heuristics include temporal heuristics that guide the timing of opportunity capture and priority heuristics that guide how opportunities are ranked in relation to each other (Bingham, Eisenhardt and Furr 2007; Bingham and Ei-

senhardt 2011; Eisenhardt and Sull 2001). By utilizing these heuristics, an organization tries to balance between routinized efficiency and unstructured flexibility to have moderate structures that lead to efficiency (Eisenhardt, Furr and Bingham 2010).

Overall, the extant literature appears to be univocal in regards to four issues that relate to the constitutive elements of capabilities. Firstly, recurring activities are understood to be central for the exercise of a capability independent on whether we follow the routine or the simple rule approach. Secondly, as a consequence, this sets a clear boundary between the exercise of a capability and ad hoc problem solving (Winter 2003). Thirdly, both of these two approaches acknowledge that structures guide actions and the actions themselves can vary between instances. Finally, it has been stressed that neither a single routine nor a simple rule alone gives rise to an organizational capability but rather a constellation of them.

Capabilities can consist of both organizational and managerial activities. Organizational activities refer to either organizational or group-level activities where a number of people collectively execute a task. In completing a task groups within the organization draw from pre-existing relevant know-how (Helfat 1997) and practices residing in the human resources and codified in systems (Zollo and Winter 2002) as well as from resources such as brands (Bruni and Verona 2009), and link these together to generate outcomes (Danneels 2002). These activities link more strongly to the domain of routines.

Managerial activities, on the other hand, refer to the actions through which organizational actions are initiated and controlled by management. In completing these tasks the managers' draw, for instance, from their capacity for asset orchestration (Teece 2007) and strive towards attaining fit within the organization (Helfat et al. 2007). Overall the activities are used to control and direct activities and processes occurring at different levels of the organization. These activities link more strongly to the domain of simple rules.

Despite the possible commonalities between different capabilities, they are still idiosyncratic in their detail (Eisenhardt and Martin 2000). This means that they are distinctive to each organization. However, they do share commonalities on an abstract level. This notion is also upheld from the perspective that activities on a detailed level are specific to a company but on a general level may be of the same genus between organizations. Therefore, for instance, how organizations utilize their absorptive capacity (Zahra and George 2002) to acquire, assimilate, transform and exploit knowledge is firm specific but these processes share commonalities on the aggregate level.

Capabilities are also fungible (Eisenhardt and Martin 2000) which means that a component of a capability can be replaced by another component and it can still lead to a similar outcome. What this denotes is that components of capabilities can be mutually interchangeable. This highlights the multiple paths through which a single capability can be built and exercised.

Now that a general introduction to capabilities has been provided we can next discuss the different forms of capabilities identified in the extant literature.

2.1.2 Types of organizational capabilities

On a broad level, organizational capabilities can be disseminated into two classes: operational capabilities and dynamic capabilities (Helfat et al. 2007). Operational capabilities are the zero-level capabilities that the organization uses to make a living in the present (Winter 2003). These capabilities enable the production and selling of goods and services and therefore constitute the foundation on which the organization functions. The zero-level capabilities can be enhanced to achieve higher technical fitness, i.e., to enhance how well the capability is performed (Helfat et al. 2007). In the short run this enabled the efficient operation of the organization. However, this provides only means to increase the current efficiency of the day-to-day activities, not means to change them to abide with market changes.

In their seminal article Teece, Pisano and Shuen (1997) proposed the dynamic capability concept to explain how organizations renew themselves in rapidly changing context. Its foundation rests on the capability of the firm to change and develop the firm-specific combinations of resources and operational capabilities to address changing environments. After the seminal article of Teece and colleagues, the concept has been defined in multiple ways. Table 1 outlines main definitions of the concept.

Table 1: How dynamic capabilities have been defined

study	definition
Teece, Pisano and Shuen (1997)	"the firm's ability to integrate, build, and reconfigure internal and external competences to adress rapidly changing environments."
Eisenhardt and Martin (2000)	"The firm's processes that use resources - specifically the processes to integrate, reconfigure, gain and release resources - to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die."
Makadok (2001)	"'capability' is defined as a special type of resource—specifically, an organizationally embedded nontransferable firm-specific resource whose purpose is to improve the productivity of the other resources possessed by the firm."
Zollo and Winter (2002)	"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."
Winter (2003)	Capabilities that operate to extend, modify, or create operational capabilities
Helfat et al. (2007, p. 121)	"**Dynamic capability** is the *capacity* of an organization to purposefully create, extend, or modify its *resource base*, and consists of patterned and somewhat practiced activity." [italics and bolding in original]
Teece (2007)	"The ability to sense and then seize new opportunities, and to reconfigure and protect knowledge assets, competencies and complementary assets so as to achieve sustainable competitive advantage."

Where the definitions are univocal is that dynamic capabilities alter the way in which the organization conducts its day-to-day activities. Therefore, dynamic capabilities can create, extend or modify the operational capabilities of the organization (Winter 2003). Subsequently by utilizing dynamic capabilities, an organization is capable of either matching or even creating market change (Eisenhardt and Martin 2000). This can mean, for instance, altering the corporate form through reconfiguring divisional resources (Galunic and Eisenhardt 2001) or by integrating technical and customer competences for the creation of new products (Danneels 2002). Dynamic capabilities therefore provide means for achieving evolutionary fitness by altering operational capabilities to better match market changes (Teece 2007).

Delineating dynamic and operational capabilities in the present research

In studying new product development in the empirical context, the associated capability was conceptualized as being a dynamic capability because it altered the way in which day-to-day activities were conducted, as the main activity of the company was the production and selling of goods.

Winter (2003) proposed that capabilities form a stratification where operational capabilities are the lowest order, zero-level capabilities on which higher order capabilities (in essence dynamic capabilities) are built. In doing so, he

proposed that higher order capabilities outperform lower order capabilities as they enable the company to systematically enhance how it functions. Despite this, an organization has to first develop operational capabilities that the dynamic capabilities can modify. Collis (1994) noted that competition on higher order capabilities could lead to infinite regress in which organizations develop even higher order capabilities when the current order is no longer able to lend competitive advantage. If dynamic capabilities are perceived as capabilities to learn capabilities, the development of even higher order capabilities would lead to capabilities of learning to learn and learning to learn how to learn ad infinitum.

Capability stratification and new product development capability

New product development capability in this study is treated as a first-order capability as it alters the zero-order day-to-day operating capabilities.

Developing higher order capabilities is not always necessary but rather tied to the development stage of the industry (Grant 1996). Therefore, developing higher order capabilities in an industry where competitors are incapable in the zero-level could be deemed unnecessary as capabilities are costly to develop and sufficient zero-level capabilities can grant competitive advantage. However, as competition within an industry intensifies and capability development is intense, development of higher order capabilities can grant a competitive advantage as it enables generating new kind of isolating mechanisms that can alleviate the effects of competition such as the capability to capture opportunities faster and more efficiently than competitors (Bingham and Eisenhardt 2011).

The effect of operational capabilities can be associated with how well the organization functions in its day-to-day activities. This can be labeled as technical fitness (Helfat et al. 2007), which depicts how efficiently an organization is able to perform these activities. It enables assessing how efficiently the organization functions in its present context.

The effects of dynamic capabilities can be associated with changing how the organization functions on a day-to-day basis. This can be labeled evolutionary fitness (Helfat et al. 2007) and it refers to how well the company is able to alter its operations to better match the needs of the external environment. In doing so, the effects of dynamic capabilities can be associated with the ability to reconfigure as desired (Zahra, Sapienza and Davidsson 2006) improved effectiveness that the capability can induce (Zollo and Winter 2002) and effects on the resource base (Helfat et al. 2007).

2.1.3 Mechanisms related to organizational capabilities

There are a number of studies that focus on the mechanisms related to organizational capabilities, especially with regards to dynamic capabilities. Two seminal studies on dynamic capabilities exclusively focus on unraveling mechanisms. Makadok (2001) concentrated on comparing the rent creation mecha-

nisms of the resource-based view and the dynamic capability view. Moreover, Zollo and Winter (2002) focused on unraveling the mechanisms through which dynamic capabilities are developed and refined. In addition to this, a number of studies related to dynamic capabilities touch upon the subject of mechanisms. Table 2 sketches out studies that outline or propose mechanisms, identify what kind of mechanisms are proposed, how they are described, how they could be categorized and how they were identified/proposed.

Table 2: Mechanisms related to dynamic capabilities

identified mechanism	description	decision-making	knowledge related	means of identification
resource allocation (Tripsas 1997)	resource allocation defines how well the company is able to match customer needs	✔		qualitative inquiry
cross-functional teams (Tripsas 1997)	enable integration of firm-internal knowledge		✔	qualitative inquiry
repeated practise (Eisenhardt and Martin 2000)	through repreated practice people understand processes better and are able to develop them further		✔	theoretization
past mistakes (Eisenhardt and Martin 2000)	past mistakes contribute to effective learning of individuals of the processes they conduct		✔	theoretization
pace of experience (Eisenhardt and Martin 2000)	too frequent experience can be overwhelming, while too infrequent learning does not enable building on past experience		✔	theoretization
variation (Eisenhardt and Martin 2000)	variation enables companies to deepen capabilities by elaborating them in current situations and applying them in different contexts		✔	theoretization
selection (Eisenhardt and Martin 2000)	which experiences should be generalized and incorporated to the current capabilities		✔	theoretization
capability building mechanism (Makadok 2001)	through capability building, managers enchange the productivity of resources	✔		theoretization
new product development (Danneels 2002)	product development is a mechanism throuhg which companies create, extend and modify their resources		✔	theoretization
experience accumulation (Zollo and Winter 2002)	central learning processses through which operational routines develop		✔	theoretization
knowledge articulation (Zollo and Winter 2002)	collective articulation of implicit knowledge and its evaluation		✔	theoretization

Table 2 Continued

identified mechanism	description	decision-making	knowledge related	means of identification
knowledge codification (Zollo and Winter 2002)	codification of performance implications of routines into written tools such as manuals or blueprints		✔	theoretization
co-ordination (Verona and Ravasi 2003)	co-ordination of activities related to product innovation	✔		qualitative inquiry
variation (Zott 2003)	search through imitation and experimentation		✔	simulation model
selection (Zott 2003)	firm evaluates each alternative generated in the variation stage and chooses the one that yields highest performance improvement	✔		simulation model
retention (Zott 2003)	firm decides whether or not to retain and implement the alternative solution identified in the selection stage	✔		simulation model
timing (Zott 2003)	Earlier timing of resource deployment leads to competitive advantage	✔		simulation model
cost effect (Zott 2003)	utilization of a dynamic capability drives their use cost down that can lead to suboptimal use of that capability due to cost effect	✔		simulation model
learning effect (Zott 2003)	learning drives down cost of operationalizing certain dynamic capabilities and can lead to path dependency		✔	simulation model
transformational mechanism (Wang and Ahmed 2007)	adaptive capability, absorptive capability and innovative capability together form the mechanism that explains the common features of dynamic capabilities		✔	theoretization
processes (Helfat et al. 2007)	through organizational and strategic processes dynamic capabilities are actualized	✔		theoretization

If we contrast these proposed mechanisms of dynamic capabilities with how mechanisms have been treated in extant literature (Hedström and Swedberg 1998; Schelling 1998; Stinchcombe 1991), we see a number of convergence points. Firstly, they depict pieces of theory that explain the component processes of a larger system as has been suggested by Stinchcombe (1991). Secondly, many of the proposed mechanisms depict specific actions of actors that connect an initial condition into an outcome (Hedström and Swedberg 1998). For instance, repeated practice as outlined by Eisenhardt and Martin (2000) denotes that repeatedly conducting an activity leads and actor to understand and learn from his own activities and therefore enhance the way in which the activities are undertaken. Thirdly, many of the mechanisms provide an interpretation of a model that abstractly reproduces the phenomenon that is being explained (Schelling 1998). Therefore, variation mechanisms, as proposed by Zott (2003), abstractly reproduce the possibilities that a company has in developing new offerings.

In general the existing mechanism oriented theorizing has largely focused on proposing component processes that dynamic capabilities can constitute of. However, these largely lack empirical grounding and analyses of the relations between the different mechanisms appear to be sparse. Therefore, empirical studies that would fully embrace a mechanisms perspective are largely still missing.

The mechanisms related to dynamic capabilities can be split into two broad categories that are somewhat intertwined. The first category relates to decision-making. These mechanisms focus on how the organization is able to effectively allocate resources to best possible use and to (further) develop capabilities. Therefore, it includes mechanisms such as resource allocation and capability building that are aimed towards changing how the organization uses its resources. As Makadok (2001) noted, the goal of these mechanisms is to enhance the productivity of resources.

The second category of mechanisms is related to knowledge, its creation and use. These studies focus largely on explaining how dynamic capabilities develop and change over time through learning. These learning mechanisms have been proposed as the means through which dynamic capabilities are developed and changed (Zollo and Winter 2002). The mechanisms could be described as the feedback loop from the resource base modification mechanisms through which resource allocation and use is enhanced over time.

Based on this short overview, we can point out that a uniform body of research on the mechanisms of dynamic capabilities is still only just developing and that the extant research on mechanisms underlying capabilities focuses on a very high level of abstraction. While studies call for more research on the mechanisms of dynamic capabilities, they appear slow to emerge. Furthermore, we can also point out that many of the studies that discuss mechanisms are theoretical in nature and thus empirical grounding of the mechanisms of dynamic capabilities is still sparse. Building on this, it can be stated that in-depth empirical analyses of the actualization of capabilities through mecha-

nisms are rare. This is a definite gap in our understanding of the mechanisms of organizational capabilities that this study aims to address.

2.2 New product development

New product development (NPD for short), according to Product Development & Management Association, can be defined as "The overall process of strategy, organization, concept generation, product and marketing plan creation and evaluation, and commercialization of a new product" (PDMA 2004, p. 595). Thus, NPD encompasses the development of new products from initial idea into being commercialized products. NPD serves the organization by enabling it to renew its offering portfolio and to compete with its rivals. It answers to Schumpeter's (1934/2004) call that the stimulus of economic development is the introduction of new products, processes or methods of working.

We must first acknowledge the impact that new product development has on industry sectors, innovation networks and national economies. However, the focus of this review will be kept on the level of a single organization in order to serve the purpose of uncovering bases for the capability of an organization to development new products. Thus I focus on reviewing how new product development has been studied as a phenomenon pertaining to a single organization, especially with regards to the new product development process.

The need to develop new products rarely emerges ex nihilo but rather organizations face stimuli that direct them to conduct such activities. As Schroeder et al. (2000) note, these activities can be stimulated by internal or external shocks such as change in leadership or loss in market shares. This confronts people with a problem that sparks them to act (Van de Ven 1986). Therefore, new product development is largely aimed at solving emerging problems through the development of new offerings.

Once innovation initiatives are undertaken, they are rarely unitary processes with a clear start and finish but rather ideas proliferate during development activities and enable creating new business areas (Van de Ven et al., 2000). This creates a challenge in managing the attention of the involved parties as new opportunities emerge during development and differing perceptions of the opportunity emerge (Van De Ven 1986).

The development of new and innovative offerings is also linked to the existing organizational arrangements. New products are rarely simple additions or replcacements to existing offerings but rather they are enmeshed with the already existing offerings and coexist with them (Schroeder et al. 2000). Innovation intiatives can also alter organization structures or require alterations as an antecedent for development (ibid.). Therefore, new product development activities can have far-reaching effects on the organization as well.

Largely stemming from the previous considerations, in approaching new product development as an activity I follow an approach labeled by Brown and Eisenhardt (1995) as disciplined problem solving. From this perspective NPD

is conceptualized as a series of autonomous problem solving activities by a project team combined with a discipline that management imposes on the development. Thus, my focus is on the process of development and its actualization, rather than assuming a rational plan approach (ibid.) that focuses on the quantities of antecedent conditions and assumes their perfect use during the NPD projects to reach outcomes.

2.2.1 Levels and units of analysis

New product development has been studied by using multiple units and levels of analysis. Drawing from extant literature (Calantone, Harmancioglu and Droge 2010; Evanschitzky, Eisend, Calantone and Jiang 2012; Garcia and Calantone 2002), these studies can be broadly divided into four categories that are:

1) New product development as business unit or program/portfolio
2) New product development as a process
3) New product development as projects
4) New product development as actualization of NPD practices

On an aggregate level, new product development can be conceptualized as a business unit and as a program or portfolio. Research focusing on new product development on the organizational level has uncovered antecedents to successful new product development such as information processing (Moorman 1995) and how new product development can be affected through interaction and cooperation with other organizational functions such as marketing (Atuahene-Gima and Evangelista 2000) or with third parties such as universities (Bishop, D'Este and Neely 2011). For instance, many studies that examine dynamic capabilities related to new product development embrace this kind of a perspective (e.g., Deeds, DeCarolis and Coombs 2000; Helfat 1997).

On the program/portfolio level studies have focused on aspects such as how product portfolio development is managed (Cooper, Edgett and Kleinschmidt 1999) to effectively allocate resources and develop products. This draws our attention to the notion that new product development rarely consists of a single product or offering but rather families of related new products are developed (Schroeder et al., 2000). Therefore, there is a necessity to manage the relationships between interrelated products. Additionally, organizations also learn during and from the development activities that open up new avenues for product development as these activities are carried out (Schroeder et al., 2000; Van de Ven and Polley 1992). This necessitates the management of the opportunities that product development activities open up for the company.

If we take a step closer to the actual NPD activities, the subsequent level of analysis focuses on the NPD process. NPD process defines the tasks and steps that characterize the means through which ideas are transformed into marketable products (PDMA 2004). Thus, it includes the temporal sequence of events

that occur when people interact with each other to develop and implement a product (Van de Ven and Poole 2000). Delineating from this, the NPD process can constitute, for instance, from the following steps: 1) generation of ideas for new products, 2) preliminary design of the product, 3) detailed business analysis of the product, 4) actual product development and 5) commercialization (Calantone and di Benedetto 1988). Success in the NPD process can be enhanced by, for instance, involving customers (Schreier, Fuchs and Dahl 2012) and people from different functional units into the NPD process (Olson, Walker, Ruekert and Bonner 2001; Song, Neeley and Zhao 1996) or by enhancing how new products are evaluated (Ozer 1999). Therefore, succesful management of the NPD process includes managing the part-whole relationships between NPD activities and different organizational actors (Van de Ven 1986) so that the whole could be more than the sum of its parts.

There have also been a lot of studies that focus on NPD projects. An NPD project can be defined in as follows:

> "A unit of activity in the product development process that usually deals with creating and marketing one new product. A project involves a multidisciplinary group of people, tightly or loosely organized, dedicated to the new product assignment that created the project. A project is often part of a larger unit of work, a program, which delivers a stream of new products, one from each project." (AMA dictionary)

Therefore, a project deals with the development of a single product, involves a group of people assigned to the task and is usually tied to a larger program of new product development. On the project level, factors such as team stability (Slotegraaf and Atuahene-Gima 2011) have been suggested to influence NPD project performance. A single project embodies both the NPD process as a blueprint of action and a selected array of NPD practices through which the project is carried out from beginning to the end. On an aggregate level, a number of projects constitute the activities of the NPD department and the NPD program.

On the micro-level of NPD, a number of studies have focused on the NPD practices. The Product Development Management Association (PDMA) has been tracking the best practices of new product development for a number of years (e.g., Barczak, Griffin and Kahn 2009; Griffin 1997). These include for instance cross-functional collaboration during the NPD project (Song, Montoya-Weiss and Schmidt 1997). In the present study I wish to focus on the NPD practices that are repeatedly used in NPD projects. Thus, I draw from the notion made by Eisenhardt and Martin (2000) that many dynamic capabilities have a strong grounding in their own respective field as, for instance, the way in which new product development affects an organization has been researched extensively.

Importance of these identified factors and units of analyses are associated to the outcomes they generate. These include monetary gains from NPD as well as project-level outcomes that enable future product development, augment

the intellectual capital of the company or describe the outcomes of the NPD process. The monetary outcomes include factors such as profitability and product advantage (Harmancioglu, Droge and Calantone 2009) and project-level outcomes include factors such as the characteristics of the product (Evanschitzky et al. 2012), patenting of the product or its components or the impact that a product has on the technological trajectory of the company or the industry. For the purpose of the present study, my aim is to focus on project-level outcomes that affect how new products are developed and how they affect future development projects and the organization. Therefore, the monetary impact that new product development can induce is left outside the scope of this study and the focus is on mechanisms that affect the introduction of products and the future NPD activities of the company. This stems from the reason that there are other capabilities that affect the financial performance of the organization besides the development of new products such as marketing capabilities related to pricing, selling and channel management (Vorhies and Morgan 2005).

To draw this discussion to a close, in the present study my primary focus is on NPD projects as a unit of analysis and project-level outcomes such as product launches, patents and effects on future development as the outcomes of development. By focusing on this, we can understand how NPD process is manifested and how different NPD activities are used in the projects to reach project-level outcomes. This should give us an understanding on what kind of activities contribute to new product development and how they affect the launch of new product and other possible outcomes. Understanding these factors enable me to also touch upon how the projects affect each other and what kind of a whole they create.

2.2.2 New product development process

There are multiple ways to depict the process through which new products are developed (Adler 1995; Adler, Mandelbaum, Nguyen and Schwerer 1995; Barczak, Griffin and Kahn 2009; Calantone and Di Benedetto 1988; Maggitti, Smith and Katila 2013), many of which focus on specific industries such as pharmaceuticals (Bruni and Verona 2009; Pisano 1997), automobiles (Clark and Fujimoto 1989; 1991) or high technology industries (Iansiti 1998). Furthermore, many of these models guide towards certain type of development such as the PDMA model (Barczak, Griffin and Kahn 2009) that highlights idea generation, screening and business analysis to develop products to existing markets in which these kinds of analyses can be readily made. These highlight the notion that processes are not directly observed but rather they are conceptual inferences about the temporal patterns of observed events (Van de Ven and Poole 2000).

Despite inherent differences in content and focus, what the aforementioned process models share in common are three phases, which are: 1) the **ideation** of a new product through which product concept and technology is initially

developed, 2) **evaluation** in which managers assess the product and decide whether to commercialize it and 3) **outcomes** that depict the changes induced by the project. Figure 1 provides an overview of these stages through which new products are developed. Next I will deconstruct each of these stages separately.

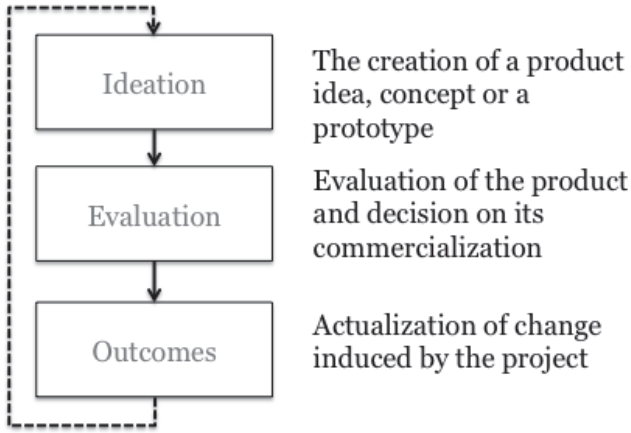


Figure 1: New product development process

Ideation refers to a stage in which the initial product concept and technology is developed. Therefore, this stage consists of concept development and product planning through which product architectures are developed, information of market and technological possibilities is generated and model building and small scale testing is undertaken to understand how the product would function (Clark and Fujimoto 1991; Clark and Wheelwright 1993). Doing this can include both local and boundary spanning search (Rosenkopf and Nerkar 2001) and incorporate both the creation of new knowledge and/or the application of existing knowledge (Iansiti 1998). This stage enables an organization to identify alternative solutions to a problem and share these among the members of the organization (Zott 2003). The goal of this stage is to develop the product concept/prototype into a form which can be evaluated by the management.

Evaluation refers to a stage in which the management assesses the product and decides whether it will be commercialized. As evaluation requires ideas and concepts as its feeding stock, it logically follows ideation. As there can be many more opportunities than a single organization can grasp, evaluating the projects that can possibly be commercialized becomes crucial. In doing so, managers evaluate how to deploy resources to ends they perceive most efficient (Mahoney 1995). In evaluating the feasibility of products, managers evaluate factors in the external environment such as customer needs and competition (Clark and Fujimoto 1991; Cooper and Kleinschmidt 1986; Teece 2007), whereas important factors in the internal environment include reviewing the product itself (Clark and Fujimoto 1991; Cooper and Kleinschmidt 1986) and its role in the product portfolio of the company (Barczak, Griffin and Kahn

2009). Repetitive evaluation activities emerge when they are undertaken multiple times and when they are confronted by market feedback (cf. Zollo and Winter 2002). The goal of effective evaluation is to select products for commercialization that fit both the way in which the organization operates and the demand conditions of the market.

Outcomes refer to a stage in which the product development project is drawn to a close and the developed product is incorporated into the daily activities of the organization. As outcomes require a decision to commercialize a product, this stage logically follows evaluation. This stage can include, for instance, process development to prepare for full-scale production (Adler 1995; Cooper and Kleinschmidt 1986; Pisano 1997), launching the product (di Benedetto 1999), patenting the product to protect proprietary assets (Belenzon and Patacconi 2013; Pisano 1997), learning from the development projects by updating development principles (Clark and Wheelwright 1993) or by altering how certain day-to-day tasks are undertaken (Zollo and Winter 2002) as knowledge is codified and embedded into to the standard modes of operating. Therefore, the category of outcomes refers to the actual implementation of organizational change through the project as the previous stages refer to the ideation and evaluation of possibilities for change. Next I move into defining new product development capability.

2.3 New product development capability

Now that I have provided an introduction to organizational capabilities and new product development, it is timely to proceed into defining new product development capability, which is the focal concept of this study. This is done by first defining new product development capability, after which specific characteristics of the capability will be highlighted in addition to the stages through which the capability is perceived to manifest itself.

2.3.1 Defining new product development capability

There is a large body of research that focuses on the capabilities related to the introduction of new products, services, processes, and business models (Danneels 2002; Galunic and Eisenhardt 2001; Lawson and Samson 2001; Salvato 2009). A central concept in this discussion is innovation capability, which can be defined as the capability to transform ideas and knowledge into new products, processes and systems that benefit the organization (Lawson and Samson 2001). This is often used and measured as analogous to firm innovativeness (Calantone, Cavusgil and Zhao 2002; Cavusgil, Calantone and Zhao 2003). Paralleling the innovation capability concept, some authors have used concepts such as radical innovation capability (O'Connor and DeMartino 2006), new product development capability (Salvato 2009), transnational new prod-

uct development capability (Subramaniam and Venkatraman 2001) and dynamic capability (Eisenhardt and Martin 2000; Teece, Pisano and Shuen 1997) to denote the capability of organization to introduce new products, services, processes or business models into markets.

In this research I focus on new product development capability and by doing so draw attention to the development of new products instead of, for instance, services that the innovation capability includes. Therefore, I follow Salvato (2009) in focusing on the capability of an organization to develop new products. This restricts the study into focusing on new product development, as using the concept of innovation capability concept would include aspects such as introduction of new services I wish the leave beyond the scope of the current inquiry. Specifically, I define new product development capability as the follows:

> *New product development capability is constitutive of the organizational and strategic processes through which an organization develops and commercializes new products.*

I conceptualize new product development capability as a form of dynamic capability, much like Lawson and Samson (2001) define innovation capability as a form of dynamic capability. Therefore, in further defining the concept I will draw extensively from the dynamic capability discourse.

The capability constitutes of exercising recurring activities in different stages of new product development process. These can take the form of routines and/or simple rules. As these two can have overlap and as Bingham and Eisenhardt (2011) have noted that there is still debate whether heuristics are a subset of routines, an explication of the nature of different activities will be made in the empirical part when these recurring activities are examined.

Recurring activities

When explicating activities, I use the term activity and recurring activity interchangeably to denote a category to which routines and simple rules belong to.

A closer explication of the nature of the recurring activities is made when the activities are described in detail in chapter six.

The new product development staff is capable of conducting multiple different activities in different development projects at any given time. Stemming from this, how the capability is utilized depicts what the managers perceive as the most efficient use of the available human resources (Teece 1980; 1982) who conduct such activities. Therefore, examination of these activities on the organization level lends us an understanding of how the organization utilizes the capability for new product development.

The impetus of new product development capability is to enable a company to develop and commercialize new products. The capability can create, extend and modify the operational capabilities of the organization such as production and marketing by providing them with new offerings to produce and market. This follows the notion of Winter (2003) in defining the function of dynamic capabilities as affecting the operational capabilities of the organization.

Utilizing the capability can enable achieving multiple different ends, especially as it can drive an organization towards becoming a multiproduct firm. Utilizing the capability can enable a company to expand beyond its current market to seek faster growth (Teece 1982) or to lower the risk related to a narrow product portfolio. These outcomes can be achieved by utilizing the knowledge base of the company towards new ends as has been suggested by Teece (1980; 1982). This can relate to both using existing knowledge of products or knowledge of how to develop products to new ends. What can drive organizations towards these ends is the profit-seeking nature of managers (Augier and Teece 2009). Therefore, exercising the capability enables the company to seek new profit opportunities through the development of new products.

Locus of the NPD capability is organization at large and resulting from this the organization is able to develop and commercialize new products. Therefore, the capability lies upstream from the end products that are developed (Teece 1982). The capability is actualized by operationalizing NPD process and the associated NPD activities in NPD projects. Building on this, NPD capability is possessed by organization and actualized through the NPD process that manifests in NPD projects where different NPD activities are performed. In doing so, I follow the disciplined problem solving approach to new product development outlined by Brown and Eisenhardt (1995). What the capability enables is the generation of project level outcomes such as product launches and patents that can also have an impact on the future product development activities of the organization. Figure 2 illustrates these relationships.

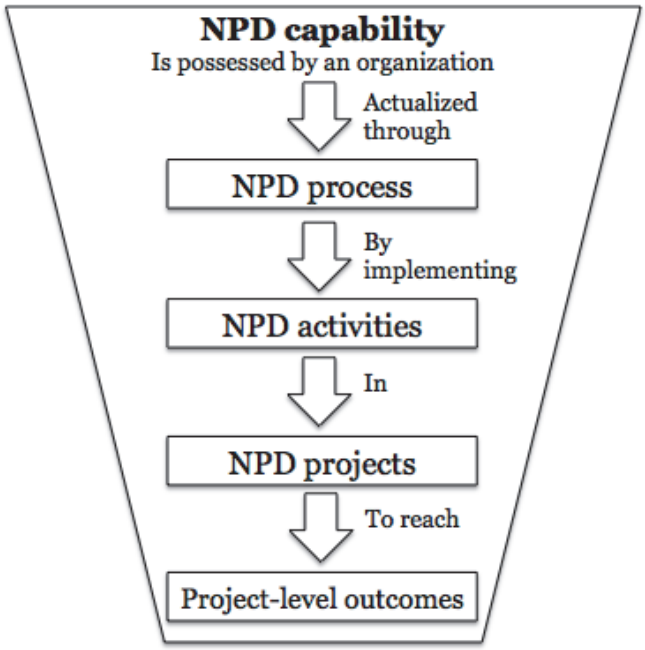


Figure 2: NPD capability and its operation

The definition has a number of facets that I wish to discuss here. Firstly, the definition does not explicitly define whether the products are meant to match current market needs or create change in customer needs. This stems from the notion of Eisenhardt and Martin (2000) that dynamic capabilities can match or even create market change. Thus, I perceive that operationalizing the new product development capability can yield both radical and incremental products.

Secondly, for a company to possess new product development capability, it has to be able to successfully exercise the capability i.e. develop and introduce new products to the market. This stems from the notion that capabilities are expensive to develop (Zollo and Winter 2002) and therefore they have to be successfully exercised in order to be meaningful.

Thirdly, I associate the effect of exercising new product development capability into project-level outcomes such as the introduction of new products. Therefore, I focus on the effects that the capability can generate. In doing so, I primarily focus on whether the capability enables reconfiguration as desired (Zahra, Sapienza and Davidsson 2006) which in this study is associated with the capability to successfully launch new products and whether the capability enables other effects that could enhance future new product development and therefore induce improved effectiveness (Zollo and Winter 2002) and/or generate effects on the resource base of the organization (Helfat et al. 2007). Additionally I do not wish to sideline the effects that new product development can have on the organization itself as, for instance, Schroeder et al. (2000) has highlighted that new products have to be integrated into the organization and that the development of new offerings is often accompanied by the restructuring of the organization.

2.3.2 The process of exercising new product development capability

Earlier ideation, evaluation and outcomes were presented as the phases through which new products can be developed and their effects could be assessed. What they provide is a set of generic development process stages through which new products can be developed that aims to avoid context specificity that characterizes many of the new product development process models. In understanding new product development capability, these phases are taken to be the typical steps through which new products are developed. Therefore, they depict periods of coherent activity that serves some product development function (Van de Ven and Poole 2000).

My intention is to use the aforementioned stages to break down the different phases of new product development that include the initial creation of a product idea, evaluation stage in which the commercialization of the product is decided and outcomes of the project that depict the impact that the project had on the organization. To help in operationalizing these stages in the empirical part of this study, I next outline the purpose that each of the stages have and the kinds of activities that the stages can contain.

Ideation refers to the creation of a product idea, concept or a prototype. Within a single NPD project, ideation includes all the activities aimed at identifying alternative solutions to a problem. Therefore, this stage consists of concept development and product planning that combines information of market and technological possibilities, creation of product architecture, model building and small scale testing to understand how the product would function (Clark and Fujimoto 1991; Clark and Wheelwright 1993). Ideation focuses on creating a plethora of possible options that can be later on subjected to evaluation. As the generation of new ideas increases, the organization develops activities through which it searches for new solutions and opportunities. The activities develop through trial and error, where some activities prove to be effective means of attaining desired outcomes and therefore become recurring.

Operationalization

I use ideation to distinguish the initial stage in NPD in which the organization searches for new possible solutions by utilizing ideation activities. In this stage different NPD activities are conducted and combined to search for new possible alternatives.

Variation between NPD projects depends on the kind of development that the organization aims to accomplish and on the kind of initial conditions from which NPD projects are initiated. This inter-project variation enables the organization to refine how it develops new products (Salvato 2009) and how the ideation activities emerge. Therefore, inter-project variation can enhance ideation activities on the level of single NPD project.

Evaluation refers to the evaluation of the potential of product ideas in part by the management and it can be taken to refer to the actions of the management related to decision-making to commercialize a specific product idea. In doing so, the management approximates the selection criteria of the customers and evaluates the new product idea/concept itself. Based on these criteria the previously created ideas are either discarded or selected for further development and commercialization. As the launch of a new product is largely about fitting the product into the market, evaluation can include evaluation of the market potential, evaluation of the product, or evaluation of risk associated with finalizing and launching a new product.

Operationalization

I use evaluation to distinguish a stage where management evaluates the outcomes of ideation through different evaluation activities. In this stage different evaluation activities are conducted and combined to select appropriate ideas for further development and commercialization.

Recurring evaluation activities emerge as the amount of ideas increase, leading to the development of standard procedures for evaluating ideas and learning from market feedback that the selected ideas generate. Failure to develop efficient evaluation activities can lead into unprofitable investments and suboptimal resource allocation and therefore undermine the whole new product development.

Outcomes refer to a stage in which the development project is drawn to a close and the developed product is incorporated into the daily activities of the organization. In the context of new product development, outcomes includes all the actions that sediment a selected product into the organization's way of operating. This includes, for instance, the launch of a new product that affects operating routines related to production and/or investment into new production equipment to start mass-producing a selected product.

Operationalization

I use outcomes to distinguish a stage where changes induced by the new product are actualized in the organization. In this stage different activities are used to, for instance, incorporate the offering into the offering portfolio of the company, patenting the product or its components, or steer future product development based on the new product.

2.3.3 The role of knowledge in new product development capability

Knowledge as a dimension of new product development capability relates to firms' ability to create, accrue and use knowledge (Lawson and Samson 2001). This has been researched in the field of strategic management under the auspices of absorptive capacity concept (Cohen and Levinthal 1990; Zahra and George 2002), technology integration (Iansiti 1998), search behavior (Nelson and Winter 1982) and through market orientation concept in the field of marketing (e.g. Hurley and Hult 1998; Slater and Narver 1995).

Knowledge can be understood as an asset of an organization that is tied to the human capital, which is not fully specialized and therefore can be directed towards multiple different ends (Teece 1980; 1982). Therefore, previous knowledge of the methods to develop products or directly product related knowledge could be utilized in the development of new products.

With regards to new product development, knowledge relates to the search of new solutions to existing or emerging problems (Nelson and Winter 1982). Knowledge constitutes the content of new product development, as it focuses on the means through which new product ideas and concepts are created. Search can be either local or boundary spanning in nature and relates to whether the search activity is conducted in the existing technology domain of the company or whether it spans beyond it (Rosenkopf and Nerkar 2001).

Local search refers to the search for solutions to problems in the vicinity of current expertise or knowledge (Stuart and Podolny 1996). By engaging in local search, the organizational unit becomes more proficient in its current technological domain and is capable of creating incremental innovations (Rosenkopf and Nerkar 2001). While this activity enables the unit to deepen its knowledge in its current knowledge domain and make use of complementary assets (Helfat 1997), it can also turn into core rigidity as it may inhibit new types of innovations (Leonard-Barton 1992). However, focus only on the search for new opportunities can hinder the organizations' exploitation of existing opportunities and performance in the short run (March 1991).

Boundary spanning search can be described as being a search activity that extends beyond the immediate technological domain of the organizational unit and can be actualized for instance through cooperation with third parties or other units of the organization (Rosenkopf and Nerkar 2001). Discussion on absorptive capacity pertains largely to this domain, as it focuses on acquisition, assimilation, transformation and exploitation of external knowledge (Zahra and George 2002). Spanning the knowledge boundaries of an organizational unit enables it to widen the options that it can choose from and invest in. However, it may simultaneously dilute the strategic consistency of the unit as it is pulled in different directions. This may also result in over-investments into the search of new possibilities.

Knowledge also related to the means through which technological knowledge is integrated into specific product development projects (Iansiti 1998). Specifically, Iansiti (1998) highlights that effective technology integration consists of knowledge generation, knowledge retention and knowledge application. These together depict how new and existing knowledge are combined in specific new product development projects.

New product development embodies the search activities into new offerings through different means. Technological and R&D knowledge have been identified as important forms of knowledge through which new products can be developed (e.g. Rosenkopf and Nerkar 2001; Stuart and Podolny 1996). However, the accumulation and use of customer knowledge has also been stressed as being important (Aspara et al. 2011; Atuahene-Gima 2005). Thus, while technological development opens up possibilities for the creation of new products, linking these to customer needs enables the firm to reap the benefits of technological knowledge. This linking of technological and customer knowledge can occur in various degrees in different development projects (Danneels 2002).

Some studies in the capability discussion have also focused on uncovering knowledge related mechanisms in new product development. For instance, Danneels (2002) conceptualized new product development as a mechanism for integrating technological and customer competences. In the same vein, Zott (2003) highlighted that variation is an activity in which the firm searches for new solutions through imitation and experimentation. Thus, in the mechanism related capability discussion, the role of knowledge in the creation and embodiment of ideas into new products has been acknowledged.

The knowledge dimension of new product development capability relates largely to the ideation stage. Through the creation of new knowledge an organization generates ideas that can be embodied in new products and be subsequently subjected to evaluation and the creation of outcomes. This does not mean that knowledge does not have any role in evaluation and outcomes as substantial amount of new product development relies on previous knowledge (Rosenkopf and Nerkar 2001) and therefore relies on previous product development outcomes. However, knowledge does not singularly explain the new product development capability as decision-making has a definite role as well. This is where I will turn to next.

2.3.4 The role of decision-making in new product development capability

Decision-making relates to managers' decisions to allocate the scarce resources of the organization to certain new product development projects, while leaving other projects without necessary development resources. Resource allocation relates to the managers' decisions to deploy resources to ends that they perceive most efficient (Mahoney 1995). Therefore, managers are inherently profit-seeking (Augier and Teece 2009) in the way in which they approach the development of new products. This profit-seeking motive can direct how the company utilizes its knowledge of making new products towards ends that are perceived to be most efficient (Teece 1982).

While the previously discussed knowledge dimension of new product development capability relates to the creation of alternatives, decision-making relates to the choices the company makes in starting to search for alternatives and taking advantage of them. Therefore, decision-making creates the framework in which search for new opportunities is made. This starts from the initial decision to initiate product development (or to even focus on developing new products), leading to the evaluation of an individual project or the project portfolio as a whole and ultimately to the decision to launch a product and to assign productive resources for making the offering.

If we perceive knowledge as the content and means of new product development (the creation of new alternatives and solutions), decision-making forms the structure of the NPD process by imposing goals and boundaries for the projects. Within these boundaries the search for new alternatives is made with the allocated resources. Therefore, it directs the search activities to optimize the use of available resources. Without efficient decision-making procedures the search for new alternatives might not even crystalize into an offering but rather remain an elusive search for even more options and possible solutions.

While decision-making in new product development might sound like rational decision-making from the outset, they may still contain not-fully-rational behavior that is largely masked from the decision-makers by the unpredictability of new product development (Nelson and Winter 1982) and by that notion that success of the development activities can be judged only after the project has ended (Van de Ven 1986). To counter this, Teece (2007) suggested that in order to avoid bias and delusion different decision-making procedures could be established and that managers should be aware of how they orchestrate assets.

Decision-making also highlights control that the top management has over NPD projects. This enables the management to exert subtle control over NPD projects and direct the projects towards the creation of a distinct product concept (Brown and Eisenhardt 1995) toward which the development team strives.

These activities do not necessarily have to constitute large actions and as Teece (2007) suggests, a sequence of smaller decisions can enable the management to calibrate their decision-making by learning from failures. Decision-making can consist of multiple smaller activities such as step-by-step al-

location of resources for developing new products through phases of evaluating products.

Some studies in the capability discussion have focused on identifying mechanisms related to decision-making. For instance, Tripsas (1997) stressed the importance of resource allocation as a mechanism that defined how well a company is able to deploy resources to match customer needs. In allocating the scarce resources of the organization, Zott (2003) emphasized the importance of selection and retention in evaluating and implementing the best possible alternatives. In addition to these aggregate level mechanisms, Verona and Ravasi (2003) stressed the importance of co-ordination as a mechanism to enhance product development activities. Thus, in the mechanism related capability discussion, decision-making has been acknowledged as a category of mechanisms.

Decision-making relates to all stages of developing new products as managers exert subtle control over the development activities. However, it is most pertinent when managers evaluate the feasibility and commercial potential of products. Following this notion, evaluation in organizational context is perceived to be a decision-making process where the outcomes of ideation are evaluated on the basis of their perceived suitability for the organization. Furthermore, the generation of outcomes is largely a resource allocation decision, as it comprises of actualizing the selected change in the organization. Therefore, decision-making creates a structure for new product development and enables the actualization of search activities.

Now that a working definition for innovation capability has been provided and I have briefly explicated how the capability functions, I can proceed into outlining a theoretical framework for this study through which the capability can be studied.

3. Theoretical framework

At this point I have reviewed literature related to organizational capabilities, new product development and outlined new product development capability as a form of dynamic capability. In this section my goal is to build a theoretical framework that integrates these perspectives and enables the study of the mechanisms that underlie new product development capability.

New product development capability depicts the strategic and organizational processes through which new products are developed and commercialized. The activity of new product development centers on new product development projects i.e., the development of a single product. Therefore, building a theoretical framework concentrates on depicting how an organization is capable of conducting these projects. After understanding how the capability functions on the project level, we can draw broader implications on the functioning of the capability.

Explaining how the capability functions through new product development projects necessitates understanding the recurring activities that animate the new product development projects. Recurring activities such as routines or the use of simple rules can be understood as the base-level components that contribute to the use of a capability. They are utilized in multiple different projects, which enables us to differentiate them from ad hoc problem-solving (Winter 2003). Furthermore, they can be constitutive of both organizational and managerial activities. As outlined earlier, these recurring activities rarely function alone but in conjunction with other activities. Therefore, these represent the activities that contribute to the exercise of a capability.

Mechanisms can be situated between the recurring activities and the capability itself. They depict specific actions of actors that connect initial conditions to outcomes (Hedström and Swedberg 1998). In this study mechanisms are used to depict how recurring activities are combined together to reach certain outcomes. The mechanisms in themselves depict the component processes of the larger system, as has been suggested by Stinchcombe (1991). Mechanisms, therefore, depict the component processes of the new product development process that together give rise to the capability.

These considerations lead us to understand the relations between the main concepts in the following way. Recurring activities are base-level constitutive elements of the new product development capability. When the recurring activities are combined together to reach a certain outcomes in a specific stage of new product development process, they can be understood to constitute mech-

anisms. Mechanisms therefore explain the component processes of how the capability functions. The mechanisms together enable explaining the capability as each of the mechanisms provide a depiction of a component process of utilizing the capability. How the mechanisms function together enables us to understand how the capability is actualized on the level of new product development project and also on the level of the organization.

To understand what kind of mechanisms underlie the capability to develop new products, we have to deconstruct the process through which new products are developed. In doing so, I utilize the three stages presented earlier to depict typical stages of new product development. These stages were ideation, evaluation and outcomes. Each of these stages relate to a specific kind of problem solving activity and follows the discipline problem solving approach of Brown and Eisenhardt (1998). Subsequently, I associate the mechanisms related to the search for new product ideas and solutions to ideation, the mechanisms related to the evaluation and the selection of ideas for evaluation and the mechanisms that depict how the selected variants diffuse into the organization to outcomes. These together cover the process of developing a single product from idea into a ready product.

Understanding the mechanisms of each of the stages can enable us to understand how the new product development capability functions to enable a company to develop and commercialize new products. Therefore, understanding the mechanisms should enable us to abstractly reproduce the phenomenon that is being explained (Schelling 1998) i.e., how the new product development capability functions through the associated mechanisms in new product development projects.

Based on this discussion, I now outline a research framework that is presented in figure 3. In the framework recurring NPD activities are treated as the base-level recurring activities of new product development. When these activities are combined together to reach certain outcomes in specific stage of new product development, they are treated as mechanisms. These mechanisms together constitute new product development projects. Understanding how the mechanisms combine together enables us to understand how the new product development capability is actualized through the associated mechanisms on the project level.

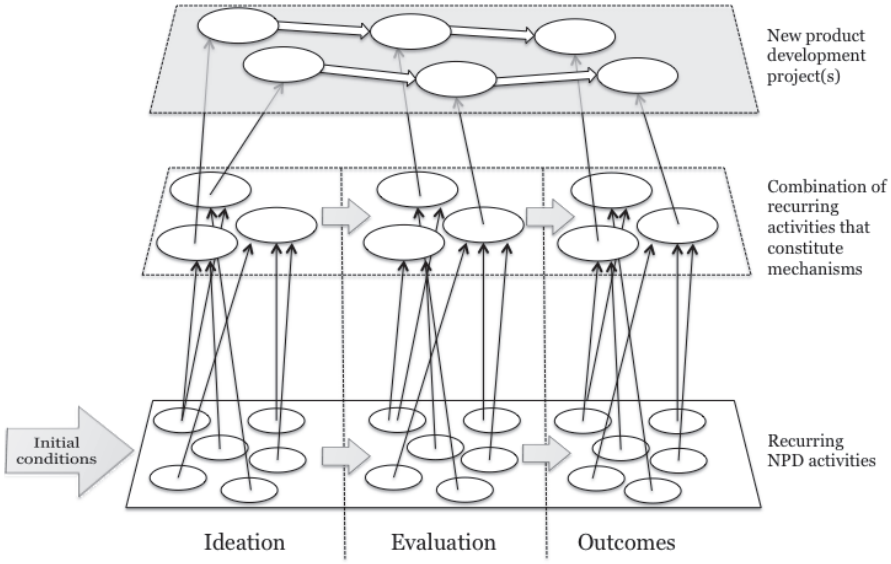


Figure 3: Theoretical framework

On the base level of the framework are recurring NPD activities. When these activities are combined together to perform a new product development stage, they together formulate mechanisms. A single mechanism explains how a stage in new product development process is conducted from the initial conditions into an outcome. Depending on the activities, there can be multiple different mechanisms pertinent to each of the stages, which depend on the way in which the recurring activities are combined together. The mechanisms can also be fungible, as Eisenhardt and Martin (2000) have suggested that a component of a capability can be replaced by another component and it can still lead to the same outcome.

For a new product development project to start there have to be some kind of initial conditions. These can be, for instance, a shock or a proliferation of existing idea or an existing project that sets a separate project into motion, as suggested by Schroeder et al., (2000). After the project is set into motion, a combination of ideation, evaluation and outcome mechanisms depict how the project is carried from the beginning into an end.

These mechanisms together can explain how the new product development capability functions on the new product development project level. Therefore, the new product development capability is perceived to be an abstract category that explains how an organization develops new products through NPD projects. Thus, it is through postulating and examining the mechanisms that I wish to understand how the capability functions. This project-level understanding can thereafter be used to understand how the projects affect each other and the product development activities overall. Ultimately this provides grounds to understand how the projects and their interaction change the organization.

In operationalizing this framework, product development projects are the primary unit of analysis. Within the projects, different recurring NPD activities are conducted. By understanding how the activities function together in a project during the ideation, evaluation and outcome stages, it is possible to postulate mechanisms that depict different stages of the development project. This enables us to understand the NPD projects through the mechanisms that they contain. By understanding the projects, it is also possible to examine how the projects together change the organization and its new product development activities.

This gives us an ample starting point for empirically studying mechanisms related to the new product development capability. However, before proceeding into the empirical part of this study, I will outline the procedure through which the theoretical framework will be operationalized in the empirical part.

4. Methodology

The foregoing discussion has laid out a theoretical basis for understanding new product development capability. The next step is to explicate a methodology that enables operationalizing the study. This is preceded by a discussion on the epistemological and ontological assumptions of this study. This is then followed by a discussion on the methodological choices. The final part then depicts how these methodological tools are employed in the empirical field study.

Broadly this research follows a historical approach. However, history is merely a direction and therefore my intention is to further explicate how historical approach will be used in this study. However, historical approach directs the researcher towards historical narrative as a starting point for describing how events have occurred. Therefore, my first goal is to outline how historical narratives are written and what they usually consist of.

When moving beyond a narrative account of historical events, more formalized methods will be used. These will enable me to get closer to postulating mechanisms that function in new product development projects. This will be done by using three methods of analysis. First, the initial historical narrative will be formalized using event structure analysis (ESA) that enables the systematic analysis of the historical narrative (Heise 1989). This will enable me to explicate the main events and their relations that can be compared. Subsequently, the NPD projects, which are the primary unit of analysis, will be separately analyzed by using case study (e.g. Eisenhardt 1989; Yin 2003) and process research methods (Langley 1999; Pentland 1999) to disseminate projects into phases and to uncover recurring activities. Next, I outline qualitative comparative analysis (Ragin 1989) as a method for understanding how different activities are combined with each other during NPD projects. Finally, I provide a description of the procedure through which I operationalized the use of the approach and the analysis methods.

At the beginning of the methodology section, it is necessary to also discuss the generalizability of the findings that the chosen approach can yield. What this kind of a case-oriented comparative study enables is limited historical generalization (Ragin 1989) and analytical generalization (Yin 2003). Limited historical generalization refers to a modest generalization of the historical origins and outcomes of a narrow phenomenon (Ragin 1989). Thus, with caution, the findings can be applied to other cases that share reasonable number of similar characteristics to the one under study (Berg-Schlosser et al. 2009).

With regards to the theoretical domain, the methodology provides possibilities for analytical generalization – generalization from empirical observation to theory (Yin 2003). From a critical realist perspective this enables the theoretization of deep structures behind the events (Danermark et al. 2002). Therefore, the goal is the development and refinement of the concept of new product development capability through empirical investigation.

4.1 Underlying ontological and epistemological assumptions

In approaching ontological and epistemological questions, this study draws primarily from critical realism. A central tenet of critical realism is that a world independent of our knowledge of it and of scientific inquiry exists (Bhaskar 2008; Sayer 2010). Stemming from this, reality is understood as being stratified. Following Bhaskar (2008), reality can be stratified into three domains: the real, the actual and the empirical. This enables us to explain how and in which domain causal powers, events and experiences take place (see Figure 4).

	Domain of Real	Domain of Actual	Domain of Empirical
Causal powers	✓		
Events	✓	✓	
Experiences	✓	✓	✓

Figure 4: Stratification of reality (adapted from Bhaskar 2008, p. 56)

The stratification of reality implies the separation of what can be empirically investigated, what actually occurs and what really is behind the occurrences (the causal powers). The domain of the empirical is where observations can be made (Easton 2010). This is the stratification that scientific activity is confined to. As it does not directly correspond with what actually happens, scientific change is made intelligible and scientific progress becomes possible (Bhaskar 2008). The domain of the actual is where events are situated. These events are categorically different from experiences, as events can occur without any experience of them (Bhaskar 2008; Steinmetz 1998). The domain of the actual is the domain where causal powers coincide to generate actual events. However, events occur as a result of causal powers that operate in the domain of real (Easton 2010). The domain of real is where we can posit the existence of causal powers (Bhaskar 2008). This is the domain where real powers exist, as they are not the events that they generate and therefore they have to be treated separately (ibid.). Therefore, the domain of real is understood as being the backdrop through which reality unfolds.

In order to make science possible, the independent existence of the social objects and the pre-interpreted reality can be claimed to be science independent,

as it does not suppose the existence of science (e.g. Bhaskar 1998; Mäki 2012). Therefore, it is possible to treat social objects as distinct from scientific ones. This enables the separation of these two types of objects and the treatment of social objects as science independent (existence without science to reveal them).

However, there are ontological limitations to treating social and natural sciences as equal. These relate closely to the objects of inquiry, which in natural sciences are the causal powers of natural objects and in social sciences the structures of society and of social objects (Fleetwood 2004; Bhaskar 1998). These limits of naturalism according to Bhaskar (1998, p. 38) are:

1) Social structures do not exist independently of the activities that they govern.
2) Social structures do not exist independently of the agent's perception of what the social structures in themselves are doing.
3) Social structures may only be relatively enduring in their existence.

These ontological limitations can be understood to govern the existence, powers and reproduction of social structures that possess powers. Therefore, social structures have to exist for a purpose (as stated in point one), which means that they have to have intentionality built in them. In order for such structures to govern activities, agents have to be (at least tacitly) aware of them and therefore abide to the powers imposed by them (as stated in point two). However, these structures only exist as long as the agents perceive them as governing their activities (as stated in point two). Finally, structures are reproduced and changed through the actions of the agents. Therefore, the role of an agent is both to produce structures as well as to change them. The actor is therefore not an automaton mindlessly reproducing the structures but an active agent. The aforementioned result in the third point.

The objects of knowledge that we try to understand are the powers of social objects that create phenomena (Bhaskar 2008). This differs from empiricism, which perceives the objects of knowledge as being the events and invariances. The central point of difference is therefore that critical realists focus on objects and their powers and not simply events and their relations as empiricists would. This differs also from transcendental idealism in the sense that the structures and mechanisms are perceived to be real and to function independently of our knowledge of them (Bhaskar 2008). Therefore, our explanations of powers of objects can be compared and contrasted to seek correspondence with what happened.

Objects, structures and powers

Objects are things or states of the world that are capable of creating some kind of outcomes. These outcomes are generated by the powers that rise from the structures of the objects.

To bridge the epistemic and ontic domains, critical realism utilizes the distinction between transitive and intransitive objects of knowledge (Bhaskar 2008). This can be explained by relating the intransitive objects of knowledge

to the reality of being or the ontological dimension and, on the other hand, relating our knowledge of the intransitive objects into the epistemic or transitive dimension (Al-Amoudi and Willmott 2011; Bhaskar 2008). This distinction enables statements about being to be referred to as rising from the intransitive objects of knowledge (Al-Amoudi and Willmott 2011).

Intransitive objects possess causal powers that lead to outcomes (Bhaskar 2008). In social sciences, these are perceived as being real due to the notion that that they are not constituted only in our actions but also as the structures that govern them. Thus we can have independent intransitive objects of knowledge in social sciences within the limits of naturalism identified earlier (Bhaskar 1998).

Transitive objects of knowledge are the objects through which we make intransitive objects intelligible to us (Bhaskar 2008). These objects are intersubjective as their meaning is established in relation to other people in society (Sayer 2010). Furthermore, these objects of knowledge are ascribed meanings in relation to real objects but also in relation to other concepts in the domain of language (ibid.). Therefore, in order for one to be a landlord, one has to have the material property and a tenant to occupy it (to use a classic example). The concept of landlord does therefore require the existence of a material arrangement and the concept of tenant. Also, this meaning has to be shared by the participants of such arrangement.

Making and conceptualizing

When in this study I talk of capabilities and mechanisms, I do not refer to them as being real but as conceptualizations. Therefore, capabilities and mechanisms are means through which I try to make sense of the new product development of an organization rather than something being something concrete and real.

To uphold the distinction between intransitive and transitive objects of knowledge, we have to avoid conflating terminology related to making with conceptualizing (Fleetwood 2005). While making relates to creating or constructing something, conceptualizing relates to the making sense of, interpreting or comprehending. Therefore, science does not make the world but conceptualizes it. This means that social phenomena are concept dependent, i.e. made sense of through our concepts but the concepts themselves do not create the phenomena (Sayer 2010).

In terms of knowledge creation, critical realism posits two kinds of systems (open and closed). On one hand, closed systems are artificially closed systems established under experimental conditions where the goal is to isolate causal powers (Bhaskar 2008). This represents an attempt to conflate the empirical and the actual. On the other hand, open systems are systems of the actual that are not restrained by experimental conditions (Bhaskar 1998).

Attaining a closed system in social sciences provides many challenges as living objects also have internal structures and complexity that affect how they act and which inherently affects the external conditions (Bhaskar 2008). The controlling of internal and external states is further complicated when elements of organization are brought into the picture, because in order for them

to enable a closed system we have to assume constant organizations or organization as a constituent of its components (organization as explained by the behavior of its components) (Bhaskar 2008). This is not possible when dealing with complex social systems.

Now that we have explored the epistemological and ontological foundations of this study, we can move into depicting the central area of interest of this study – mechanisms.

4.1.1 Mechanisms and their components

Building on the previous discussion, mechanisms are the way through which I aim to understand the powers of objects, be they social or natural. Therefore, mechanism is an (transitive) explanation of how a power connects an initial state into an outcome. This kind of explanatory perspective to mechanisms is upheld by: 1) Stinchcombe (1991) who states that a mechanism is a piece of theory explaining a component process of a larger system, 2) Hedström and Swedberg (1998) who note that mechanisms describe specific actions of actors that connect initial conditions to outcomes, and 3) by Schelling (1998) who defines mechanism as an interpretation of a model that abstractly reproduces the phenomenon that is being explained.

A mechanism can be conceptualized as a process, which means that it describes a movement from initial conditions to an outcome (Bunge 2004; Danermark et al. 2002; Steel 2004). Therefore, when building an explanation, there should be a clear beginning and an end for the functioning of the mechanism. As described by Pajunen (2008), a mechanism should produce something. This being said, the functioning of a mechanism can be intervened by countervailing forces that nullify its effect. Thus, when two similar mechanisms produce different outcomes one has to search beyond the immediate mechanism and look for intervening forces.

Between the initial conditions and the outcome, three common components can be identified that animate the mechanism. These are: 1) entities, 2) activities and 3) structures. This broadly follows the approach advocated by Pajunen (2008) and numerous other authors who have used one or more of these components to denote what a mechanism constitutes of (Danermark et al. 2002; Hedström and Swedberg 1998; Steel 2004).

In this research I use the term entity to denote the actor that does the acting within an object (Pajunen 2008; Steel 2004). Similar definitions to this one are causal agents advocated by Bhaskar (1998) and actor used by Hedström and Swedberg (1998). Entities are the basic building blocks of mechanisms and can be conceived as the actants within objects (Pajunen 2008) that act within structures to generate outcomes. In social sciences these elementary entities are individuals (Hedström and Swedberg 1998) or groups of individuals acting together. These entities individually or in groups make things happen within objects such as organizations.

Activities are the actions and procedures that entities conduct. In order to understand mechanisms, we have to understand the activities of the entities that ultimately constitute mechanisms. By uncovering the activities that link together different states or events, we are capable of postulating mechanisms (Hedström and Swedberg 1998). Thus, to understand how a mechanism could function, we have to understand how actions result into specific outcomes solely or in conjunction with each other.

While entities are the basic building blocks of mechanisms, they act within structures that guide their action (Bhaskar 1998) and activities mediate this interrelationship. Structures do not exist *an sich* but rather they are produced and reproduced through action (Bhaskar 1998; Sayer 2010). Therefore, actions produce conditions for their reproduction that can be conceived as structures. This does not, however, mean that people are passive automata that keep on reproducing structures, but rather that through action they have the possibility to alter them (Sayer 2010). This augments the structuralist perspectives by giving power to the entities and their skills in acting (Sayer 2010). Therefore, it is the entities that do the acting, not the structures that direct them. Still what is noteworthy here is that the structures have to be perceived by the entities and they have to relate to the conducted activities. Structure can be understood by uncovering factors that drive the reproduction of activities of entities.

Now that we have underlined the main components of a mechanism, we can move to a discussion of mechanisms within objects. While objects have powers, they do not automatically operate but rather they have to be triggered (Danermark et al. 2002). Therefore, some kind of initial conditions are required from which the power starts to function from. A power also has to result into some kind of outcome. Between the initial conditions and the outcome lies the gist of the power which can be understood as a process that links together different states between the initial conditions and the outcome (Bunge 2004) that can be conceptualized to be internal or necessary relations. This process comes to life through the activities of entities that act within structures.

As there can be multiple powers that operate simultaneously within an object, the outcome of a power can be cancelled by a countervailing power (Danermark et al. 2002). Therefore, in the flux of the domain of actual, events are conjunctures of all the powers operating simultaneously in a system (Bhaskar 2008). This leads us to a notion that while we would not be able to observe the outcome of a power, it does not mean that the power does not exist. For example, while an organization would be able to open a new retail outlet to extend its fleet of retail outlets (potentially a power for replication), management might decide not to do so and therefore counteract the activation of this casual power. A power can also operate without us knowing of their operation (Bhaskar 2008). For example, an organization can develop a new product but never commercialize it, which conceals the effect of the power. Thus, the recurrence of outcomes does not tell much about the power(s) themselves. Therefore, we can conclude that the existence of a power does not depend on the outcomes it generates, while the creation of outcomes is in the nature of a power. Now that a broad understanding 0f the nature of mechanisms has been

provided, we can proceed into depicting how to build mechanisms explanations.

4.2 Production of mechanism explanations

Now that I have outlined the nature of mechanisms and the components of which mechanisms are constituted of, we can proceed to depicting how to produce explanations of them. Thus, we proceed towards the methodological procedure utilized in this study. In doing so, I broadly follow the suggestions of Bhaskar (2008) and Danermark et al. (2002) for building a mechanism explanation. The aforementioned authors have distinguished altogether six steps for building a mechanism explanation. These are: 1) description, 2) analytical resolution, 3) abduction/ theoretical redescription, 4) retroduction, 5) comparison between different theories and abstractions and 6) concretization and contextualization. This process enables the researcher to move from concrete to abstract and back into concrete in order to explain phenomena (Sayer 2010).

The first stage of building an explanation is description (Danermark et al. 2002). In this stage the events under study are described using ordinary language (ibid.). Therefore, the processes are described as closely as possible to provide a rich and detailed description of the events that transpired. This lays the grounding for further analyses and builds an overall understanding of the phenomena under study.

The second stage consists of analytical resolution of the events into their components (Bhaskar 2008). This enables the researcher to dissolve the larger whole into specific dimensions that are then subjected to study. By doing so, we can focus on certain dimensions that are deemed important for building an explanation of the phenomena under study, which in this research are the entities and their activities within organization.

The third stage consists of abduction/theoretical description (Danermark et al. 2002). This stage consists of redescribing the previously identified components through theory. This enables the research to bring into bear the theoretical grounding for each of the identified components. For instance, in the present study many of the new product development activities such as collaboration with third parties had received attention in extant literature and therefore enabled good theoretical description of the component.

The fourth stage consists of retroduction (Danermark et al. 2002). The goal of this stage is to define how the previously identified and redescribed factors generate the outcomes. Therefore, the stage concentrates on finding the central components that have generated the outcomes (Bhaskar 2008). Identification of these factors lets us postulate mechanisms and their central components.

The fifth stage consists of comparison between different theories and abstractions (Danermark et al. 2002). This stage involves comparing how different theories are capable of explaining the postulated mechanisms. This leads to an

analysis of how the employed theories are capable of explaining the phenomena in question.

Finally, the sixth stage consists of contextualization and concretization (Danermark et al. 2002). In this stage the identified mechanism are examined in concrete situations to define how they interact with other mechanisms and can explain actual phenomena. The goal of this stage is to interpret the meaning of different mechanisms in their context and secondly to contribute to explaining concrete events and processes (Danermark et al. 2002). Thus, the stage gauges the applicability and implications of the mechanisms.

To get and overview how this process is conducted in this study, table 3 describes this process and complements it with the analytical procedures that are used to accomplish each of the stages of the process. The first five steps are essential for the methodology of this study in how different analytical procedures are employed in each of the stages. The sixth and last stage pertains to the contextualization of the postulated mechanisms to understand how they function to produce change in an organization and its new product development. The table should give the reader an overview of how the research operationalizes different methods to desired ends.

Table 3: Implementation of the mechanism analysis

The process of building an explanation		Empirical operationalization	Section of the study
Stage 1	**Description**	**Production of a historical narrative**	**Chapter 5: Historical narrative**
	Description of the events that had taken place	Building a historical narrative that describes main events and their relations	
Stage 2	**Analytical resolution**	**Event structure analysis**	**Chapter 6: Analyses of NPD projects and the recurring activities**
	Dissolution of the complex structure into its components	Dissolving the historical narrative into NPD projects and factors that influence them	
		Dissolution of NPD projects into phases	
		Dissolving each NPD project into ideatio , evaluation and outcome stage	
		Identification of the main actions through NPD case	
		Depicting the actions that have been undertaken in each stage of the NPD process	
Stage 3	**abduction/ theoretical redescription**	**Redescription of the main actions through theory**	**Chapter 6: Analyses of NPD projects and the recurring activities**
	Redescription of the causal components through theory	Redescription of the main actions and identifying their theoretical grounding from literature	
Stage 4	**Retroduction**	**Qualitative comparative analysis**	**Chapter 7: Postulating mechanisms**
	Defining which causal components create the outcomes	Finding configurations of central causal components that can explain a mechanism	
Stage 5	**Comparison between different theories and abstractions**	**Theoretical grounding of the different mechanisms**	**Chapter 7: Postulating mechanisms**
	Comparison of how different theories can explain the phenomena under	The different mechanisms that have been identified are reflected through extant theorizing related to capabilities	
Stage 6	**Concretization and contextualization**	**Discussion on the new product development capability**	**Chapter 8: Understanding new product development capability on the project level**
	Examination of mechanisms interact in their context and enable explaining phenomena	Discussion of how the mechanims constitute the new product development capability	**Chapter 9: Understanding new product development capability on the aggregate level**

Now that an overview of the methodological procedure has been provided, we can proceed into explicating how each of the steps is to be done.

4.3 An argument for historical approach

> "Here, on the contrary, we shall preserve the broadest interpretation of the word "history". The word places no *a priori* prohibitions in the path of inquiry, which may turn at will towards either the individual or the social, towards momentary convulsions or the most lasting developments." (Bloch 1953 p. 20, italics in original)

Following the notion of Bloch, historical approach in this research is used as an umbrella term that directs the researcher's attention to the past. As Witkowski and Jones (2006) also note, history refers more to a subject than a specific method. Therefore, historical approach in this research is used to guide the empirical research that focuses on past events. From this broad perspective of what history is, my aim is to explicate the way in which I intend to approach it.

One could question the relevance of history for a contemporary scholar and ask what does looking into past help us in understanding the problems of the present? Hegel (1837/1997) provides an ample answer to this by noting that reflection of the past always belongs in the present, as it is only through the present that we try to understand the past. This echoes also of Bhaskar (2008) who separated the intransitive and transitive objects of knowledge and of Sayer (2010) who notes that we interpret past through the present. Therefore, while we may focus on past, our interpretation is always aligned to the present.

There are multiple ways to approach history from the postmodern perspective of Hayden White (Iggers 1997) to the more realist approach of Edward Hallett Carr (1961). In this inquiry I broadly follow the realist approach of Carr (1961) who noted that everything that happens has a cause and that the job of a researcher is to find causes for the occurrences of the world that can then be used to explain other occurrences across time. While this may sound a grandiose task, a historical inquiry is always a perspective to the events that have occurred, as we can never fully know what has happened nor is it worthwhile to be written out. This does not make the student of the past inferior to the students of the present, as we can never fully perceive an event (Bloch 1953; see also Bhaskar 2008). Focusing only on the events that serve the purpose of building an explanation provides a reasonable grounding, as what we write out can never fully represent what has happened. Still, the goal of a historian is to produce an accurate description of the phenomena on the basis of careful evaluation of all the relevant and available material (Golder 2000).

From a critical realist perspective, history is the mean through which we try to understand the world. As Bhaskar (1998 p. 46) has noted, the development of theories must be explanatory and non-predictive (explaining past events). This suggestion to focus on history stems from the notion that contingent mechanisms are locked into place by the flux of the present, leading to the past. Therefore, in history we can find a partially closed system. To understand this, we can separate time into three states that are the past, the present and the future. Their interrelationship is well explained by Gaddis (2002):

> "Their interrelation functions in a way that present transforms the future by locking in together continuities and contingencies that are fluid and decoupled on the side of future and locked in to each other in the past. This continuum functions much in the similar way as a zipper that constantly zips two parts together but can never unzip them." (p. 30)

Therefore, the past can provide us with a partially closed system, as the open system of future is interlocked into stable past through the present. This provides us with two main ramifications for social sciences. First, as the future is interlocked into the stable past with set relations, our knowledge of the past cannot be used to predict the future as there the relations still are just forming. Therefore, social science cannot be predictive of the future but only explanatory of the past. Secondly, the past is the only place where we can find stable intransitive objects of knowledge as the actions and structures of organizations have been locked in place by time. To continue from the critical realist standpoint, past provides us a context where actual relations between events are stable and where causes and mechanisms can be mapped. Historical approach, therefore, gives us a stable domain of actual as events are interlocked together by time. How well we can understand these events depends on how we experience the events or in this case how we try to construe the events through historical field studies.

Partially closed past

When keeping in mind that the past can provide us with a partially closed system, I limited the empirical inquiry solely to archival material that provided me with the intransitive objects that I studied. The understanding that is generated from this material is of course transitive and dependent the on the means through which the intransitive dimension is examined.

Now after this brief argument for the use of history as an approach, I move to depict how the historical inquiry is constructed in this research. As a starting point I will next turn to historical narrative from which the empirical inquiry begins.

4.4 Historical narrative as a starting point

When the focus of a study is on the past, historical narratives can provide us accounts of past events, be they written or oral. This provides us with the first step in building a mechanisms explanation i.e., a description of the events that have taken place. Historical narratives are a mean of making sense of history by positing a beginning, middle and an end to the events (Gaddis 2002). Especially in an organizational context, narratives provide means through which sequences of events that connect causes to effects can be understood (Pentland 1999). A narrative enables the researcher to make sense and construct meaningful wholes of the events that have occurred. They also enable the researcher

to uncover historical periods and their influences (Savitt 1980) on a broader scale. Furthermore, a narrative is also a common way of presenting findings in historical research (Witkowski and Jones 2006). The role of historical narrative is therefore in a sense dualistic as it mediates between a chronicle that consists of the temporal ordering of events and interpretation of these events through a narrative that directs our attention to the events that are perceived as being central (Staloff 1995).

While historical narratives usually move forward, their preparation moves backwards (Gaddis 2002). This stems from the notion that writing a historical narrative usually starts from an outcome and then traces its antecedents. This enables the building of meaningful explanations for occurrences and outcomes. Therefore, the goal of a historical narrative is to depict the processes through which a certain outcome occurred.

The way in which historical narratives are written can differ substantially. In this study my intention is to produce a narration of events in a time sequence that can act as grounding for further analysis, especially event structure analysis (Heise 1989). Therefore, I explicate the main events in the light of available evidence in the historical narrative section.

When historical narratives are used as research data, understanding the temporal sequencing of events as well as depicting the main events and their relation is essential. Understanding historical events, processes and their relations enables the researcher to decide which events are central in building an explanation and which can be seen as peripheral. This can guide the writing of a historical narrative and direct the researcher to focus on events that can be deemed central.

In writing a historical narrative and further analyzing it, my aim is to try to find a midway solution between the construct oriented perspective purported by Eisenhardt (1989) and the narrative driven perspective of Dyer and Wilkins (1991). I doing so, I follow the suggestions of Pentland (1999) and formulate the narrative by focusing on focal actors (entities doing the acting), sequences of events (actions of entities and relations between the entities and actions) and narrative voice (providing a point-of-view to the narrative). Therefore, the narrative consists of the interplay of the aforementioned aspects.

Finally, comparison is a central facet of historical research (Savitt 1980). Without comparison we are unable to see and understand differences. Groundwork for comparison can be done by organizing the data according to subject areas (Golder 2000), periodization of the historical narrative (Witkowski and Jones 2006) or producing micro-level narratives of momentary events. This enables the researcher to zoom in on a certain instance (Gaddis 2002) and to understand similarities and differences between instances that can be separated by time and space (Savitt 1980). The events can then formally analyzed to highlight what kind of events happened and how they contributed to certain outcomes. Therefore, my aim is to provide for a larger overarching narrative of the events and closer descriptions of NPD projects to enable comparison.

Historical narrative can give us an overarching picture of what has happened on a large scale as well as on the level of momentary occurrences. However,

next I shall move to depict how these narratives can be formally analyzed to postulate mechanisms from them.

4.5 Formalization of historical narratives through event structure analysis

As already noted, a historical narrative can provide a chronological account of events that have occurred. While a narrative provides a chronological account of the events, it still does not directly provide us with an explanation. Therefore, historical narratives have to be further analyzed by using a more formal method to connect events and instances to each other and to provide grounding for mechanism explanations. This enables beginning to address the stage two of building an explanation, which focuses on analytical resolution of the events.

In this study, I use event structure analysis (ESA) associated with the computer program ETHNO to formally uncover relations between events and states (Corsano and Heise 1990; Heise 1989) and thus proceed towards postulating mechanisms. The procedure has been previously used by Pajunen (2004) in uncovering mechanism related to organizational decline and turnaround processes and by Griffin (1993) in depicting the causal process that led to a lynching in Alabama in the 1930s. In these studies the method has proved to be a valuable tool in depicting causal processes and the relations between events.

In practice ESA forces the researcher to transform the historical narrative into a series of events and then answer a series of yes/no questions in order to find out if any of the previous events are required for the occurrence of the present event. ESA is very suitable for analyzing long and complex event sequences as it enables the researcher to systematically analyze the relations between events by using a computer assisted procedure. Overall, in this stage the historical narrative is dissolved into NPD projects and factors that influence them. Specifically, the analysis was done by using an online computer program ETHNO (http://www.indiana.edu/~socpsy/ ESA/home.html). To understand how the procedure functions, I will next provide a brief description of it.

First, the researcher constructs a raw narrative of the events that have occurred. The narrative is then disseminated into a series of chronological events. This chronology of events is the initial input into the ETHNO program with which it will be analyzed by the researcher.

There are a number of central assumptions for using the ETHNO program that have been outlined by Heise and colleagues (Corsano and Heise 1990; Heise 1989) that I also wish to sketch out here. Firstly, the program assumes a production system approach, where actions are governed by simple if-then rules. Therefore, if certain conditions arise, then a production has to occur. Secondly, ETHNO assumes event-event relations, which means that events lead to subsequent events. Thirdly, the program assumes priming of events,

which means that an event remains latent until all of its preconditions have been fulfilled. After this the event activates. Fourthly, the program assumes depletion of event. This refers to the notion that an event has to end before it can lead to a new event (event depletes before the next event begins). Therefore, a single event cannot perpetually generate new events. Finally, the program assumes that event structures are acyclical without loops. Therefore, an event in a pair of events has to end before the next event can begin and the first event cannot be activated again before the latter event has ended.

By using the ETHNO program, events are reshaped through a series of questions about the connection between the actions and events. Specifically, the questions that are asked take the form of 'Does X require Y or a similar action?' At this point one must note that it is not the program doing the analysis but the researcher from whom the program asks questions of the relations between events in a structured manner. Therefore, the main advantage of the program is the systematic questioning of the relations between events. It also forces the researcher to endeavor into counterfactual thinking (Durand and Vaara 2009; Gaddis 2002) as it forces the researcher to ask whether an event would have occurred without the occurrence of all the prerequisite events.

The ETHNO program generates an illustration that connects events to each other based on the answers of the researcher. When this is arranged into a historical sequence depicting different domains of action, we can see the researchers interpretation of the connections between different events. Thus, the historical narrative is transformed into a form that depicts the relations between events.

While it is possible to produce a general level coding scheme with the ETHNO program, the large number of new product development cases constrains this procedure. Therefore, in this research ETHNO is used for the following purposes:

1) Disseminating the company history into its components
2) Uncovering internal influences to NPD projects
3) Uncovering external influences to NPD projects
4) Identifying initial ideas/starting points for specific NPD projects
5) Identifying outcomes/end states of NPD projects

The activities related to ideation, evaluation and outcomes occur between these nodes of action. Uncovering these activities is done by conducting more in-depth analyses of the events and influences that were present in each of the NPD projects.

4.6 Uncovering recurring activities in NPD projects

While ETHNO provides an overarching picture of the events that have taken place and it can be used to pinpoint turning points in a NPD project, a closer analysis of the stages of NPD projects is necessary in order to uncover NPD activities and the underlying structures behind them. This enables proceeding in the second stage of building a mechanism explanation. Conducting this procedure is further emphasized by the notion that routines are many times codified in the documentation of the organization which are left outside the scope of the event structure analysis. For doing this I draw from both case study (e.g. Eisenhardt 1989; Stake 1995; Yin 2003) and process research methods (Langley 1999; Pentland 1999) to uncover routines in different stages of the NPD projects.

Firstly, the three stages of ideation, evaluation and outcomes are taken as the typical patterns of events that explain the surface patterns of events (Pentland 1999). This enables decomposing each NPD project in three smaller mini cases of ideation, evaluation and outcomes. The procedure follows the suggestion of Eisenhardt (1989) in forming mini cases out of larger cases that can then be then analyzed separately.

Secondly, within each of the three categories I can then more closely pinpoint entities, activities and structures that bind the entities and activities together. This leads us to understand the components that may contribute to the functioning of a mechanism. Identification of the main actors enables understanding of when different entities participate in new product development as well as what is their role in the NPD project. By extending this analysis with the identification of activities, it is possible to understand how different entities contribute into new product development. Finally, rising from the nature of entities and their activities, I can uncover structures that govern new product development. By following this procedure for each of the projects, mini cases of ideation, evaluation and outcomes for each NPD project can be constructed.

Thirdly, when each case has been analyzed separately, between-case analysis becomes possible (Eisenhardt & Graebner, 2007). Through this procedure it is possible uncover recurring and predictable patters of behavior in the firm *vis-à-vis* structures. This is further supplemented by an analysis of the codification of activities in the internal documentation of the organization that can strengthen the argument for the existence of the specific activities in question. Therefore, this procedure gives us a roadmap of 1) the activities that the organization exercises in new product development and 2) which activities are used in specific projects.

Understanding the specific activities gives grounds for theoretical redescription of the activities made in step 3. Whilst this has been done, we can proceed into retroduction i.e. defining which components could create the outcome. The next subsection explains the procedure used for this analysis.

4.7 From recurring activities to mechanisms

While case analyses can provide an understanding of the recurring activities, a closer examination of the activities and their role in the NPD projects will be made by using qualitative comparative analysis (referred to as QCA from here onwards) that enables comparison between cases (Ragin 1989). This is a procedure suggested by Pajunen (2005) for proposing mechanisms. Specifically, QCA offers a systematic tool that uses Boolean algebra to compare cases and to reveal similarities and differences (Pajunen 2005; Ragin 1989). It is especially suitable for uncovering central conditions and their constellations that generate outcomes. Therefore, what the methodological procedure enables is finding what Bhaskar (2008) describes as uncovering central components that generate the outcomes.

QCA as a toolkit of analytical methods consists of three distinct approaches: 1) crisp-set QCA that uses dichotomous conditions, 2) multi-value QCA that uses multichotomous conditions and 3) fuzzy-set QCA that introduces partial membership to the dichotomous conditions. Of these methods, the present study uses crisp-set QCA that will be hereafter labeled only as QCA for the sake of clarity. Decision to use this variant of the method stems from the notion that certain activities are either present or absent in the projects and therefore a dichotomous approach is perceived to be suitable.

QCA can be used for a number of purposes. Berg-Schlosser et al. (2009) identify five types of uses for QCA which are: 1) summarizing data, 2) checking data coherence, 3) testing hypotheses, 4) quick testing of different conjectures and 5) developing new theoretical arguments. Of these five my goal is to use the method to develop new theoretical arguments (essentially to postulate mechanisms) of new product development capability. Therefore, I combine the minimization procedure of QCA with case specific analysis to propose mechanisms.

Together the entities, activities and structures form configurations that enable postulating mechanisms (Bhaskar 2008; Fleetwood 2004). A configuration is a cluster of factors which can consist of, for instance, social structures, positioned practices, relations or rules (Fleetwood 2004, p. 48). To understand how these components give rise to mechanisms, we have to find central components that have led the outcome to occur (Bhaskar 2008). QCA is used to conduct this analytical step.

Configurations

To understand configurations, I abstracted categories of structures that govern recurring activities of new product development and used qualitative comparative analysis to find central components. This enabled me to postulate mechanisms and depict the inner workings of the mechanisms through the central components.

QCA enables the researcher to uncover similarities and differences between cases and to propose mechanisms that drive certain sets of cases. QCA treats the cases as constellations of factors, rather than examining each of the factors separately (Befani, Ledermann and Sager 2007). This gives credence to the constellations of factors and their combinative effects rather than direct effects of single con-

ditions. This enables the concretization of a mechanism into a constellation of central components.

A central underlying assumption of the method is that it relies on conjunctural causation, which means that different constellations of factors may lead to the same result (Berg-Schlosser et al. 2009). This directs the researcher to seek and determine different causal paths that lead to a single outcome, rather than specifying a single path (Ragin 1989). Therefore, a central goal of the QCA procedure is to uncover which factors are central in a configuration and generate an outcome *vis-à-vis* a mechanism.

QCA can deal with both small-N data sets where the breadth of data can range from two to 15 cases, as well as intermediate-N data sets with up to 100 cases (Berg-Schlosser et al. 2009). The current study is a small-N study, as the number of studied NPD cases is 15. Therefore, the approach used in this study veers more towards using QCA in conjunction with case specific analyses to take advantage of the depth of the dataset.

In QCA each of the conditions are coded as being either present/true or absent/false (Ragin 1989). Therefore, for each of the projects the presence and absence of activities is coded. In coding the data, zero indicates the absence of the condition and one indicates the presence of the condition. By so doing it is possible to construct a raw data matrix for the presence and absence of each of the conditions in each of the distinct cases. This raw data table is called truth table (Ragin 1989). In the data matrix each row represents a configuration of conditions (either present or absent) that are manifested in one or more cases. This represents the causal configuration of factors for each of the studied cases. When this table has been constructed, it is possible to apply Boolean logic to find configurations of central conditions (either present or absent) that are shared between the cases.

From the outset each case consists of a number of possible factors that could be central to a mechanism. To overcome this challenge, QCA provides a method for minimizing the clusters of factors to the central factors that produce the outcome. This enables the researcher to eliminate irrelevant factors and to approximate the central conditions (Berg-Schlosser et al. 2009) that constitute the mechanisms.

In order to understand the Boolean minimization, a number of main conventions have to be outlined. In doing so, we start from the Boolean expressions. First, an uppercase letter represents the presence of a condition (1) in the truth table and a lowercase letter represents the absence of a condition (0) in the truth table (Ragin 1989). Logical OR is represented by an addition (+), logical AND is represented by a multiplication (*) and the connection between conditions and outcome is signified by and arrow (→) (Berg-Schlosser et al. 2009). For the purposes of this study, the multiplication operator will, however, not be used and therefore the absence of an addition between two causal factors implies a logical AND. These logical operators enable the researcher to transform the truth table into Boolean expressions.

The basic Boolean minimization process is described by Ragin as follows:

> "If two Boolean expressions differ in only one causal condition yet produce the same outcome, then the causal condition that distinguishes the two expressions can be considered irrelevant and can be removed to create a simpler, combined expression" (1989, p. 93).

Let us now illustrate this with an example. For instance if we have the following expressions:

$$ABC + ABc \rightarrow O$$

This expression can be read as follows:

> [the presence of A, combined with the presence of B and with the presence of C] OR [the presence of A, combined with the presence of B and with the absence of C] lead to the presence of outcome O

From here we can conclude that condition C is superfluous and can be removed from the initial expressions. If we remove the condition C, we are left with a much shorter reduced expression that is able to explain both of these configurations of conditions. These reduced expressions are called prime implicants (Berg-Schlosser et al. 2009). To find prime implicants from a truth table with a number of cases, the computer program Tosmana (Cronqvist 2011) will be used. It is capable of suggesting possible prime implicants from a truth table. This is used as a starting point after which manual minimization will be made to exert case specific knowledge into the minimization procedure.

The next step in the procedure is to analyze whether the conditions or configurations are necessary or sufficient for explaining the cases. Therefore, these analyses pertain to how the used conditions explain the cases. On one hand, Rihoux and Ragin (2009) define necessity in the following way:

> "a condition is *necessary* for an outcome if it is always present when the outcome occurs. In other words, the outcome cannot occur in the absence of the condition." (p. xix, italics in original)

Therefore, necessity refers to a situation where a single configuration or a condition alone is only capable of explaining a specific outcome. On the other hand, sufficiency according to Rihoux and Ragin (2009) can be defined as:

> "a condition is *sufficient* for an outcome if the outcome always occurs when the condition is present. However, the outcome could also result from other conditions." (p. xix, italics in original)

Therefore, sufficiency refers to a situation where a single configuration or a condition is capable of explaining an outcome, which is also attained by other conditions or configurations. In some instances, a single configuration or a condition is capable of being necessary and sufficient for explaining an outcome. This means that only the fulfillment of a specific condition or configuration leads to the outcome.

While the Tosmana program is capable of extracting all possible prime implicants from the truth table, it is the job of the researcher to define which prime implicants best describe the cases and how the number of prime implicants can be minimized by assigning cases under certain prime implicants. In the present study, my aim was to use as few prime implicants as possible and therefore use prime implicants that could explain the largest amount of cases. Next I will move into depicting the actual research process and how the outlined methods were actually used.

4.8 Research design

Now that the general methodological background of this research has been explicated, it is timely to explain the practical procedures through which the empirical research was conducted. In doing so, my aim is to describe the research context, levels and units of analysis, data sources and data collection, and the analytical procedure through which the findings were generated.

4.8.1 Research context

The empirical research was conducted on the new product development of a Finnish company called Vaisala, founded in 1936. Vaisala is a technology company focused on developing and producing meteorological devices such as automatic weather stations, weather balloons and weather radars. The company exports most of its products and it can be considered one of the first high technology companies in Finland.

The current research focuses on a time period that spans from the year 1969 to year 1981. During this time Vaisala expanded rapidly from being a company manufacturing radiosondes for weather balloons into producing automatic weather stations and other measurement devices. It is a very suitable context for studying new product development capability as the company expanded its operations largely through NPD. Furthermore, what makes the company and the chosen time period interesting from both theoretical and empirical perspective is that in the early stages of the 1970s they realized the need to span beyond their immediate market and successfully pursued this new direction throughout the decade. Therefore, the period under investigation enables the studying of how to successfully expand from a single product line company into a multi-product firm in just ten years.

Second main reason for choosing these specific years was that Vaisala altered its product development during the period to enhance their expansion. Before 1969 new product development was organized as a departmental function with loose responsibilities. From 1969 until 1981 Vaisala reorganized their product development around a project organization with a specific team to manage these activities. After 1981 the project organization became superseded by decentralization of NPD into each product area. Also at this point focus of the company changed from expansion into developing products in the existing product areas. Therefore, the period provides grounds for studying how new product development and the associated capability changed to enable growth and expansion.

4.8.2 Levels and units of analysis

This research spans multiple levels and units of analysis. The whole period of inquiry can be thought of as a unit of analysis because during this period Vaisala expanded from radiosonde production into weather stations and other measurement instruments and therefore provides a case of organizational transformation. By examining the company throughout the whole period it is possible to analyze how the company made this expansion possible.

While the focal interest of this study are the new product development projects, contextualizing them into the broader company evolution gives depth to the analysis. Thus, preceding project-level analysis it is essential to highlight major changes pertaining to the company's operating context, its relations to third parties and understanding the role that NPD had during the period of inquiry. This enables the creation of a holistic picture of how the company evolved during the time of inquiry.

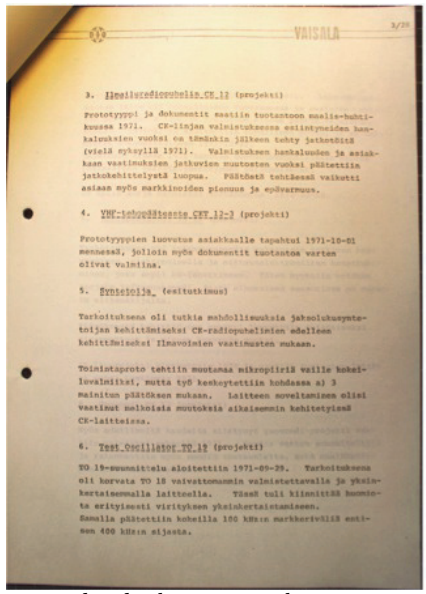
New product development projects constitute the focal unit of analysis in this study. These projects are treated as distinct case entities that are subjected to within- and between case analyses (Eisenhardt 1989; Eisenhardt and Graebner 2007). By doing so, I can distinguish what entities are involved in the NPD projects and what kind of activities they conduct in the projects. By understanding the entities and activities, I can uncover what kind of recurring NPD activities are employed in different kinds of projects. These activities can then be further analyzed with regards to their codification in the operating procedures of the company, following the suggestion of Zollo and Winter (2002).

By using recurring activities as the base-level unit of analysis, I can redescribe the cases (Bhaskar 1998; Danermark et al. 2002) through the activities employed in the projects. This enables the identification of recurring activities involved in each stage of each NPD projects. Through this I can use QCA to analyze and minimize the configurations of activities to extract central and peripheral elements of mechanisms. Therefore, I am capable of identifying minimized configurations of activities that constitute mechanisms in the ideation, evaluation and outcome stages of new product development.

After postulating the mechanisms, they can be used to reconstruct whole NPD projects as configuration of mechanisms and they can also be used to analyze NPD activities (and product development capability) of the company throughout the whole period of inquiry. Therefore, the research process moves from macro-level to micro-level and back to the macro-level.

4.8.3 Data collection

The main source of data for this research is the archives of Vaisala located in Central Archives for Finnish Business Records in Mikkeli, Finland. The Vaisala archive consists of 127,73 shelf meters of archival material of the company. The bulk of the archival material spans from the inception of the company in the 1936 to the 1990s. The archival materials cover a lot of technical aspects of products, as well as new product development and sales related documentation. See Figure 5 for two examples of the archival data used in this study.



3. Ilmailuradiopuhelin CK 12 (projekti)

Prototyyppi ja dokumentit saatiin tuotantoon maalis-huhtikuussa 1971. CK-linjan valmistuksessa esiintyneiden hankaluuksien vuoksi on tämänkin jälkeen tehty jatkotöitä (vielä myöhyllä 1971). Valmistuksen hankaluuden ja asiakkaan vaatimuksien jatkuvien muutosten vuoksi päätettiin jatkokehitelyä luopua. Päätöksä tehtäessä vaikutti asiaan myös markkinoiden pienuus ja epävarmuus.

4. VHF-johdeyhteyslaite CKT 12-3 (projekti)

Prototyyppien luovutus asiakkaalle tapahtui 1971-10-01 mennessä, jolloin myös dokumentit tuotantoa varten olivat valmiina.

5. Synteisoija (esituuttmus)

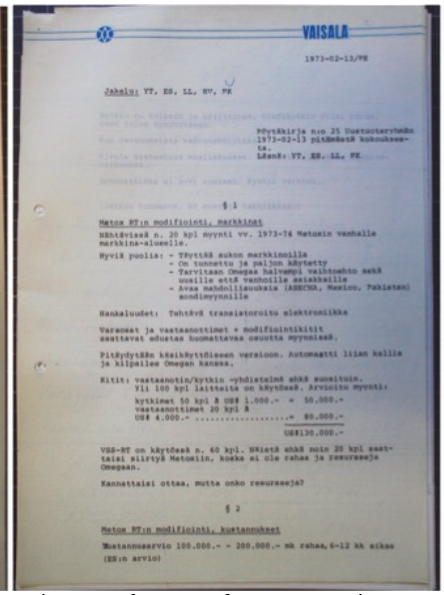
Tarkoituksena oli tutkia mahdollisuuksia jaksolukusynteitojen kehittämiseksi CK-radiopuhelinten edelleen kehittämiseksi Ilmavoimien vaatimusten mukaan.

Toimintaproto tehtiin muutaaa mikropiiriä vaille kokeilovalmiiksi, mutta työ keskeytettiin kohdassa a) 3 mainitun päätöksen mukaan. Laitteen soveltaminen olisi vaatinut melkoisia muutoksia alkuperäisiin kehitetyisiä CK-laitteissa.

6. Test Oscillator TO 18 (projekti)

TO 19-suunnittelu aloitettiin 1971-09-29. Tarkoituksena oli korvata TO 18 valvattomasmin valmistettavalla ja yksinkertaisemmalla laitteella. Tässä tuli kiinnittää huomiota erityisesti virityksen yksinkertaistamiseen. Samalla päätettiin kokeilla 100 kHz:n markkerivälitä entisen 400 kHz:n sijasta.

New product development annual report 1971-1972, page 2/28



VAISALA

1973-02-13/PK

Jakelu: VT, ES, LL, RV, PK

Pöytäkirja n:o 25 tuotuoteryhmän 1973-02-13 pitämästä kokouksesta.
Läsnä: VT, ES, LL, PK

§ 1

Metox MT:n modifiointi, markkinat

Hhtövissä n. 20 kpl myynti vv. 1973-74 Metoxin vanhalle markkina-alueelle.

Hyviä puolia: - Täyttää sukon markkinoille
- On tunnettu ja paljon käytetty
- Tarvitaan Omegaa halvempi vaihtoehto sekä uusille että vanhoille asiakkaille
- Avaa mahdollisuuksia (ARECNA, Mexico, Pakistan) sondimyynnille

Hankaluudet: Tehtävä transistoroitu elektroniikka

Varaosat ja vastaanottimet + modifiointikitit saattavat edustaa huomattavaa osuutta myynnissä.

Pitkydytään käsikäyttöiseen versioon. Automaatti liian kallis ja kilpailee Omegan kanssa.

Kitit: vastaanotin/kytkin -yhdistelmä ehkä suosituin.
Yli 100 kpl laitteita on käytössä. Arvioitu myynti:
kytkimet 50 kpl à US$ 1.000.- = 50.000.-
vastaanottimet 20 kpl à
US$ 4.000.- ..... = 80.000.-
US$130.000.-

VSS-RT on käytössä n. 60 kpl. Niistä ehkä noin 20 kpl saattaisi siirtyä Metoxiin, koska ei ole rahaa ja resursseja Omegaan.

Kannattaisi ottaa, mutta onko resursseja?

§ 2

Metox MT:n modifiointi, kustannukset

Muutannusarvio 100.000.- - 200.000.- mk rahaa, 6-12 kk aikaa (ES:n arvio)

First page of a new product group meeting memo number 25, dated 13.2.1973

Figure 5: Examples of research data

The data set was collected in a number of stages. First, I collected historical studies related to Vaisala that yielded a number of books and book chapters related to the company, its products and relations with third parties such as Finnish Meteorological Institute. The goal of the first stage was to get an overall picture of the activities the company had done. Through this stage I was also able to broadly orient the archival work to the chosen period of time.

The first stage of archival data collection was made in April 2013 at the Central Archives for Finnish Business Records. This stage constituted of collecting data to further approximate the period of inquiry and therefore focused on getting a general picture of the activities of the company. Therefore, the collected data in this phase included for instance annual reports, board of director meeting memos and annual reports of new product development. This was then analyzed to plan for the second period archival data collection.

The second stage of archival data collection was made in August 2013 at the Central Archives for Finnish Business Records. In this stage closer documentation related to specific new product development projects were collected, as well as documentation related to organizational changes during the period. This enabled me to fill the gaps left in the first stage of data collection.

In total 2939 pages of archival material was collected. This includes acquisition of books related to Vaisala and filming the archival material with a digital camera. Therefore, most of the research work was actually done by using digital copies of the original archival materials. Table 4 depicts the data sources, types, covered period and breadth of each data type in the final data set.

Table 4: Data sources, types and breadth

data source	data type	time period	no. of pages
Central Archives for Finnish Business Records	Annual reports of the company	1968-1984	257
Central Archives for Finnish Business Records	Board of directors meeting memos	1970-1983	359
Central Archives for Finnish Business Records	Annual reports of the new product development department	1966-1981, 1984	367
Central Archives for Finnish Business Records	New product group weekly meeting memos	1972-1982	446
Central Archives for Finnish Business Records	Research program documentation	1971, 1975	30
Central Archives for Finnish Business Records	Personal records of the development director Jan Hörnhammer		46
Central Archives for Finnish Business Records	Personal records, presentation and articles of the CEO Yrjö Toivola		119
Central Archives for Finnish Business Records	Vaisala News (the companys customer bulleting)	1969-1983	491
Central Archives for Finnish Business Records	Documenting related to the organization structure and changes in it		66
Central Archives for Finnish Business Records	New produc development project documenting		225
Central Archives for Finnish Business Records	Documents related to shutting down products and product lines	1973, 1974, 1975, 1978, 1979	41
Central Archives for Finnish Business Records	Miscellaneous company internal documents		170
Fifty years of environmental measurement (Janatuinen 1986)	Historical studies/ books / book chapters related to Vaisala		110
Global Innovator - The story of Vaisala (Michelsen 2006)	Historical studies/ books / book chapters related to Vaisala		180
Keihäänkärkiä - Kolmetoista kertomusta suomalaisesta huipputekniikasta (Lyyra 2005)	Historical studies/ books / book chapters related to Vaisala		18
Kaisaniemestä Kumpulaan: Tutkimusta, havaintoja ja ihmisiä Ilmatieteen laitoksella (Ketonen 2005)	Historical studies/ books / book chapters related to Vaisala		14
		total size of the dataset (pages):	**2939**

This dataset was considered sufficient for conducting the chosen analyses and therefore no further data collection was deemed necessary. It also enabled me to mitigate the challenge of working with a dataset that is expansive and can easily lead the researcher astray and immersion into the data rather than meaningful theorization generated from analyzing the data.

Throughout the process I tried to critically evaluate the evidence in light of the suggestions of Golder (2000), which are:

- Interpretive criticism (capacity to determine the authors meanings)
- Negative internal criticism (evaluation of the truthfulness of the evidence)
- Evaluation of the independence of the observations (corroboration from other sources)

To address these criteria I did the following actions. Firstly, I read through the whole material to familiarize myself to the company so as to understand how the company functioned. This helped me in interpreting the data. Furthermore, the decision-making oriented documentation was very helpful, as it did not leave too much room for interpretation. Secondly, I evaluated the truthfulness of the documentation from either the nature of the document or the circulation of the document. For instance, the new product groups meeting memos were circulated only amongst the participants of the group and thus I deemed them to be truthful of the managers' perceptions and decision. Also I perceived it not to be necessary to question the veracity of the annual reports (including annual reports of new product development) of the company. In this respect, the material was deemed to truthfully represent what had happened. Finally, when possible, I evaluated the independence of the observation by tracing the action from multiple documents. Additionally, I considered whether interviews with managers of Vaisala could be made to enable better triangulation of data. This was not done because retrospective interviews can lead to hindsight bias in which people exaggerate the inevitability of events and to attribution bias which leads people to attribute outcomes to appealing but inappropriate causes (Huber and Power 1985). Therefore, I rather aspired to focus on situational accounts encapsulated in the internal reporting. These actions together were perceived to assure a degree of criticality towards the documentation.

4.8.4 Data analysis

The data analysis proceeded in successive stages in which I worked from the macro-level towards more micro-level aspects and then back into the macro-level. The first step was to choose a period of company history on which my inquiry would focus on. The written historiographies by Janatuinen (1986) and Michelsen (2006) proved to be an invaluable help in this step as they gave an overall picture of what the company had done during its time of existence. The 1970s and the beginning of 1980s appeared to offer a suitable period for study because during this time Vaisala rapidly expanded its size and introduced many of its central products during these years. In this stage I was also able to identify many of the company's central new product development projects.

The second step was to collect data regarding this period from the Central Archives for Finnish Business Records. I collected approximately 1500 pages of

archival material as the initial dataset. The material was first read through thoroughly to get an overview of events that had taken place. At this point the annual reports of the new product development department and new product group's weekly meeting memos appeared to be the most consistent time series data available. By using these two data sources I coded one chronological sequences of new product development action by the new product development department and a second sequence of actions by the new product group.

This yielded a total of 1468 discrete new product development actions and decisions, 669 for the new product development department and 799 for the new product group. These decisions and actions span all the new product development projects that Vaisala undertook during the period of inquiry and they were used as a basis for further analyses. The decision to do the initial analysis in this manner was made because of the need to identify central NPD projects and complement the list of central projects identified in the first step so as to not leave out essential projects.

The case selection ended up being a fairly straightforward process as the peripheral NPD projects received only scant reporting and documentation, whereas central NPD projects were extensively reported in both the annual reports of new product development department and the in the memos of the new product group. Also at the beginning of the 1980s the company's internal documenting identified the most important projects that had been undertaken in the past ten years. Building on these considerations, the initial set of cases was selected. At this stage a total of 22 central new product development projects were identified. These projects were:

1) ELSA
2) Radiosonde RS 16
3) Radiosonde RS 17
4) RS restructuring (RS 18)
5) RS 21 & 24
6) CORA
7) METOX switch
8) New sonde batteries
9) SODAR – acoustic radar
10) RS 80 radiosonde (NASTA)
11) HUMICAP
12) Aviation radiophone CK 12
13) Personal Dust Sampling Pump
14) Electronic microscope
15) FGGE
16) Meteor Scatter
17) Kemin Kasuuni
18) HATTARA
19) MIDAS
20) THERMOCAP
21) Holmström barometer
22) Loran C

After defining the initial set of new product development projects I simultaneously started writing individual case narratives and the wider company narrative for the period. While examining the NPD projects and writing case narra-

tives, a number of product development cases were excluded from further analysis, mostly due to insufficient data. Specifically, RS 16 & RS 17 projects proved to have insufficient data in order for them to be kept in the dataset of NPD cases. FGGE proved not to constitute new product development, as the project did not result in the introduction of a new product but rather the bundling of existing offerings for a single client. Meteor Scatter project had excellent data from the early stages of development but the development stalled until 1984 and proper data for outcomes could not be found. Similarly Loran C was a project in which initial development documentation was available but the later stages of development spanned beyond the time period of which proper time series data could be acquired. THERMOCAP project ended up being subsumed into the RS 80 radiosonde (NASTA) project and therefore it was excluded from the dataset as being a distinct case. Lastly, the development of Holmström barometer could be traced to an extent but the initial conditions for starting product development could not be found and therefore it was excluded from further analyses. In the end there were 15 NPD projects of which proper narratives could be written out and which could be thoroughly analyzed.

When structuring the historical narratives I followed two different approaches. In depicting the background and early years of the company I utilized a loosely chronological structure with scale shifting (use of small examples to depict large changes [Gaddis 2002]) to illustrate the broad changes in the company through examples. With regards to the narrative on the main period of inquiry I maintained a more chronological account that highlighted the main events. This enabled the use of event structure analysis (Heise 1989) in latter stages. This chronological approach was also used on the NPD project level to enable the analysis of sequences of events.

At this point approximately 40 pages of raw company and NPD project narratives had been written. The narratives were deemed to depict the main events, product development projects and activities. Thus, event structure analysis (Heise 1989) was conducted. This was the first step in doing analytical resolution i.e. the dissolution of the events into their components (Danermark et al. 2002).

Event structure analysis enabled me to situate the new product development projects into the wider company history and identify internal and external influences for each NPD project. Specifically, for each of the NPD projects I tried to identify three actions that would define a project on aggregate level in addition to explicating relations between projects. These three actions were:

1) Initial source of idea(s)
2) When the project was initiated in Vaisala
3) Outcome of the project

This step gave me a broad picture of how the NPD projects were related to each other, what factors influenced the inception of the project, and broadly what kind of outcome(s) the project ended up into.

Now that a broad picture of the NPD activities had been attained I returned to analyze and compare individual NPD cases. In this stage four distinct groups of actors were first identified, two of them company-internal and two external to the company. These were 1) Vaisala new product development department, 2) Vaisala new product group, 3) Finnish research institutions such as Helsinki University of Technology (HUT) and 4) customers and institutional developers such as European Cooperation in Science and Technology (COST).

After identifying the main actors, I formulated logs of all the actions that were undertaken in each of the NPD projects. These logs were disseminated into three categories depending on whether they pertained to ideation, evaluation, or outcomes. These action logs were first compared with each other to identify recurrent patterns. These recurrent patterns were then examined across cases to distinguish the action that they all focused on. These recurrent actions were then conceptualized either as routines or simple rules and a broader description of the activities was given. This analysis was then supplemented by going through additional company-internal documentation to determine whether certain routines were codified in the operating manuals of the company (following the suggestions of Zollo and Winter 2002). An especially valuable document at this point was a document that stated the goals, responsibilities and purpose of the new product group. In conjunction with the new product development action log and the codified goals and responsibilities I was able to identify routines and simple rules that Vaisala NPD utilized. This was the second step in doing analytical resolution – the dissolution of the events into their components (Danermark et al. 2002).

The identification of routines and simple rules in each of the stages was followed by theoretical redescription (Danermark et al. 2002) in which I used extant theory to describe the possible components of mechanisms. Each of the identified routines and simple rules had received some form of attention from marketing, management or new product development literature and therefore I used extant literature to describe each of the activities from a theoretical perspective. This inclusion of extant research into deconstructing the activities was deemed essential, as Eisenhardt and Martin (2000) noted that many components of capabilities have received attention in their own respective fields.

By using this procedure I was able to define routines and simple rules for the ideation, evaluation and outcome stages. Therefore, at this point an array of new product development routines and simple rules was at my grasp. The next step was to subject the activities in each of the stages to QCA (Ragin 1989) to determine how the activities are combined, which activities had a central role, which ones a peripheral role and to ultimately define how the activities could constitute mechanisms.

I first constructed truth tables for each of the ideation, evaluation and outcome stages to depict the presence and absence of activities. Evaluation proved to be the most challenging one to code due to the absence and negative outcomes generated by the activities. In coding evaluation, I coded the evaluation activities that resulted in a positive outcome as being 1 and negative evaluation or absence of the evaluation activities as being 0. This decision was made on

the basis that the focus of the study is to concentrate on how projects are selected for commercialization to which positive evaluations contribute. Despite this, I recognize the possible weakness of this approach.

At this point no contradictory configurations were found for any of the stages and I was able to proceed with the analyses. Next I subjected the configurations to minimization procedure of the Tosmana program (Cronqvist 2011). This enabled me to extract a number of prime implicants for each of the stages.

It is not uncommon that the researcher faces situations where a case could be minimized into more than one configuration, which means that there are possible concurrent or competing explanations for a single configuration. In the instances where this occurred, I followed the suggestions of Rihoux and De Meur (2009) and resorted into qualitative analysis of the cases to determine the category to which a specific case belonged. This also enables the exclusion of prime implicants that are logically possible but not consistent with the case analyses. These generated formulas are taken to refer to the central elements of mechanisms pertinent to the projects under question.

This procedure enabled me to extract a number of prime implicants for each of the ideation, evaluation and outcome stages. It enabled me to define which components created the specific outcomes, essentially representing retroduction (Danermark et al. 2002). Therefore, I postulated a mechanism for each of the minimized configurations based on the components present in the minimized formula.

After this, I provided theoretical grounding for each of the mechanism to compare between different theories and abstractions. This enabled me to evaluate how different theories were able to explain mechanism in each of the stages, as suggested by Danermark et al. (2002).

Finally, I contextualized and concretized the mechanisms by examining how they interact in their context and enable explaining phenomena (Danermark et al. 2002). This was done by using two methods. On the project level I formulated mechanism paths by mapping how the mechanisms combine together to form successful NPD projects. This gave me an opportunity to unravel how and in what ways the new product development capability functions as combinations of ideation, evaluation and outcome mechanisms. On company level I situated each of the mechanisms into a timeline to define whether certain mechanisms were pervasive to certain periods of time. This enabled me to analyze whether certain mechanism emerged or were not actualized in certain periods of time from which an understanding of the functioning of the new product development capability could be generated. I also analyzed the role of different mechanisms in the emergence of new product lines and how changes in strategy and NPD organization affected the capability

This concludes the methodology section. Next I move into presenting historical narrative of Vaisala, followed by narratives of the main NPD projects. This formulates the baseline for further analyses, as outlined earlier.

5. Historical narrative

The historical narrative of Vaisala depicted in this chapter is based on a number of sources. To write this I used archival documents gathered from the Vaisala archives located in the Central Archives for Finnish Business Records as the main source. This was supplemented with historiographies of the company (Janatuinen 1986; Michelsen 2006), book chapters related to the company and its relations to other institutions (Lyyra 2005; Ketonen 2005) and a short history of the company provided in their website (www.vaisala.com).

The main narrative is organized in a chronological order, in which focus is given to the main events that affected the company. This is followed by more in-depth narratives of the main NPD projects and the events that took place in the projects. Finally, I provide narratives of the development and change of individual product lines.

5.1 Background and early years of Vaisala

> "In the Articles of Association of his company, Vilho Väisälä defined its task: "To engage in the manufacture of scientific and technical devices as well as to financially support scientific research." This section is still in force in the Articles of Association of Vaisala Oy." (Janatuinen 1986, p. 22)

Vilho Väisälä, a Professor of meteorology in the University of Helsinki, founded Vaisala Company in 1936. The original goal of the company was to manufacture radiosondes to research institutions around the world. These devices were used in weather balloons to measure atmospherical parameters such as temperature, pressure and humidity in the lower and upper atmosphere. Frequent use of weather balloons in multiple locations in turn made it possible to make weather forecasts. In a country dominated by the production of pulp and paper, we could say that Vaisala was one of the first Finnish high-tech companies to be established.

Before the company was founded Vilho Väisälä had already sold his radiosondes to Sweden, Poland and Denmark (Michelsen 2006). However, the first actual sale for the company was made to MIT's Guggenhem Aeronautical Laboratory in 1936 (Janatuinen 1986, p. 24). This event marked the birth of the

company. Because of the small size of the national market, the company was essentially born global. As Finland did not have many other potential customers than the Finnish Meteorological Institute, most of its products went to export and expansion to foreign markets was perceived as the main method for growth.

While the birth of the company was quite a feat, this success story came into a halt because of World War II. During this time, Vaisala supplied weather balloons to the Finnish military that used them to predict weather patters which was crucial for air defenses and artillery fire (Michelsen 2006). In 1944 Vaisala established a contract with Elvometer Ab. in Sweden to license manufacturing in Sweden (http://www.vaisala.com/en/corporate/history/). This was done to keep up the supply to existing customers. Despite the disturbance created by the wartime, the company managed to stay intact through the wartime period and keep most of its key employees.

Second World War and the subsequent Cold War had an impact on the company on many fronts. After the war, radiosondes became an everyday instrument and weather stations around the world made daily soundings in order to provide weather forecasts (Michelsen 2006, p. 77). While this sounds very rosy for Vaisala, the Cold War also closed many markets for the company as Western Europe, the US and the Soviet Union were out of the company's reach because of the strategic role of weather measurement.

The war also had an impact on company strategy and its pursuit for globalization. As it was feared that Cold War could jeopardize the future of the company, Vaisala actively sought to expand to international markets and expand their operations to new countries. Thus, internationalization and product development were necessary due to contingencies that the technological and political context imposed on the company. Vaisala tackled these challenges both on the front of internationalization as well as new product development. Throughout its history, Vaisala had invested heavily on new product development. Since the 1930s they continuously invested in average more than 10 percent of their annual income into product development and R&D (Michelsen 2006).

In 1955 Vaisala changed its name to the present form and left out the umlauts from the Väisälä family name. This was done to make the company more accessible to international clients. Simultaneously the company started to establish international subsidiaries. In 1959 Vaisala established Vaisala S.A. in Johannesburg, South Africa, to manufacture the Vaisala measurement devices. In the same year Vaisala established Vaisala Sudamericana in Buenos Aires, Argentina. Through these expansions, Vaisala was the first Finnish company to establish production facilities in both the African and South American continents (Janatuinen 1986, p. 50). However, both of these countries had very little experience in making high-tech instruments, despite their long tradition in meteorology, and thus both of these facilities were fully operational three years later in 1962 (Michelsen 2006, p. 115).

Throughout its history, Vaisala had also invested heavily in creating relationships with both local and international actors. Since the early days Vaisala has

had close relationships with Finnish Meteorological Institute (FMI), from where a member also sat in the Vaisala Board of Directors. From the inception of the company, FMI has also been an important client of Vaisala. Vaisala has also been an active player in the international field. The company has been a member of the World Meteorological Organization since its inception in 1950. In addition to this, Vaisala actively participated in international meteorological conferences, where they launched and exhibited new products.

Management style and the method of pursuing growth have always gone hand-in-hand in the company. In the early years of the company, Vilho Väisälä pursued growth for the company by selling the instruments to research institutions in the field of meteorology, where he was an established figure. This proved to be a viable solution as their sales grew from 51 radiosondes in 1936 into 509 radiosondes in 1938 (Michelsen 2006). After the Second World War, the 1940s was a time of rapid growth as by the end of the decade they sold over 15.000 radiosondes annually (ibid.). This was a tremendous feat for a Finnish company when we keep in mind that most of the sold products were exported. When Pentti Väisälä (the managing director) died in 1963, Yrjö Toivola was appointed as the deputy managing director and the new product policy of developing solutions to meteorological measurement problems emerged (Janatuinen 1986). This new direction became fulfilled in the 1970s, which is the main period of inquiry on which I will focus on next.

5.2 Organizational growth and performance: 1969-1981

Before outlining the main events that took place during the period of inquiry, it is first necessary to depict the ethos that the company had during that period and the outcomes that their actions generated. This should give the reader a broad understanding of the nature of the period on which my inquiry focuses on. Also it gives us the outcomes from which we can start tracing the activities that yielded them.

Throughout the entire period of inquiry, Vaisala enjoyed a tremendous growth of turnover. In 1969-1970 their turnover was reported in the financial statement as being 4.662 million FIM and it grew to be 49,972 million FIM in 1979-1981 (adjusted to 12 months). Therefore, turnover of the company grew tenfold during the period. This was largely due to new product launches, as their importance in accelerating turnover was stressed year-after-year. Despite this, the company was able to be profitable in all years except the 1970-1971 period. Figure 6 depicts turnover of Vaisala in million FIM and profit in 100.00 FIM throughout the period.

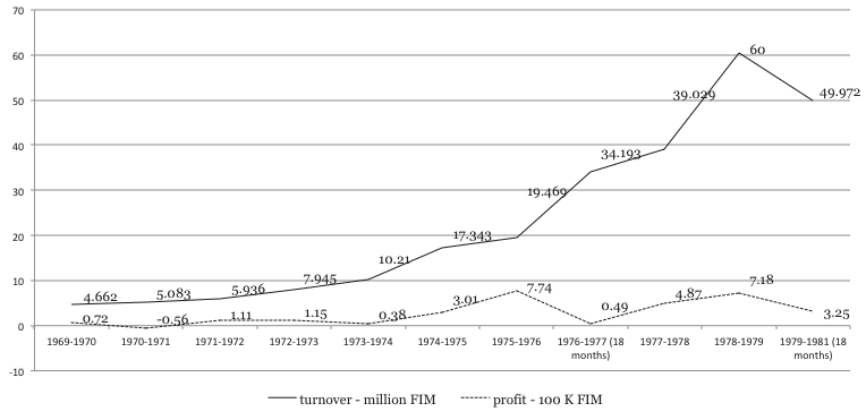


Figure 6: Development of turnover and profit 1969-1981

It is also noteworthy that during the 1970s the global economy was hit by the oil crisis and the rapid growth that the post-war period had provided was coming to an end. Despite this, Vaisala managed to assume quite a steady growth. The large bumps in the growth of turnover resulted mainly from large deals such as contracts with WMO that the company was capable of securing.

The growth was fueled mostly by exports as on average 93,6% of sales was to foreign countries. Only in the financial year 1969-1970 the exports were below 90% of the sales (89,5% to be exact). The number of countries Vaisala exported their products to in a single year also grew during the period to an average of 55 different countries each year. Many of the new export destinations were developing countries such as Nigeria, Venezuela and Algeria. Also larger countries such as France and China were added to the list of countries where they had customers in (France in 1969-1970 and China in 1978-1979).

Throughout the period Vaisala strived to expand beyond the radiosonde market, as it was perceived that the radiosonde market would not yield significant growth after the mid-1970s. Therefore, the company invested heavily in new product development to expand into new markets such as automatic weather stations where growth potential was perceived to exist. Simultaneously as the new products started to expand sales, Vaisala had to invest in both production equipment and facilities. Figure 7 depicts the total investment of the company during the period in FIM and the percentage of turnover that they invested in new product development.

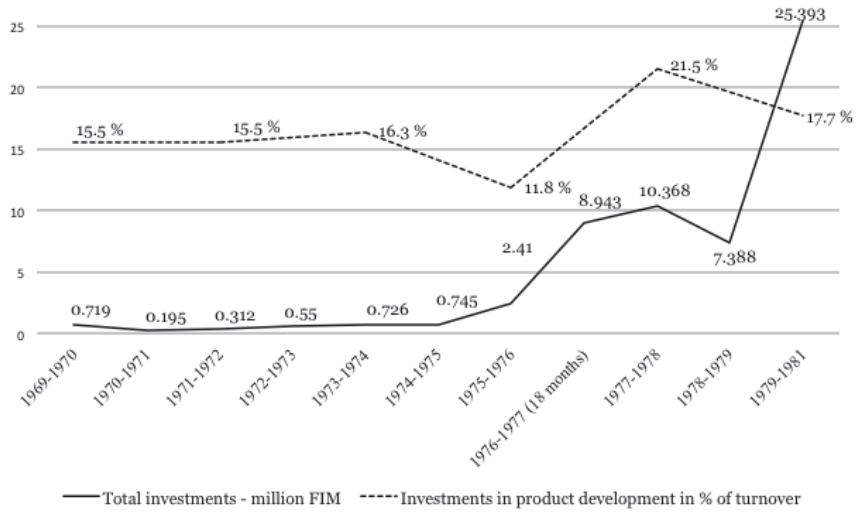


Figure 7: Total investments and product development investments 1969-1981

This growth had to also be matched by increases in the number of staff the company employed. Whereas in 1969 they employed 139 people, this number had grown to 286 in 1981. During the 1970s, the management of the company also highlighted staffing as being a problem because finding talented people was deemed challenging.

Now that I have outlined some of the key figures that depict the growth of the company during the period, it is time to move into depicting the events that took place and explain how this growth was attained. Therefore, I will next move into depicting the main historical narrative of the period of inquiry.

5.3 Historical narrative of the main events: 1969-1981

When Vilho Väisälä died in 1969, Yrjö Toivola was appointed as the new CEO. His vision was to develop the company's technological potential. This is well exemplified by the fact that he was the head of the new product group (instated in 1971) and participated in almost all of the meetings that the group held until the organization transformed into a structure where each product area had their own new product groups in 1981. Therefore, he had a very hands-on approach to the NPD activities of the company.

It had also long been known in Vaisala that operating in a limited market could have risks. Already in 1955 the deputy managing director Pentti Väisälä had voiced out concerns that there was a possibility that due to rapid technological development a new measurement method or device could emerge and wipe out the whole market (Janatuinen 1986). Thus, there were long roots in recognizing the fragile nature of the radiosonde market. This had also resulted in some attempts to develop products to new markets. These included a radiophone, a targeting training system for military aircrafts and a receiver system

for radiosonde signals but none of them provided significant avenues for expansion into new business areas (Janatuinen 1986). This historical background and the change in management set the stage for what the company was to undertake during the 1970s.

During the year 1969 Vaisala restructured the organization. As a result of this, NPD department was transformed into a project management organization. One of the reasons behind this transformation was that the product development had grown rapidly and tripled its headcount in the past four years.

During that year the company began to plan the RS 17 and RS 13 radiosondes that would continue the longstanding line of radiosondes and initiated talks to develop CK 12 aviation radiophone that would replace CK 11 that the company had earlier sold to the Finnish air force. At the same time the new product development focused on developing a new radiowindsounding system, new radiosondes and ELSA (an automatic antenna for receiving satellite signals). Many of these new products were intended to help Vaisala to move beyond merely producing radiosondes.

In 1970 Vaisala introduced the RS 16 and RS 17 radiosondes. These were made to continue the long line of radiosondes, which was at that time the core business of the company. The RS 16 was developed in conjunction with Helsinki University of Technology and it participated in a sonde comparison held in August 1969 in Leningrad. RS 17 was developed based on a survey sent to customers and stimulus for its developed was gathered from Norway in 1967, as they had made measurements with a similar device. The RS 17 was introduced in CIMO VI conference. At this point it was known that RS 16 would be just an in-between phase and further development of the product commenced immediately. This project became known as RS restructuring. Later on in 1981 RS restructuring was identified as one of the most important product development projects of the decade leading to the development of RS 18 radiosonde.

In 1971 Finland joined the 19-nation program called European Cooperation in the field of Science and Technology, COST for short. This was a move already predicted by Vaisala. It gave Vaisala access to COST programs that focused on meteorology and meteorological device development. This benefitted Vaisala tremendously in the upcoming years.

The previously lingering concerns with regards to the necessity to diversify into new markets were explicitly voiced out at the end of 1971. In the research and development plan laid out for a period from 1972 to 1982, it was explicitly stated that Vaisala needs to span beyond the radiosonde market as operating in a single market created major risks for the future of the company. An excerpt from this document embodies well the impetus for expanding beyond the immediate market:

> "From 1975 onwards we have to enter the market with new product because the sonde business does not anymore provide enough fast growth. [...] From the beginning of 1977 we have to make something new besides meteorological devices. Considering the competence of our staff, it would supposedly be elec-

> tronics intensive, maybe nuanced towards micromechanics." Research and development plan 1972-1982 (p. 4), dated 1.11.1971, underlining in original

Due to the small size of the company, it was also pointed out that Vaisala should develop better relations with outside research institutions such as VTT, HUT and different consultants. Thus, the management explicitly recognized the threat that Vaisala was a small single product category company.

Using satellites for meteorological purposes was already underway in the late 1960s and Vaisala also wanted to take part in this business. Helsinki University of Technology (HUT) had developed an automatic antenna for receiving satellite signals that seemed a promising avenue for expanding into the field. Vaisala took part in the project, improved the device and ran tests in their own laboratories and in Finnish Meteorological Institute. In March 1970 Vaisala bought the rights for the product from the HUT researchers and started marketing it and developing it into a commercial product under the product name ELSA. It was launched in 1971. Partly due to ELSA, the sales of new products increased by 83% and broke the 1 million FIM mark in 1971.

In the organizational front changes were also made. New product group was instated to supervise and direct new product development in 1971. It was chaired by the CEO of the company and included the R&D, marketing and commercial directors of the company. The tasks of the group were outlined as follows:

- Think and formulate product policy for the company
- Decide on which ideas will be developed into products
- Prioritize and resource new product development projects
- Decide on further development of products in relation to competitive environment, performance goals, and technical execution
- Define technical and financial thresholds for product development projects
- Coordinate projects
- Decide upon important changes in projects
- Decide on moving new products into production
- Decide on patents and patenting of products and components

This group functioned as the main body that decided on new product development up until 1981 after which these responsibilities were moved to be a responsibility each profit-and-loss unit where each unit had an equivalent group.

During 1972 Vaisala was on the crest of the wave of expansion and the main challenge identified in the annual report was that they had to invest heavily in equipment and recruitment of new workers as the demand for their equipment was on the rise. In part due to the fact that the sales of radiosondes grew that year by 23,3%, the sales of ground equipment for radiosondes grew by 46,4% and the company's' turnover grew by 33,8%.

In Finland Vaisala had good working relations with national institutions, universities and the Finnish Meteorological Institute (FMI). This was due to the fact that a portion of the shares of the company were donated to the Finnish Academy of Science and Letters and the founder of the company Vilho Väisälä was a professor in the University of Helsinki, having also worked as the head of the Ilmala observatory (part of FMI). FMI was also one of the key customers of the company. However, in 1972, the relations of Vaisala were reordered in the university front because the social democratic party published a new national research policy that put a halt to the research projects universities were doing with private businesses (Michelsen 2006, p. 133). As a result, Vaisala started steering its cooperative relations towards national research institutions such as VTT (Technical Research Centre of Finland) and FMI that were still allowed to do applied research (ibid. p. 134). Cooperation with VTT was especially widespread. Universities still had a role in developing new ideas and products with the company but particularly the role of the University of Helsinki was diminishing with which Vaisala had previously been closely affiliated to.

The projections made at the end of 1971 had an impact on the new product development of the company as Vaisala started to study automatic weather stations and VTT was developing a new way to measure humidity for Vaisala (later result of this project would be named HUMICAP). On the front of developing radiosondes, RS restructuring that began in 1971 reached its goal in 1972 and the new RS 18 radiosonde was introduced to the market. As a byproduct of this two additional radiosondes, the RS 21 and RS 24, were also introduced.

In 1973 Vaisala set up collaboration with Metox, a French company specialized in making radiotheodolites. This gave Vaisala access to sell their radiosondes to sounding stations that used METOX ground equipment and possibilities to do additional devices to complement the central METOX hardware. The company also tried to expand its portfolio of offerings by starting projects to develop an electronic microscope (that was soon discontinued) and an acoustic radar.

Vaisala also secured the first deal for making an automatic weather station, which would be placed in the Kemi lighthouse in Northern Finland. This deal was won because the company begun to collaborate with Sierra Corporation that had previous experience in making automatic weather stations. With their help Vaisala managed to win the bid that the Finnish Maritime Association had been planning to give to another Finnish company called Strömberg. This gave the company an opportunity to expand into a new product area.

Back in 1971 Yrjö Toivola had commissioned a study aimed at identifying which meteorological problems could not be accurately measured and what kind of technology would enable solving these problems. The challenge had been taken up by a research team in VTT. Two years after the team had taken up the task they came up with was a new solution to measure relative humidity in the atmosphere by using semiconductor technology. A product developed from this new idea became known as HUMICAP. First orders of this product were delivered to customers in November 1973.

In 1973 Vaisala also delivered the first two CORA (Correlation Radio Wind Finder) systems to French Meteorological Research Institute. This was an important milestone for a product that was later on identified as one of the most important products that were developed in that decade. It still took two years to fully launch the product.

During the year 1974 Vaisala was able to reap the benefits of the previously developed products as two thirds of the delivered new radiosondes where of the new types. Due to the diverging needs of the company to simultaneously mass-produce radiosondes but also to make more unique solutions such as weather stations, the production was split into two lines, one manufacturing radiosondes and the other focused on equipment manufacturing. A network for supplying humidity measurement devices was also being developed mainly in Europe to enable wide distribution of the new HUMICAP humidity sensor. This was accompanied by the furnishing of a separate laboratory with necessary equipment to manufacture the HUMICAP products on a larger scale (Michelsen 2006).

The year 1974 was a bit less hectic in terms of the number of new products introduced but Vaisala was able to drive home big and important projects. Two large development projects were drawn to a close as the new METOX switch was launched and HUMICAP was finally fully commercialized. Of these two, HUMICAP would later on be referred to as one of the biggest success stories the company had in this decade.

Vaisala had previously started a research project with FMI on automatic weather stations that could be used in airports. As a result of this initial prestudy Vaisala got an offer to tender for automatizing the weather equipment in Helsinki-Vantaa airport in 1974. This project was immediately considered a top priority and Vaisala managed to secure the deal. This project would continue the efforts to expand into the automatic weather station business and a similar product was also sold to Saudi Arabia to be installed into the Medina airport. The project was given the name HATTARA. A big contributor in this project was that the newly founded Finnish National Fund for Research and Development (SITRA) that gave Vaisala ample financing to focus fully on the development and search for new products (Michelsen 2006).

In 1975 the company's product policy was reviewed and it was emphasized that the new products have to fit the guiding principles of the company, which was the production of solutions to meteorological measurement problems. If deviations from this were to be made, the new products should be unique and new to market or they should fill a gap in the market that would enable pricing the offering freely. This further streamlined how the company would develop new products.

One-millionth radiosonde was delivered in February 1975 on behalf of the whole company and the Finnish main company broke the 800.000 mark on producing radiosondes. However, the economic recession (oil crisis to be specific) in the western world had also hit Vaisala that year and resulted in reduced sales, especially in South Africa and the World Meteorological Organiza-

tion. This was a short-lived period as by the beginning of 1976 the stock of orders was on an all time high and crossed the 21 million FIM point.

On the front of developing automatic weather stations Vaisala was able to hand over the Kemi lighthouse after substantial hardship such as the toppling over of the lighthouse in the winter of 1974-1975. The COST 30 initiative was also started and enabled Vaisala to reap the benefits of Finland being part of COST. This enabled Vaisala to develop a new type of microprocessor-based automatic weather station, which would later on be commercialized under the name MIDAS. The previously started HATTARA project sparked the interest of FMI in buying this system as well and they ended up being the first customer for the system. During the same year the CORA system was also finally fully commercialized and Vaisala also started a new project with University of Tampere to develop a personal dust sampling pump to be used by healthcare professionals.

In 1976 Vaisala transformed the organization structure again. The principal idea behind this was to separate the functional organization into product lines that use similar production methods. This idea came from a Harvard Business Review article by Skinner (1974). The main idea behind this was that it enabled each product line to focus on its core technologies, responding to the demand of this specific market sector and providing the level of quality that was required. Therefore, three lines were established. These were: mass product (i.e. radiosonde), device and system lines.

With regards to new product development, Vaisala was finally ready to switch to new sonde batteries developed in-house that had been under development since 1973. This substantially increased the reliability of battery deliveries. Also HATTARA was handed over and the MIDAS weather station was completed when the first prototypes were presented in a meeting of the COST initiative held in Reading, England in September 1976.

In 1977 Vaisala was able to secure the single biggest project in the history of the company when WMO decided on January 1977 that Vaisala would be the main supplier of equipment for the First Global Garp Experiment (FGGE). The goal of the project was to obtain reliable observations from all over the world and the plan was to equip 15-30 ships with the CORA system developed by Vaisala (Janatuinen 1986). The total value of the order was almost 10 million FIM (ibid.) which was huge for a company that had a yearly turnover of around 40 million FIM.

During the same year the development of a new radiosonde was started. The main reasons for this were that installing the HUMICAP into the existing radiosondes made the other parts look helplessly clumsy and that the Australian Weather bureau had noted that they would not buy the RS 21 radiosonde as it did not provide any significant improvements when compared to the radiosondes used in Australia. These events sparked the development of a whole new radiosonde.

In 1978 the board of directors made a crucial decision on the international expansion of the company. Vaisala would open up sales subsidiaries both in the United Kingdom and in the United States. These plans were to be actual-

ized in the near future. Also, they decided to deepen knowledge of thin film technology (essentially semiconductors) that the company had and it was separated to be an independent product line.

In summer 1979 Vaisala started transforming the organization structure into a matrix organization. In addition to the already existing finance and accounting, product development, production and commercial functions, four profit-and-loss centers would be established. These were sounding line (including radiosondes and their ground equipment), humidity line, weather station line and thin film line (focusing on semiconductor technology).

The transformation was intended to enhance the capacity of the organization to provide solutions to customers' problems in each market and the product lines received designated product line directors. The responsibility of product development would also be moved from the new product group into being the responsibility of each of the profit-and-loss units. This transformation was predicted to last for approximately a year.

In the annual report of 1979 it was highlighted that Vaisala had enjoyed a tremendous growth during the past ten years. During that time billing had grown thirteen fold and the amount of staff had almost doubled. This was identified mainly as resulting from investments in product development, training of staff, increasing automation and the building of new facilities that increased production output. This was projected to give a good starting point for the next decade.

During 1979 Vaisala was also able to launch SODAR. This was the acoustic radar project that had already been started in 1972. While market for the product had changed vastly during the past years, it was still deemed that market for the product would still exist outside US and that the product had potential.

By 1980 the product development department had reached the 70-employee mark. This was largely due to the heavy emphasis on developing new products in multiple different product areas. In the annual report, an emphasis was added on internationalization and marketing. These were the new goals that the company would strive towards in the first half of the new century. Grounding for them was based on the new product lines that had been developed, which would from now onwards focus more on maintaining the quality of the products and develop new add-ons.

Despite change in the focus of the company, Vaisala launched the new RS 80 radiosonde in 1980. This added a new smaller and lighted radiosonde to the product portfolio of the company. The new RS 80 was a pocket-sized radiosonde that weighted 200 grams and did not need any assembly or calibration before use (Michelsen 2006, p. 143). It became the new standard radiosonde for the company and later on it was identified as one of the most important product development projects that had been undertaken in the 1970s.

The organizational transformation that started in 1979 was completed in 1981 as the original new product group was dissolved and the responsibility of new product development was moved to each of the profit-and-loss units. The

fulfillment of this transformation ends the period of inquiry as the organization and its way of developing new products transformed.

5.4 Main product development projects

During the 1970s and the beginning of the 1980s Vaisala undertook a large amount of product development projects. To select cases I applied two main criteria. First, the project has to develop something substantially new. Therefore, small incremental projects that only aimed to create a new part for an existing product were excluded from the analysis. What is more, mere extensions of already existing products were left beyond the analysis. The decision to do so was based on the notion made in the theoretical part that such projects rather represent outcomes of the project. These kinds of cases were abundant in the data.

Secondly, the cases had to be extensively documented in the company reporting. This enabled proper analysis and also indicated their centrality for the company. Many projects had abundant descriptions of their principles and background logic on how they function in the new product development annual reports but had only scant information on what was actually done. Many times this was also reflected on the minuscule attention they received from the new product development group that supervised the product development initiatives that the company undertook.

Next I will provide a brief narrative of each of the main NPD projects in chronological order. By doing so my aim is to highlight the main events through which the project proceeded and the outcomes that resulted from the project.

ELSA (Electronic Lobe Switching Antenna)

ELSA was an automatic antenna for receiving satellite signals that was later complemented with a switch for selecting the satellite. Weather satellites had been a new developing technology in the 1960's as NASA had launched their first weather satellite NIMBUS into orbit in 1960 and in 1963 Soviet Union launched their first satellite (Michelsen 2006).

The initial idea and prototype of the product was developed in HUT (Helsinki University of Technology) in 1969 and Vaisala complemented this prototype with their own technology. At the end of the year 1969 the prototype was first tested in the laboratories of Vaisala and after this in the FMI (Finish Meteorological Institute). The results from both of these tests were so positive that Vaisala decided to add ELSA into their product portfolio. In March 1970 Vaisala made a contract with the inventors of the product to transfer the rights of the product to Vaisala. After this, marketing and design of a commercial product commenced. While designing the switch proved to be more challeng-

ing than anticipated, the finalized product was moved to production in February 1971.

While in 1972 there were plans to make a new version of the product in 1680 MHz frequency, it proved to be technically too challenging and thus ELSA remained a single product. In 1973 further development of the system was cancelled as new more interesting technologies were emerging. By 1979 sales of the product had pretty much died but it still had left an impression on the customer base as new solutions were asked from the company on monthly basis.

RS Restructuring (RS 18 Radiosonde)

In 1969 Vaisala had developed the RS 16 upper-air radiosonde. With the help of HUT, Vaisala tried to find a solution for correcting measurement errors that resulted from radiation. A proper mechanical solution was not found and the product was complemented with a template for correcting these errors. This was partly due to the deadline of presenting the product in a sonde comparison held in Leningrad in 1969. Despite deficiencies, RS 16 was announced as a reference sonde for the market.

Due to the deficiencies that the RS 16 had, in January 1970 a new project was set up to correct all known errors that had been left in the product. At this point the project was directed at improving the existing RS 16 product. During 1970, specifications for the project were reorganized several times due to technical changes and in March 1971 the specifications were also changed based on an analysis of customer value the product would give. During the winter 1971 the product was also exhibited in WMO conference in Genève and it was used to make measurements in Nairobi. While the project was clearly making progress in regards to improving the product technically as well as customer value wise, it suffered from constant changes in the goals of the project.

The restructured product got its final form in May 1971 and it was named RS 18. In August 1971 final drawings for the product were commenced and in September subcontractors were commissioned to provide the selected parts. In March 1972 the first production run of 3000 radiosondes were ready. Overall the project was done in-house using concurrent engineering accompanies by selected presentations and testing in international venues such as the WMO conference mentioned earlier. The RS 18 remained a standard product that was sold to customers until 1974.

RS 21 and RS 24 Radiosondes

The RS 21 and RS 24 radiosondes were developed as a byproduct of developing the RS 18 radiosonde but they functioned on a different frequency. They were developed because customers were putting increasing pressure on Vaisala to develop radiosondes that would work with ground equipment of other manufacturers as well. This resulted in the development of a new sender for the sonde that would fit with receivers of other manufacturers as well. Technically

the product would be similar to RS 18 and would enable selling radiosondes to ground equipment of other manufacturers that would increase the size of the market Vaisala could serve with radiosondes.

In 1972 the first production run of the sonde was ready. The new radiosonde was also made compatible with OMEGA system that would be used as its ground equipment. Furthermore, in 1973 the sonde was further developed so that HUMICAP could be used in it. Of the two products RS 21 was the more lasting model as it was sold throughout the decade, whereas in 1973 last 800 RS 24 radiosondes were delivered to Italy. After this RS 21 replaced RS 24. What makes the project significant was its role as the central radiosonde product that Vaisala had before they introduced the RS 80 radiosonde at the beginning of 1980s.

CK 12 Aviation Radiophone

The CK 12 aviation radiophone was a backup radiophone system for air traffic control that could be used either from a static location or moved into a vehicle and used as a mobile air traffic control unit. In the 1960s Vaisala had developed a previous version of it to the Finnish air force and in 1971 they wanted Vaisala to develop a new product that would have a synthesizer.

During 1971 a prototype and documentation of the product was made by the Vaisala product development department. However, the project suffered from many challenges as producing the radiophone was harder than anticipated and the customers' needs were constantly changing. The project lay dormant until September 1973 when the new product group decided to shut down the project due to following reasons:

- Too difficult to fulfill the needed specification
- Home market was too small and expansion to international markets was hard as competition was fierce
- The product did not fit with marketing and there was a lack of know how in the company

Therefore, the CK 12 aviation radiophone remained only a prototype and Vaisala negotiated their way out from the deal of producing aviation radiophones for the Finnish air force.

CORA (Correlation Radio Wind Finder)

The CORA-system was an automatic upper-air observation system for on-line processing of pressure, temperature, humidity and wind data (Michelsen 2006). The CORA-system was built to function in the global OMEGA radio navigation system that was at the time the only possible solution to do upper air wind measurement from moving ships at a decent cost.

The CORA-system was developed from two separate pre-studies, namely the RT 400 radiotheodolite study and Fledermaus-component study that were both originally intended to be standalone products. On one hand, the RT 400 was a pre-study project to develop a new kind of radiotheodolite and the project had been initiated in October 1969. While the project was able to do successful test soundings in February 1970, the sounding results did not provide satisfactory results. Thus, the product development management decided that continuing on this initiative was not possible and a new principle for doing these functions had to be developed.

The Fledermaus-component, on the other hand, was a pre-study project to develop a new component into the radiosonde to measure distance using transponder principle. The project was done in 1970 and 1971. While it produced test sounding, some of which were promising, the project was lagging in schedule and was low in the priority list.

In 1971 these two pre-studies were bundled into a single upper-air wind measurement system project. The new bundled project was commenced through an in-depth literature review of different ways to measure upper air winds. Of the possible solutions, the use of a response sonde and a theodolite proved to be the cheapest option to develop and it was pursued in the latter part of 1971. At the beginning of 1972 the market for developing NAVAID systems was enhanced substantially. At that time the product development management predicted that of the NAVAID systems, OMEGA would cover most of the world in the near future. Also WMO (Word Meteorological Organization) had indicated that the OMEGA system was a crucial component in the weather measurement network of the future. Therefore, the development of an OMEGA system was chosen as the new goal of the project.

Active development of the system started in February 1972. The project consisted of developing a new radio receiver, developing a new processor and making them compatible with a radiosonde. To assist in the development Vaisala made an informal agreement with HUT that they would assist in the development of a suitable processor for the system and applied for financial support from Finnish Ministry of Trade and Industry.

During 1972 numerous prototypes of the receiver were developed and a functioning solution was found. This part of the project proved to be efficacious as many successful soundings were made and a test production run of 20 units was made. The system used the new RS 21 & 24 radiosondes that had just been developed. To process the data, Vaisala ordered a study from HUT on the theoretical principles of how such a processor should function and decided to use Data General Corporations NOVA 1220 computer to process the data. Based on the study ordered from HUT, a functioning correlator was built onto the NOVA computer. By November 1972 numerous successful soundings had been made with the OMEGA sonde, correlator and receiver. Three units of the system were ready by autumn 1973 and two of systems had already been sold to French Meteorological Research Institute (to be installed in French ships La Perle and Capricorne) (Janatuinen 1986, p. 60).

The system was further extended with a digitalizer that was ordered from HUT in March 1973. This provided a functioning prototype that was ready in March 1974. To further develop the PTU (Portable Test Unit) potential for the system new software also had to be developed. Vaisala had developed the original software for CORA but an outside research team was hired at the end of February 1973 to deliver new software. They had completed this task by summer 1974. In March 1975 development of the final system was completed and later on the system was patented.

Further development of the CORA system was continued throughout the 1970s' and 80s'. A MicroCORA system was developed from the original CORA by switching the computer into a MikroNova and it was launched in 1981. The CORA system was also the central component in the FGGE project that started in 1977. It was the single biggest deal Vaisala had made until that point. It was worth 10 million FIM, while the turnover of Vaisala was in the year 1976-1977 approximately 39 million FIM (Janatuinen 1986, p. 66).

Kemi Lighthouse

In April 1972 Vaisala started a pre-study on the functions of existing automatic weather stations and the kind of specification WMO suggested for them. This set the requirements for developing an automatic weather station. After this, they negotiated VTT to partake in the development of the sensors for the automatic weather station. They also negotiated a research contract with the newly founded SITRA to finance the development. This project was the first step in establishing a presence in the automatic weather station market.

The development continued in-house until the Finnish Maritime Association started a project to develop an automatic weather station for Ulko-Kalla. Vaisala had no information of this development as the CEO of the company Yrjö Toivola read about the project in a newspaper (Michelsen 2006, p. 147). At this point negotiations were already underway with the Finnish company Strömberg and Pleassey Radar Ltd. (ibid.).

Vaisala started immediate negotiations with an American Sierra Research Corporation for jointly delivering a bid for the project. Sierra was a very potential collaborator as they had already delivered automatic weather stations to Swiss Meteorological Institute (Michelsen 2006, p. 147). After hard negotiations the Vaisala-Sierra collaboration won the deal and signed a contract on developing the station in April 1973. This was splendid news for Vaisala as at that point they estimated that there would be market potential for approximately 20 similar stations.

Project execution did not go as planned and there were several delays due to suspensions in receiving equipment from subcontractors and technical problems with the weather station. In addition, the Ulko-Kalla lighthouse collapsed in the winter of 1974-1975 and installing the system was moved to Kemi. Despite the setbacks, in June 1975 the weather station was up-and-running.

In the summer of 1975 Finnish Maritime Association sent Vaisala an invitation to tender on two more automatic weather stations that were completed in

1977. This enabled Vaisala to further develop the weather station. This project also helped in the development of new automatic weather stations in the future such as HATTARA which is described later on.

METOX switch

METOX, a French company manufacturing radiotheodolites, and Vaisala initiated collaboration in 1972 in which Vaisala would redevelop the METOX theodolite into a semiconductor based product. Decision to venture into the collaboration was based on a market analysis of the potential cash flow that this collaboration would result in. Furthermore, the METOX product was perceived to be a cheaper solution to customer than the OMEGA-based one which was under development. Therefore, it filled an open spot in their current product portfolio.

The project was initiated through a pre-study where Vaisala constructed a functioning prototype of a possible product. As building a whole new receiver was perceived to be too extensive a project, Vaisala developed a new automatic switch that would increase the reliability of the METOX theodolite instead. The first version of this was finished in March 1973. However, the prototype development continued throughout the year 1973. At the beginning of 1974 the product was still under testing and further considerations to determine whether it would be a feasible product were postponed until after the tests. At this point there were both good and bad sides to this kind of product. On the upside, the mechanical construction of the product was pretty much done and there was an existing customer base for it. On the downside, the product was growing old because it was a mechanical solution.

In October 1974 the switch was moved into production. This marked the completion of the original goal. Simultaneously, however, a new pre-study was initiated on improving the mechanical structure of the receiver that was its biggest deficiency. This was partly due to the fact that ERCOS S.A. that was the provider of the current mechanical structure was not interested in renewing it and their prices for the current mechanical parts were very high. In 1975 Vaisala focused on developing mechanical parts for the product so that the collaboration with ERCOS S.A. could be terminated. In 1976 the product was further improved by simplifying it in order to keep it as a viable option to CORA. Additionally, a number of smaller improvements were made to the product.

HUMICAP

HUMICAP was one of the most revolutionary products that Vaisala had ever developed. Essentially the product was a new humidity sensor that functioned on thin-film technology, instead of using the old hair hydrometer that was very fragile (Janatuinen 1986, p. 76). Development of the initial product eventually

led to the development of a whole family of products and HUMICAP affected multiple other products as well.

It all began in 1971 when the CEO of Vaisala commissioned a study to find which meteorological quantity was hardest to accurately measure and how this problem could be solved (Michelsen 2006, p. 140). This task was taken up by a team of researchers working in the semiconductor laboratory of VTT that decided to investigate technologies to measure relative humidity in the atmosphere (ibid.). In summer 1972 the team of researchers were getting promising results on the new material they had developed and they promised a test run of 100 sensors in October or November 1972.

Based on these results the new product group decided in August 1972 to test the new sensor in the new RS 24 radiosonde. In the same meeting potential for the new sensor to be used in other applications such as weather stations, greenhouses and air conditioning were also discussed. However, producing the new sensor required an investment of 100.000 FIM to set up appropriate production facilities. Based on this, the group decided that Vaisala would patent the base material and structure of the sensor.

In December 1972 further inquiries into the potential market for humidity measurement were made when the new product group inquired for the credit ratings of two companies that solely operated in the humidity measurement business (to determine their sales volumes). To continue the development of HUMICAP and to make it into a viable product, the product development group decided to apply for funding of 60.000 FIM from SITRA (The Finnish Innovation Fund).

In March 1973 the product was re-evaluated and it was deemed appropriate to be used in radiosondes and in a handheld measurement device that had already been planned in late 1972. In addition to this, the product was planned already to be a product family that would consist of four product groups: 1) sonde sensor, 2) humidity transmitter and receiver, 3) small measurement devices and 4) measurement devices for home use. At this point the product was test marketed to meteorologists and the handheld device was test marketed in Finland. In November 1973 some customers had already asked for offers for the product and therefore the new product group decided to start selling the new sensor. In December the project to further develop HUMICAP ended and the transfer of know-how to Vaisala was almost done.

In February 1974 the new production equipment was received and commercial production of the sensor was started. At the end of the month first functioning sensors were ready.

The product ended up being applied to multiple new products and contexts throughout the 1970s. For instance, General Motors inquired in 1974 whether they could use it in their cars and applications for industrial solutions were also developed.

Electronic Microscope

In December 1972 a project for developing an electronic microscope was initiated. At that time the new product group noted that the methods of production were very familiar to what the company knew but the required precision is of a different level. Also the company had already developed a prototype of a similar product for their own use. The initial plan was to promote this product in conferences and see how it sells.

The product idea was compared to HUMICAP and the CK 12 aviation radiophone and they were concluded to have more potential from a marketing perspective. Doing the project would also require new equipment for approximately 100.000 FIM worth. In January 1973 the product development was scrapped for the following reasons:

- Not enough resources
- Requires too large investments in marketing
- Competition can generate huge troubles
- The product is against the operating principles

Therefore, the electronic microscope remained a short-lived project that did not meet the needs of the new product group for it to be taken further.

New Sonde Batteries

Before endeavoring into actual product development, Vaisala had done tests on the batteries they used in 1971. In April 1972 Vaisala commenced a pre-study (literature review) on different battery solutions. The goal of the project was to find an economical and easy battery solution for the new RS 18 radiosonde. Batteries are a key component of a radiosonde and their use in radiosondes had always been challenging due to atmospheric temperature changes.

Vaisala also requested offers from 9 international battery manufacturers. The offer of Eagle-Picher proved to be the cheapest one and in April 1973 it was chose as the provider of new batteries. In September 1973 Eagle-Picher, however, decided to raise the price of their batteries and to counter this Vaisala decided to start developing its own battery. Based on the literature review, the Vaisala product development department successfully manufactured test versions of Mg-CuCl battery cells and batteries. The pre-study ended in November 1973.

After the pre-study, actual development of a battery commenced. Studying the minimum quantities of active components to develop a battery that would be cost effective started the development of a new product. Due to the fact that testing different solutions by hand was very slow, it was proposed that Vaisala would construct a part of the production machinery that would cost less that 100.000 FIM. Therefore, at the first stage, the goal was to construct a machine for producing and testing the batteries. Simultaneously, Airam (a Finnish company manufacturing light bulbs and batteries), was also interested in pro-

ducing the batteries for Vaisala. The decision to produce the batteries in-house or to outsource was left to be decided based on the price.

Producing the batteries in-house provided to be the best solution and in June-July 1975 the first test runs of the battery were done on the new production machine and optimizing the batteries for commercial use could be started. The new production machine was delivered to the production department in January 1976 and no further changes to the battery design were made after this. However, before production began, the production machine was still fine-tuned. Also production infrastructure had to be built, including an air-conditioned production space and a quality control system. Finally, compliance of the battery with RS 18 was ensured.

SODAR – Acoustic Radar

The development of an acoustic radar was initiated due to the need to partake in the remote sensing business. The goal of the project was to develop a measurement device and methods for meteorological and air pollution measurement using sound wave technology. These products were eventually used to measure height of the inversion layer in airports. Inversion layer is the lowest layer of the atmosphere where temperature increases when height increases.

Decision to start development in this area was made in the spring 1972. However, the project lay dormant for a year and in February 1973 a pre-study project was initiated. The University of Oulu proposed that they could do the pre-study. As the team from Oulu was perceived to be cheaper than using HUT they were chosen for the job. The goal of the project was to do a literature review on the subject and to build a first prototype. At that time the perceived upsides of the project were that it would be the first step in the remote sensing business, projected costs were moderate and the project did not use resources from Vaisala besides the money given to Oulu University. However, at the beginning of the development, the unclear market for this kind of product and its me-too nature were considered to be its downsides.

In December 1973 the project was reviewed and the new product group came to a conclusion that a market for this kind of a product did indeed exist. The pre-study continued until February 1974. After this, in March 1974 active development of a commercial product was initiated based on the pre-study. In fall 1975 a prototype of the product was ready and it was moved to testing where further improvements were made. At that time the new product group made a decision that the product would be simple and additions such as DOPPLER compatibility would be made later. The product was exhibited in CIMO VII conference in 1977 but moving it to commercial production was delayed until 1979. In the meantime Oulu University had also proposed a new project for improving the product but Vaisala management declined the project because the product was not on the market yet and thus no customer feedback existed.

Due to the long timespan it took to develop a marketable product, the new product development group noted in January 1979 that the product would be

launched significantly after the competition. On the same occasion they noted that market outside US would still be lucrative and taking part in this area of business was important as it provided new technologies for the company. Despite this, in May 1981 the new product group decided to discontinue the product because it did not sell very well despite the fact that it generated interest from customers.

HATTARA (HAvainnonteon, Tiedonvälityksen, TArkkailun ja Rekisteröinnin Automaatio)

During 1973 Vaisala and FMI together started to research the basic functions that a weather station at an airport should have. In May 1974 FMI sent Vaisala an invitation to tender for automatizing the weather equipment at Helsinki-Vantaa airport. The project was immediately considered crucial for enhancing the grasp of the automatic weather station market.

Actual development of the product was started August 1974. At that time there was already a second customer participating in the project as a similar system was sold to Saudi-Arabia (Medina airport). In October a potential French customer emerged as well. At this point the project was kept at very basic level, as there was knowledge that COST 30 project would start in the near future and as part of it new extensions for the basic product could be made.

A large part of the components used in the product were bought from outside and Vaisala concentrated on assembling the final product and making the different parts compatible with each other as well as producing the display units. In November 1975 the system was set up and turned on. It was tested until February 1976 when the final handover was made. At the end of that month the system in Medina was also up and running.

Further development of the HATTARA systems was done within the COST 30 initiative where a micrometeorological measurement station was developed and installed to the HATTARA system. Overall the project was very successful as it later on enabled Vaisala to develop, for example, the MIDAS system and enabled Vaisala to partake in bids regarding airport weather stations. It also spawned invitation to tender on developing similar stations to ASECNA (Agency for Aerial Navigation Safety in Africa and Madagascar).

Personal Dust Sampling Pump

In September 1975 University of Tampere proposed Vaisala the development of a personal dust sampling pump. The product was to be used, for instance, in mining, founding and stone processing by occupational healthcare officials. At this stage the Tampere research team only had an idea of what the product could be. However, they had already made a deal with the ministry of trade and industry that they would finance the development. The product was deemed by the new product group to be a possible supporting product for

HUMICAP. Therefore, the new product group decided that they would partake in the project if it would not incur costs and if they could re-evaluate their participation when a prototype of the product was ready.

The actual product development commenced in December 1975 and the goal was to have a working prototype done in 1976. During spring 1976 market for the product looked promising, as there was no product that would have the same measurement precision and three possible distributors for the product were found. In the fall a functioning prototype was ready. At this point the market situation had changed as competitors were entering the market. In November the new product group made a final review of the project and decided to shut it down. This was due to the following reasons:

- Knowledge of how the product would eventually function was vague
- Volume for the product would be too small
- The product could not be patented
- Competition would be too intense
- The product would not fit into the product portfolio

Therefore, the personal dust sampling pump remained a university led initiative that could not fill the required criteria to be made into a Vaisala product.

MIDAS 300 (Meteorological Information Data Acquisition System)

MIDAS was a microprocessor based automatic weather station that measured wind speed, wind direction, pressure, temperature, humidity and precipitation. Actual development work of MIDAS was started as a part of the COST 30 project in October 1975 due to the fact that Vaisala partook in the automatic weather station project of it. The goal in the COST initiative with regards to this project was to get a prototype into COST 72 exhibition and to produce one functioning prototype. In December 1975 FMI got interested in buying the system and there were also other possible customers for example in Saudi-Arabia (where HATTARA had already been sold to). One of the primary reasons FMI got interested in the product was that Vaisala had already had some experience in weather stations at airports in the form of the HATTARA project.

MIDAS was a particularly interesting project for many reasons. First, Vaisala was able to develop the product directly to the main customer and there were also possible customers outside Finland to whom the product could be sold. The project was also a natural continuation of the automatic weather station product line that was considered to be a growing business of the future. Finally, the Ministry of Trade and Industry also gave ample financial support for the project.

Three prototype weather stations were ready in 1976 and they were on display in the exhibition. The project also had some setbacks as the software supplier Digelius Electronics went bankrupt and Vaisala had to do the software themselves. Despite this, the project was completed during the COST 30 initia-

tive. Later a smaller version of the product called MILOS was launched in 1978. Also the MIDAS product was further developed into MIDAS 310 that was installed to Pirkkala and Turku airports.

RS 80 Radiosonde (NASTA)

Idea behind developing the RS 80 radiosonde was the need to develop a smaller, lighter and aviation safe radiosonde. Initial spark to develop a new radiosonde came when HUMICAP was installed into the RS 21 radiosonde and it made the other parts looked clumsy. This was further instigated when during a sales trip to Australia, the Australian Weather Bureau noted that RS 21 did not provide significant improvements to the current radiosondes used in Australia (Michelsen 2006, p. 142). During the flight from Australia to Singapore, the idea for a new radiosonde dawned to the CEO Yrjö Toivola and development director Pekka Kostamo and during that same flight they drafted the first specifications for the product (ibid.).

The official new product development project of the RS 80 radiosonde started in May 1977. The project was initiated by starting pre-studies on different areas of the new product. Also a separate think tank of industry experts was formed to give ideas on developing the product. The previously separate THERMOCAP project, aimed at developing a new thermometer for radiosondes, was also subsumed under this project. During 1978 prototypes of the different parts of the product were made in Oulu University and Brighton Polytechnics.

This project was of utmost importance to Vaisala as the new product group memos stated numerous times that new development work cannot be started because all spare resources are tied to this project. This is understandable as the RS 80 would be the new standard sonde for Vaisala and continue the traditional main product line of the company. Before launch the product was also extensively tested for a year in the Danish Meteorological Institute where more than 500 test soundings were made (Michelsen 2006, p. 144). First production run of the new sonde was ready in August 1980 and the product was launched the same year. The final RS 80 was a pocket-sized radiosonde that weighted 200 grams and did not need any assembly or calibration before use (Michelsen 2006, p. 143).

For Vaisala the RS 80 was the new standard sonde that would be sold to all new customers. Variants of the product were made such as a sonde that would only measure wind. It also affected the further development of ground equipment as it was first configured to work with the MikroCORA and later on separate ground equipment was developed. The product was very successful as for example in ship-based measurement stations the RS 80 sold more than any of the competitors' product in 1988.

5.5 Emergence and change of product lines

Now that I have outlined the broad organizational changes during the period of inquiry and the main product development projects, it is timely to depict how the product development projects contributed to the emergence and change of product lines. In approaching the development and change of product lines, I will provide individual narratives of how each of the product lines were developed during the period of inquiry. By doing so my aim is to highlight the relationships between different NPD projects and their role in the development of product lines.

Sounding line

The sounding line had been the traditional core business of the company since its inception. A total of eight products were developed during the period of inquiry that can be associated with this product line. These were:

1) ELSA
2) RS restructuring
3) RS 21 and RS 24
4) CORA
5) METOX
6) New sonde batteries
7) SODAR
8) RS 80 (NASTA)

The first new product that was developed was ELSA, which was started in 1969. Its development was led by Helsinki University of Technology that had initially developed the technology. The project was finalized as a joint project between Vaisala and HUT. At the time of development, there was knowledge that market for these kinds of products would increase but there was no certainty whether this opportunity could be fully captured with the product. The product was a standalone solution, as it did not have converge points with radiosondes that had already been developed in this product line.

RS restructuring continued the development of the sounding line in 1970. It was started as a project to enhance the previously developed RS 16 radiosonde. Initiation of RS restructuring also sparked the development of RS 21 and RS 24 radiosondes in 1971. Both of these products were developed to extend the already existing sonde line by correcting known errors and making the radiosondes compatible with different types of ground equipment. Their function was to retain the current position of Vaisala in the sonde market. RS 21 eventually became the standard radiosonde for the company and it was sold throughout the decade.

CORA continued the product line in 1972 with regards to producing new ground equipment to be used with radiosondes. Its development was guided

by an in-depth study on the different ways to measure upper air winds and the perception that NAVAID systems, especially the OMEGA type, would become widespread in the future. Development of CORA and the RS 21 and 24 radiosondes converged with each other as they were made to function with each other early on during their development so they could be used together to make soundings.

Only months after the development of CORA had been initiated on a full scale, Vaisala also initiated a collaboration to develop the METOX theodolite. The METOX project was perceived to complement CORA, as they both were products for the same market but at different price points (METOX being the cheaper option). The project was oriented towards extending the METOX theodolite into a semiconductor-based product and materialized into an automatic switch. As there was existing market for the METOX products and an impetus to have a stronger position in the radiotheodolite market, the product was perceived to grant a hold of the METOX market. What the product amounted to was a foothold in the METOX theodolite market and a product with a distinct position in the Vaisala product portfolio.

New sonde batteries continued the product line with the intent of increasing the reliability of radiosonde deliveries by producing the sonde batteries in-house. This project was initiated through a pre-study to learn how batteries could be made and after Eagle-Pitcher raised the price of their batteries Vaisala started the development of their own battery. What this amounted to was an in-house produced battery that could be incorporated into the existing radiosondes and further developed. Therefore, the role of the product was rather to strengthen the existing product line by increasing efficiency and reliability of deliveries. In and of itself, it did not extend the product line with a new offering but rather addressed a key challenge with radiosondes which was the functioning of batteries that were subjected to extreme variation in temperature and humidity as the radiosondes climbed through the atmosphere.

The development SODAR continued the product line, as the project was initiated in 1973. It deviated largely from the other products as it was a weather radar (something the company had not done before). It was also intended to function as a standalone product as it was not utilized in conjunction with radiosondes. A significant part of the product was done in University of Oulu. The development of SODAR lagged behind schedule for years but eventually it was launched into the market in 1979.

A significant renewal of the product line materialized when RS 80 was developed. The product usurped all the previous radiosondes with its new and lightweight construction. Like with the other radiosondes, it continued the product line and provided added value to the customers. Its impact was significant as it replaced all other radiosondes as the main radiosonde product of the company. Therefore, it became the new standard product that was sold as such and further developed into different modifications. Much like the RS 21 and 24, it was directly developed to work with MikroCORA (2nd generation CORA system).

The product line was split into two distinct sub lines in 1981. The two sub lines were sonde line and equipment line. This was preceded by a change in 1976 to separate radiosonde production into its own product line.

Automatic weather station line

The automatic weather station line was developed from zero during the period of inquiry. However, Vilho Väisälä had already tried to build an automatic weather station in the 1950s and 60s but suitable technology did not exist at that time (Michelsen 2006, p. 146). Therefore, automatic weather stations were not a completely new thing for the company. Three products that were developed during the period can be associated with this product line. They were:

1) Kemi lighthouse
2) HATTARA
3) MIDAS

The automatic weather station line was originally initiated through a pre-study on the functions of automatic weather stations and the specifications that WMO suggested for them. This was concretized in the first automatic weather station project that was the Kemi lighthouse in which the American Sierra Research Corporation collaborated with Vaisala to bid for the project and construct the weather station. The development of the lighthouse commenced in 1973. The project was perceived extremely important as the company had impetus to establish itself in the market, the first customer (Finnish Maritime Administration) was know, future customer potential was perceived to exist, and with the help from Sierra in building the lighthouse, it could fit the needs of the customer. Completion of the project established the presence of Vaisala in the market.

Shortly after the first automatic weather station project had been initiated in 1973, the development of the product line was continued by HATTARA that was initiated as a pre-study with FMI to know the basic functions of automatic weather stations in airports. Actual development of the product was started in August 1974. The project was considered to be crucial as it enabled advancing into airport weather measurement. In addition to selling the system to be used in Helsinki-Vantaa airport a similar system was sold to Saudi-Arabia.

Final main product in this product line during the period of inquiry was MIDAS, which was a new microprocessor based weather station. It was developed in collaboration with external parties as a part of the COST 30 initiative that started in October 1975. The goal of the COST project was to develop a prototype to be displayed in COST 72 exhibition. This method of working with third parties enabled Vaisala to lead the development and reap the benefit of using the knowledge of third parties in the development. FMI also agreed to buy the product when it was ready as Vaisala had previously succeeded in providing then with the HATTARA system.

Humidity measurement line

The humidity measurement line was developed from scratch during the period of inquiry. The only focal product in this product line was HUMICAP. The humidity line was originally initiated in 1971 as a challenge that the CEO had given to different research institutions on finding the meteorological quantity that was hardest to measure accurately and finding a new solution for its measurement.

What came out of the challenge was a solution from VTT that Vaisala tested in fall 1972. The product was considered to have potential as component of radiosondes and automatic weather stations. In addition to this, HUMICAP was planned to become a product family that would consist of 1) sonde sensor, 2) humidity transmitter and receiver, 3) small measurement devices and 4) measurement devices for home use.

What the single product amounted to was tremendous and a separate product line concentrating only on HUMICAP was established. However, the product line only consisted of a single central product from which different applications were made. Despite this at end of the decade when Vaisala transformed into a matrix organization, the decision to establish a separate microelectronics line was largely influenced by HUMICAP that remained a separate product line.

This concludes the section that identifies the main historical events, NPD projects and the development and change of product lines during the period of inquiry. Next I move into analyzing the NPD projects to identify recurring activities pertinent to new product development and after this to proposing mechanisms that underlie new product development.

6. Analyses of NPD projects and the recurring activities

6.1 Identifying entities, activities and their influence

Stemming from the centrality of entities, activities and structures, I now seek to depict the different actors and their influence in the new product development of Vaisala during the period of inquiry. Specifically, four different kinds of entities had an influence on the NPD projects. These were: 1) Vaisala new product group, 2) Vaisala NPD department, 3) external research institutions and 4) customers and collaborators.

Vaisala new product group was a central entity within Vaisala throughout the period, as they orchestrated product development within the company and also managed external relations. They were the central decision-making unit in Vaisala as they assessed which NPD project would be started, which projects would be commercialized and which ones would be terminated.

The new product group was in charge of a number of activities. They were mandated with choosing which projects to start. This included both projects to improve existing products as well as projects aimed to develop completely new technologies and products. The new product group also decided how the NPD work would be organized and what kind of activities would be undertaken. This could include, for instance, ordering a pre-study from the University of Oulu as was the case with SORAD or doing the same activity in-house as was the case with developing new sonde batteries.

The new product group was also the entity that evaluated NPD projects when the projects reached a stage where their technological and commercial potential could be evaluated. This evaluation led to the termination of, for example, the Personal Dust Sampling Pump project, while many other projects fulfilled the set criteria and were commercialized.

As the main decision-making entity, the new product group also bore the responsibility to decide on investments into new production equipment, whether products would be further enhanced, and how the products would affect future evaluation of new product development projects. Therefore, they also had a major role in deciding how the recently launched products would affect future product development.

As already noted, within Vaisala the new product group was the main decision maker with regards to new product development. This was largely due to the fact that the head of the group was the CEO of the company Yrjö Toivola and the group members included R&D, marketing and commercial directors of the company. Therefore, the group had direct power over different units of the organization as well as all the NPD activities that were done.

Vaisala NPD department refers to the organizational unit in Vaisala responsible of developing new products. Despite the fact that new product development was organized around projects, using the department as a single entity lends an amount of clarity to the analysis as the NPD project teams were assembled from the members of the NPD department and many of the members simultaneously took part in multiple projects.

The NPD department was in charge of creating ideas, turning them into a form that could be evaluated by the new product group and then developing them into commercial products. On one hand, when CK12 aviation radiophone project was initiated, it was the responsibility of the NPD department to first make a prototype of the product that could be then evaluated. On the other hand, in the case of developing ELSA, the Helsinki University of Technology (HUT) research team had an idea for the product but the Vaisala NPD department in cooperation with the HUT team turned the idea into a commercial product. The NPD department also conducted a number of pre-studies, such as in the case of CORA, where the development project was initiated through an in-depth literature review of possible solutions.

With regards to all the activities that the NPD department conducted, they were under direct control of the new product group. Therefore, there is a direct structural power relationship between the new product group as the decision-making entity and the NPD department as an executing entity within the company.

External research institutions are a central influencing entity on the Vaisala new product development. The research institutions included, for instance, University of Helsinki, University of Tampere, University of Oulu, and VTT (the Technical Research Centre of Finland).

The main role of these entities with regards to the new product development of Vaisala was to offer ideas and concepts for new products. This occurred through multiple different ways. For instance, the development of the Personal Dust Sampling Pump was initiated when University of Tampere proposed a joint research project on an idea they had come up with. This kind of ideation could also come about in a more indirect manner, as was the case with HUMICAP where Vaisala initially opened a competition for Finnish research institutions to come up with a meteorological quantity that was hardest to measure and to provide a solution to measure it.

Many universities and research institution had good relationships with Vaisala as it had actively developed these relationships throughout the years and the company had always valued academic research. These relationships have their roots in the inception of the company. This stems from the fact that the role of the company was to function as the commercial end of a triumvirate

consisting of University of Helsinki (that provided the scientific knowledge), Finnish Meteorological Institute (that provided financing and practical needs) and Vaisala (that provided equipment to solve meteorological problems). At the heart of this relationship was Vilho Väisälä who had a central role in all of the three instances.

Also due to the research orientation of the company, Vaisala provided many Finnish research teams one of the few opportunities to commercialize technological innovations on a global scale. This was also one of the decisive factors that drew ideas and innovations from the Finnish research institutions to the Vaisala sphere of influence.

Customers and collaborators had a central role in influencing the research projects that Vaisala undertook during the period of inquiry. Specifically, these entities influenced on what kind of NPD projects would be started by indicating demand for certain products and by indicating technological trajectories that could be followed.

The main activities that these entities induced was that they specified the products that they wanted from Vaisala or the kind of products they would be willing to develop in cooperation with Vaisala. For instance, the development of the RS 21 and RS 24 radiosondes was started because a customer put pressure on Vaisala to develop radiosondes that would work in the ground equipment of other manufacturers. On the other hand, the COST initiative provided financing for the development of MIDAS and the further development of HATTARA. Therefore, customers and collaborators had a central role in initiating NPD projects in different areas.

Throughout the years Vaisala had developed close working relationships with many customers and collaborators. For instance, the Finnish Meteorological Institute had been a key customer as well as a collaborator for Vaisala since the inception of the company. This relationship alone contributed to the development of, for instance, HATTARA and had historically been the main proving ground for new radiosondes. Vaisala had also actively taken part in the COST initiative and its meteorology branch to be able to secure their role in future COST projects. From this collaboration, the MIDAS system was developed and HATTARA was further developed. Ongoing relationships with customers also affected NPD and its direction as Vaisala aimed to provide the customers solutions to their measurement problems.

6.2 Event Structure Analysis

The previous discussion on entities, their activities and relationships between them provides grounds for uncovering the influence of different entities on the ideation, evaluation and outcomes of different NPD projects and eventually proposing mechanisms that underlie each of these stages. Now using the event structure analysis method presented in the methodology Chapter, my aim is to

construct an event structure of the events in question. This enables me to deconstruct the period of inquiry into projects, actions and relations.

In coding the events, at least three distinct events were coded for each NPD project: 1) prerequisite event(s) for the beginning of an NPD project, 2) initiation of the NPD project and 3) outcome of the NPD project. Despite the fact that Vaisala had two distinct entities that were central in the NPD projects (new product group and NPD department), the activities of Vaisala were constructed as a single entity to increase clarity of the analysis as increasing the amount of entities generates unnecessary complexity to the event log. The raw event log was also further disseminated into three domains, which were the national domain, the global domain, and the Vaisala new product development domain. This helps in further understanding activities that happened within and beyond the focal company. Figure 8 depicts the event structure of the NPD events from the 1969-1982.

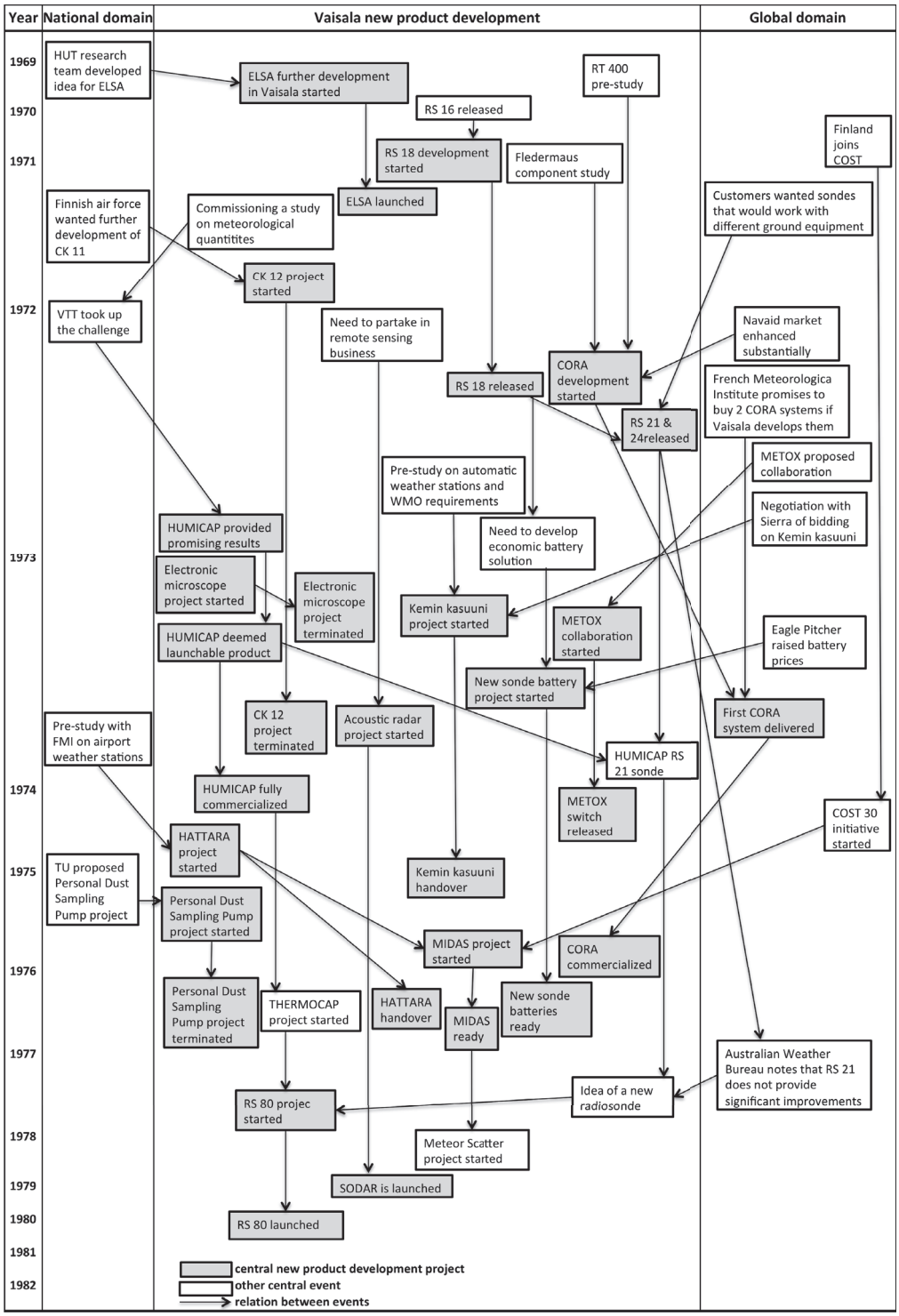


Figure 8: Event structure of NPD projects 1969-1981

From the event structure, we can easily see the influence that actors in both the national and global domain had on the new product development of Vaisala. Therefore, it appears that Vaisala was strongly influenced by the local technological domain consisting of a wide technological knowledge base held by universities and other research institutions. Simultaneously, the influence of the global technological domain focusing on meteorology as well had an influence on the product development of the company. Thus, it is evident that customers, collaborators and Finnish research institutions had a major impact on the NPD projects of the company and that very few projects were started without some kind of external stimulus.

The event structure also reveals that many projects were influenced by previous NPD projects. Therefore, despite the large amount of external influence, the technological trajectory induced by already existing products had an impact on the products that would be developed in the future. Therefore, there appears to be a balance between absorbing external influences and continuing existing technological trajectories induced by the existing products.

The event structure tells only a story of the relationships to third parties that Vaisala had in developing new products and the influence of existing products. The next step is to move to analyze the activities within the NPD projects to define the role and relationship of the new product group and NPD department in actualizing the projects. For doing this, the event structure analysis provides grounding and direction.

6.3 Uncovering recurring new product development activities

Now that a broad picture of the NPD activities has been provided with the help of the event structure analysis, a closer analysis of the NPD projects is possible. In uncovering the activities that underlie NPD my first goal is to disseminate them into three different classes based on whether they pertain to ideation, evaluation or outcomes.

In depicting the activities, I first outline the initial conditions of each NPD project in a table and then the actors and their activities that succeeded it. From this depiction of the development process I abstract the categories of activities that contribute into actualizing the process. This can also mean that a number of activities can contribute to the actualization of a single process.

In depicting the recurring activities, the main focus is on the structure of the activity. This stems from the notion that none of the activities are actualized identically between the projects but rather they share a common blueprint in the way they operate. Therefore, the activities identified here should be taken as abstract categories of action that share a common structure.

After depicting the activities I provide a separate theoretical grounding for the activities from literature to highlight the kind of attention they have received in the extant literature. This is done to follow the suggestion of Eisenhardt and Martin (2000) that many facets of capabilities have received atten-

tion in their respective field. It also constitutes the third step in the process of building a mechanism explanation. Next, I move to analyze the activities related to ideation, evaluation, and outcomes.

6.3.1 Recurring ideation activities

Deriving from the event structure analysis, external parties appear to exert a substantial influence on the ideation stage. Also previously developed products appear to have an impact. Table 5 depicts the actors and NPD activities that were conducted in each of the projects during the ideation stage. The outcome of process in the ideation stage is not depicted, as ideation was always followed by evaluation that was conducted by the new product group.

Table 5: NPD activities in the ideation stage

NPD case	initial condition	actors	activities
ELSA	HUT research team had an idea for a new product	Vaisala new product group	Initiated collaboration to develop ELSA into a commercial product
		Vaisala NPD department	Developed a prototype of the product
Electronic Microscope	The company had a prototype of the product for their own use	Vaisala new product group	Initiated a project to evaluate the further development and commercialization potential of the existing prototype
RS Restructuring	RS 16 radiosonde had deficiencies when it was launched	Vaisala new product group	Initiation of a project to correct the errors left in RS 16
		Vaisala NPD department	Developed prototypes of the different parts of the new product
Kemi Lighthouse	Need to know the basic functions of an automatic weather station	Vaisala new product development	Conducted research on the existing automatic weather stations and what WMO required of them
		VTT research staff	Conducted a pre-study on automatic weather stations for Vaisala
		Vaisala NPD department	Development of prototypes of different parts of the weather station
RS 21 and RS 24	Customers put pressure on Vaisala to develop sondes that would work with ground equipment of other manufacturers	Vaisala new product group	Initiated the development of a solution to the customers problem
		Vaisala new product group	Initiated further development of RS 18 to include a new sender
CK 12 Aviation Radiophone	Finnish military needed a new radiophone that would have a synthesizer to replace the old CK 11	Vaisala new product group	Initiated the development of a solution to the customers problem
		Vaisala new product group	Initiated further development of CK11
		Vaisala NPD department	Developed and documented the making of a prototype
CORA	Pre-development of Fledermaus radiosonde component and RT 400 radiotheodolite	Vaisala new product group	Grouping the existing projects together into a single project
		Vaisala NPD department	Pre-study on the solutions to measure upper air winds
HUMICAP	Need to develop new innovative products	Vaisala new product group	Comissioning of a study on the meteorological quantity that was hardest to measure
		VTT research staff	Took up the challenge and started researching how to measure relative humidity
		VTT research staff	Developed a prototype which Vaisala thereafter tested
HATTARA	Need to know the basic functions of an automatic weather stations in airports	Vaisala new product group	Initiated collaboration with FMI
		Vaisala NPD department and FMI	Joint research project on what a weather station at an airport should be like
METOX switch	Metox proposed a collaboration on improving their products	Vaisala new product group	Initiated collaboration to further develop the METOX theodolite
		Vaisala NPD department	Made a pre-study on possible solutions to improve the theodolite
		Vaisala NPD department	Developed a new a prototype of a switch into the product
MIDAS	COST 30 project started	Vaisala new product group	Initiated collaboration with the project
		Vaisala new product group	Steered the project to develop the product directly to FMI
		Vaisala NPD department	Initiated the development of a prototype
		Vaisala NPD department	Conducted a pre-study on automatic weather stations
Personal Dust Sampling Pump	Tampere University had an idea for a new product	Vaisala new product group	Initiated collaboration with Tampere University
		Vaisala new product group	Initiated the development of a prototype in Tampere University
New Sonde Batteries	Need to find an economic battery solution for new radiosondes	Vaisala NPD department	Pre-study on possible battery solutions
		Vaisala new product group	Asked offers for batteries from 9 different battery manufacturers
SODAR Acoustic Radar	Need to take part in remote sensing business	Vaisala new product group	Initation of a development project
		Vaisala new product group	Comissioning a pre-study in University of Oulu
		Vaisala new product group	Initiated the development of a prototype
		Vaisala new product group	Initiated a study on market potential
RS 80 (NASTA)	Australian Weather Bureau noted that RS 21 did not provide significant improvements to existing sounding systems and installation of HUMICAP into RS 21 made the other parts look clumsy	Vaisala new product group	Initiated pre-studies on different areas of the product
		Vaisala new product group	Added THERMOCAP to the project which was previously a separate project
		Vaisala new product group	Intiated the development of prototype

A total of five categories of recurring activities can be abstracted from the actions that have been undertaken in the ideation stage. These activities appear to constitute routines through which new product concepts are developed as they share a common blueprint in the way in which the organization responds to the need to develop new products. Specifically, these routines are: 1) further development of existing product or prototype, 2) execution of a pre-study, 3) initiating collaboration with a third party, 4) initiating a project to match existing customer needs and 5) initiating a development of a prototype. Next, I will describe these routines in more detail.

Further development of existing product or prototype appears in a number of NPD projects. These kinds of projects were largely set in motion by improvement of a product, where the degree of improvement led it to be a standalone solution. For instance, CK 12 aviation radiophone was a project where the old CK 11 was augmented with a digitalizer. In the same vein RS restructuring was a project that commenced from improving the deficiencies left in RS 16 but ended up being a separate project as the improvements were so significant.

The routine is initiated by the new product group, which then instructs the NPD department to initiate the further development of an existing product or a prototype. This routine seldom appears alone (only in the case of electronic microscope) but rather is a routine through which NPD staff is provided with a starting point for a project and direction how to proceed with the development. It appears to serve two main functions which are: 1) effective use of previous prototypes and projects and 2) indicating a starting point of a project/existing product from which NPD staff can commence a project.

Further development of existing products has received attention in the new product development literature and therefore it can be redescribed through extant literature. This procedure was identified in the methodology section as being necessary for giving theoretical grounding for the components of the mechanisms. These kinds of NPD projects can be characterized as incremental innovations where existing products are adapted, refined and/or enhanced (Garcia and Calantone 2002). Thus, further development of existing products is an act of local search where search depth is increased to make the search activity more predictable and decomposable into smaller tasks (Katila and Ahuja 2002).

Execution of a pre-study was a frequently used mean to approach NPD and manifested in different forms. These studies were initiated because of the need to gauge the state of technological development in a specific area, to find directions for further development, or to understand market potential. For instance, in the CORA project, the project commenced through an in-depth literature review to find out different ways to measure upper air winds. Specifically, the three main kinds of pre-studies used were: 1) studies on the used solutions and needed specifications, 2) literature reviews on possible solutions and 3) studies on the market potential/market research.

The impetus for these studies was to gain insight and approximate towards a product that could have technical and commercial potential. The new product

group always initiated the routine but a party deemed most suitable by the new product group conducted the pre-study. In most occasions this was the NPD department but external parties were also used to execute the pre-studies. The routine appears to serve three distinct functions: 1) generation of information for the management to evaluate the feasibility of the product, 2) giving direction to the project or 3) exploring new directions of development.

Through extant literature pre-studies could be redescribed as predevelopment activities. Predevelopment includes activities such as defining the product concept and developing understanding of customer needs before the actual development starts (Cooper 1988; Khurana and Rosenthal 1997; Langerak, Hultink and Robben 2004). These activities have been suggested as being one of the factors that determine new product success (Cooper 1988; Evanschitzky et al., 2012; Henard and Szymanski 2001) and they could be conceptualized as being aimed towards boundary spanning search because the activities span beyond the technological boundaries of the company (Rosenkopf and Nerkar 2001).

Initiating collaboration with a third party occurred frequently during the period of inquiry. Vaisala conducted a large amount of collaborative NPD with different instances. These kinds of projects were mainly initiated by Finnish universities and research institutions such as VTT that offered Vaisala possibilities for product development. For instance, ELSA was originally an idea developed in HUT and then further developed in Vaisala. Also, in one instance, a French company METOX offered Vaisala the opportunity to further develop their products.

The routine involves the new product group, the NPD department, and an external party. In most cases the new product group was offered an opportunity to collaborate with a third party. This opportunity was usually evaluated and if the evaluation was positive the collaboration was started. During the collaboration, there appears to be three primary modes of operating. The first mean of collaboration is that the third party provides a platform on which the Vaisala NPD can develop from, as was the case with METOX where Vaisala developed on the existing product of METOX. The second mean of collaboration is that Vaisala NPD department and the third party directly collaborate in the creation of the outcome as was the case with developing ELSA with HUT research team. The third way of operating is that the third party works under the supervision of Vaisala new product group and Vaisala new product development is involved in the development process only in the later stages of development.

The routine is almost always accompanied by a routine to develop a prototype (the only occasions where this was not done was HATTARA). This appears to be a way to hedge the risk of collaboration by doing a working prototype as early as possible to enable evaluation of the business potential of the project.

The impetus for this routine is to tap into the technical knowledge and ideas of third parties. This is an issue already emphasized in the research and development plan set out for 1972-1982. Therefore, the routine provides new ideas

and concepts that can fall beyond the immediate competence areas of the company. For instance, HUMICAP is a good example of collaboration where an external party was able to come up with a solution that could not have been figured out within the focal company itself.

Collaboration with a third party has also received attention in academic literature and it has been suggested to be undertaken to satisfy customer needs and to take advantage of market opportunities that the focal company alone cannot fulfill (Littler et al. 1995). Collaboration with universities and public institutions, as it the case in many of the NPD projects, has been studied widely and they have been suggested to enhance the focal firms intensity of product innovations (Robin and Schubert 2013), providing assistance in problem solving, improving understanding and providing sources of information for new projects (Bishop, D'Este and Neely 2011). Specifically, they enable the organization to venture into organizational boundary spanning (Rosenkopf and Nerkar 2001).

Initiating a project to match existing customer needs was how some NPD projects began. These kinds of projects were initiated by customers of the company that required new kinds of products from the company. For instance, the development of RS 21 and RS 24 radiosondes were initiated because customers were putting pressure on Vaisala to develop radiosondes that would work with the ground equipment of other manufacturers.

The routine is initiated by the new product group when a new customer need is identified and they direct the NPD department to start development project to fulfill this need. In many instances this meant the improvement of an existing product to match customer needs. Overall the routine has a purpose of responding to an emerging customer need.

Matching customer needs through product development has received substantial attention in the extant literature. For instance, Danneels (2002) proposed that product innovations stem from linking technological competences with customer competences. From a marketing perspective, this can be identified as market sensing that enables the company to learn from its customers and in part customer linking through which the company aims to establish close communications with its customers (Day 1994).

Initiating the development of a prototype was a central routine in many NPD projects. This routine never appears alone and therefore its role is to actualize the outcomes of other routines into a materialized form so that they can be evaluated. In many occasions the goal of building a prototype was to test the technical feasibility of an abstract idea. For example, this was the case with SODAR, where the initial prototype was a failure but enabled steering the future development to a new direction.

This routine was always initiated by the new product group and either carried out by the Vaisala NPD department or a third party. As such it provided the new product group better grounds for evaluating the product in the evaluation stage.

Prototype development has been identified as an NPD activity that can enhance NPD performance by shortening development times (Barczak, Griffin

and Kahn 2009). Prototype development largely focuses on technical attributes of the offering and involves turning the product idea into a high quality product (Harmancioglu, Droge and Calantone 2009). Therefore, the initial product idea is embodied into a prototype to see how the idea functions in practice. This enabled the demonstrating the efficacy of the proposed solution and evaluation of the project in part by the management (Clark and Wheelwright 1993). Next I proceed into depicting the activities underlying the evaluation stage.

6.3.2 Recurring evaluation activities

The evaluation activities commence from the point where ideation is drawn to a close. At this point specific parts of the project were at a stage where they could be evaluated and thus there were grounds to analyze whether the product could be commercialized. The management of the company executed these activities. From the beginning of 1972 the new product group was established as a formal platform for the management to decide on which projects would be carried out. These activities were codified in the documentation that describes the function and role of the group.

The initial condition for each of the NPD projects in this stage was that the project had generated enough information for it to be evaluated. The outcome of this process is either a decision to develop the product into a commercial solution or discarding the product development project altogether.

The evaluation activities were either carried out in a single instance or they were paced throughout a longer period of time. Thus, there was either a distinct evaluation event where the new product group evaluated the whole project or the evaluation activities were carried out when enough information had been generated to make a judgment on the different facets of the project.

Table 6 depicts the activities of the new product group when they evaluated new products to be developed into commercial products. For the sake of clarity only activities and outcomes are portrayed in the figure, as the initial conditions were very similar.

Table 6: NPD activities in the evaluation stage

NPD case	activities of the new product group	outcome
ELSA	The product received technically positive results both from Vaisala and FMI There was increasing customer need for this kind of solution as weather satellites were becoming more common Development risk can be mitigated with external financing	Product was chosen to be launched to the market
Electronic Microscope	Knowledge to make the product is currently lacking from the company Competition is a threat for the product Penetrating the market would require huge investments and recruitment of new people The product requires large investments (100K FIM) and it therefore risky The product would not fit into the product policy of the company and would require the creation of a new distribution network	The project was terminated
RS Restructuring	The product corrects erros of RS 16 and would create new customer value The market would consist of customers that had already bought RS 16 The product would continue the radiosonde product line and therefore is coherent with product policy	The product was chosen to be launched to the market
Kemi Lighthouse	With Sierra Corporation on board for the delivery, the final product would be technically good Competition was deemed fierce, as the project had aleady been almost promised to Strömberg, but it could be usurped Market for automatic weather stations was deemed to be rapidly growing The project would stronly support product policy to develop automatic weather stations Development risk can be mitigated with external financing	The project was deemed essential for the company and taken further
RS 21 and RS 24	The products were new versions of RS 18 and therefore technically very good The products would respond to new customer needs The products were deemed coherent extensions to the radiosonde product line	The products were chosen to be launched to the market
CK 12 Aviation Radiophone	Filling the needed specifications with the product was deemed too difficult International competition for this kind of a product was perceived to be fierce Home market would be too small for the commercialization to be feasible The product did not fit into the current marketing and there is a lack of know how in the area Development risk could be mitigated with external financing	The project was terminated
CORA	Many succesful soundings had been made and the product looked promising Market potential was deemed great and French Meteorological institute already agreed to buy two systems The product would strenghten the core business area of the company Development risk can be mitigated with external financing	Product was chosen to be launched to the market
HUMICAP	Test results with the new solution were very promising Competition and market was analyzed by looking at the possible main competitors in the field and their success The product was deemed usable in other products of Vaisala as well and thus it fit with the product policy External finance for the development of the product would lower the development risk	The product was chosen to be launched to the market
HATTARA	Final user was involved in the development from the beginning assuring product quality The market is growing rapidly and there are possible customers beyond the immediate project The product strongly supports the policy to spread into automatic weather station business Development risk can be mitigated with external financing	The project was deemed essential for the company and taken further
METOX switch	Mechanically the product was deemed good Competition exists but it can be usurped The product gives access to the large existing market that METOX has The product has a clear position in the portfolio as a cheaper option to CORA	The product was chosen to be launched to the market
MIDAS	Final users are involved in the development to assure product quality The product has sales potential outside Finland The product logically continues the automatic weather station product line Development risk can be mitigated with external financing	Product was chosen to be launched to the market
Personal Dust Sampling Pump	The prototype has provided only vague results New competitors have entered the market while the prototype was being developed The market has too small potential The product does not fit into the current market and product portfolio of the company Development risk can be mitigated with external financing	The project was terminated
New Sonde Batteries	Tests on different concentrations of active ingredients were made to find the cheapest product Having own batteries provides for a more stable solution than buying from a third party The project follows product policy by strenghtening the radiosonde line	The product was chosen to be launched
SODAR Acoustic Radar	The product has potential on its own and as a Doppler solution later on New competition has entered the market during the development of the product which hinders the competitive position of the offering Market potential exists outside the US The product adheres to the product policy and intention to expand into this area Development risk can be mitigated with external financing	The product was chosen to be launched to the market
RS 80 (NASTA)	The product is solid and has been tested in Danish Meteorological Institute with good results The product is able to match new and emerging customer needs The product continues the RS lines and adheres to product policy Development risk can be mitigated with external financing	The product was chosen to be launched

A total of five recurring activities can be abstracted from the activities undertaken by the new product group in the evaluation stage. These appear to take the form of exercising simple evaluation rules as they depict the rules of thumb that guide which opportunities to pursue, taking the form of selection rules (Bingham and Eisenhardt 2011). These activities shared behavioral patterns between projects through their repetition and many of them were articulated in the founding documents of the new product group to guide how projects could be evaluated. The evaluation documentation also provides representations of cognitive processes and their outcomes as many documents provide rationale and justification on why certain decisions were made. This follows the suggestion of Bingham, Eisenhardt and Furr (2007) in identifying simple rules. Specifically, the simple rules applied at Vaisala were: 1) product evaluation, 2) competition evaluation, 3) market evaluation, 4) product policy coherence and 5) risk evaluation. Next, I will describe these rules in more detail.

Product evaluation refers to exercising a rule in which the new product group examined the technical feasibility of the new product or concept in the light of the available information. For instance when NASTA was developed, the new product group deemed the product to be worthwhile as it had been tested at the Danish Meteorological Institute for an extensive period of time and the test results were positive. This rule is codified in the founding documents of the new product group, as their task was to set the standard level of quality for new products. This rule appears to be the most persistent in the evaluation stage as it was conducted when evaluating each of the commercialized products.

Product characteristics such as technological sophistication have been identified in the extant literature as a key predictor of new product performance (Henard and Szymanski 2001). It is these characteristics that the new product group evaluated when doing product evaluation. Therefore, in doing so the managers evaluated whether decision to deploy resources in a specific project would be effective use of them. This follows the suggestions of Mahoney (1995) on the role of management in optimizing resource allocation. Such is the case with the other evaluation rules as well.

Competition evaluation refers to exercising a rule where the new product group examined the market for a new product in light of the current and possible future competition. In the case of CK 12 aviation radiophone and electronic microscope the competition was deemed too fierce for Vaisala to succeed in it. In the case of HUMICAP and Kemi lighthouse competition did exist but it could be usurped with the offering that was being developed. This rule is codified in the founding documents of the new product group as their responsibility was to be capable of evaluating competition and relating the situation to the decision whether products would be commercialized or discarded. The rule appears to be present in conjunction with market evaluation, where these two rules in conjunction enable the new product group to evaluate the market potential of the new product.

Analyzing and maintaining an understanding of the strengths and weaknesses of competitors has been identified as being central for successful NPD

(Atuahene-Gima 2005). Marketplace characteristics that relate to competition have also been identified as potential antecedent for new product performance (Henard and Szymanski 2001). Therefore, in doing competition evaluation, the management evaluated the new product in light of competition to determine whether it is effective to allocate resources for the project or not.

Market evaluation refers to exercising a rule where the new product group evaluates the potential of the new offering to fulfill existing customer needs in light of the available evidence. When the RS 21 and RS 24 radiosondes were developed they were deemed to fulfill a new customer need in the sense that they would fit into the ground equipment of other manufacturers and thus fulfill a need voiced out by customers. This rule enabled the new product group to fulfill its goal in defining whether a new product would fill the commercial and quality related goals. The rule appears to be present in conjunction with product evaluation, where these two rules together enable the new product group to evaluate the potential of the new product in the market.

Understanding the needs of the customers has been identified as being central for successful NPD (Atuahene-Gima 2005) so as to be able to respond to these needs. Danneels (2002) has also stressed the importance of integrating customer knowledge into the new product development process. By doing market evaluation on a product, the new product group determines whether, according to their perception, the product responds to customer needs.

Product policy evaluation refers to the evaluation of whether the product fits with the current product policy of the company. Deciding on whether a certain product fits with the product policy was one of the central tasks of the new product group as one of their main tasks was to think and formulate product policy for the company. For instance, this was a central consideration when new radiosondes were approved for commercialization, as they would continue the product line. Oftentimes the use of this rule was accompanied by product and market evaluations.

The fit of a new product with both technological and marketing resources has been identified as a driver of NPD performance (Harmancioglu, Droge and Calantone 2009). Product policy evaluation could be claimed to function towards these ends. Furthermore, this evaluation enables the management to evaluate possible synergy benefits generated by the product with regards to technology and marketing (Henard and Szymanksi 2001). Therefore, the product policy evaluation directs the management towards analyzing how effective resource allocation would be in a specific project.

Risk evaluation refers to exercising a rule where the new product group evaluated the financial risk related to the final development of a new product. Throughout the period of inquiry, Vaisala applied for extensive amounts of money for product development from the Finnish Ministry of Trade and Industry and also from SITRA (The Finnish Innovation Fund). While this rule is not codified in the operating principles of the group, evaluation of the financial risk of advancing projects was done frequently. For instance, when developing the CK 12 aviation radiophone exercising the other rules resulted in a negative outcome but still the availability of external financing was deemed a positive

factor when the project was evaluated. In many instances this was a central consideration when products were made for new markets.

As the mortality rate of NPD activities is high (e.g. Barczak, Griffin and Kahn 2009; Griffin 1997), risk evaluation enabled the management to mitigate it by explicitly evaluating the risk associated with commercialization. The rule therefore mainly deals with the amount of external resources the company can use in the development to supplant the use of own resources. Therefore, through this the managers aim to optimize the resource allocation of the organization by evaluating the balance and risk related to the use of both their own as well as external resources. Next I proceed into depicting the activities that relate to the outcomes stage.

6.3.3 Recurring outcome activities

The outcome activities commence from the point where evaluation has been done. At this stage, a project has been deemed either to be launched or to be terminated. The initial condition for these activities is that the project has been selected for commercialization. While some projects represent larger systems where the term product launch may sound unfitting, all the products were deemed to be viable to be sold to new customers as well. This process depicts the impact that the implementation and commercialization created.

Table 7 depicts the actors and NPD activities that were conducted in each of the projects during the outcome stage. These actions were either executed by the new product group or the product development department. The initial condition for each project was a preliminary decision to commercialize the product and therefore it will not be presented in the table.

Table 7: NPD activities in the outcome stage

NPD case	actors	activities
ELSA	Vaisala new product group	The product was launched into the markets
	Vaisala new product group	Application of a patent for the product
	Vaisala new product group	Product incorporated to the future evaluation of other products
RS Restructuring	Vaisala new product group	The product was launched into the markets
	Vaisala new product group	The product added to the future evaluation of other products against which RS 21 and RS 24 were evaluated
Kemi Lighthouse	Vaisala new product development and Vaisala new product group	Handing over the system to customer and commencing to offer it to other customers
	Vaisala new product group	Further development of the product was initiated
	Vaisala new product group	Added to the evaluation of new products, leading to new similar weather stations
RS 21 and RS 24	Vaisala new product group	The product was launched into the markets
	Vaisala new product group	The product was further developed into different forms and modifications
	Vaisala new product group	Added to the evaluation of new products and affected future products such as CORA
CORA	Vaisala new product development and Vaisala new product group	Launched the product into market after the delivery of first two products French Meteorological Institute
	Vaisala new product group	Further developed the product into different modifications and updated versions
	Vaisala new product group	Incorporate to the evaluation of new products and steered future new product development projects such as the METOX project
	Vaisala new product group	Applied a patent for the product
HUMICAP	Vaisala new product group	The product was launched into the markets
	Vaisala new product group	Decided to invest into production facilities
	Vaisala new product group	The product was further developed into a product family
	Vaisala new product group	Incorporated into the evaluation of new products and affected future development such as Personal Dust Sampling Pump
	Vaisala new product group	Application of a patent for the product
HATTARA	Vaisala new product development	Delivered the final product to the customers in Helsinki-Vantaa and Medina and commenced to offer it to other customers
	Vaisala new product group	Decided to further develop the product as HATTARA was later extended during COST 30 project
	Vaisala new product group	Incorporated into the evaluation of new products and affected other products such as MIDAS
METOX switch	Vaisala new product group	The product was launched into the markets
	Vaisala new product group	The product was moved to furher development
	Vaisala new product group	Incorporated into the evaluation of new products and steered projects such as the further development of CORA
MIDAS	Vaisala new product group	The product was launched into markets
	Vaisala new product group	Further develop the product was commenced and resulted into MIDAS 310 & 320 and MILOS
New Sonde Batteries	Vaisala new product group	Decision to incorporate new batteries into own sondes
	Vaisala new product group	Decided to construct a production machine that costs 100.000 FIM to mass produce the batteries
	Vaisala new product group	Further development of the product was commenced
SODAR Acoustic Radar	Vaisala new product group	Decided to launch the product into markets
RS 80 (NASTA)	Vaisala new product group	Launched the product into markets
	Vaisala new product group	Variants of the product were made as a one that only measured wind
	Vaisala new product group	Incorporated into the evaluation of other products and affected the future development of other product lines
	Vaisala new product group	Applied a patent for the product

A total of five recurring activities can be abstracted from the actions that have been undertaken in the outcome stage. These activities include exercising routines and procedural heuristics and adjusting the evaluation rules. Specifically, these activities are: 1) product launch, 2) acquiring a patent, 3) further development of the product, 4) investment into production equipment and 5) becoming part of the new product evaluation. Next, I describe these activities in more detail.

Product launch refers to a routine with a number of activities orchestrated by the new product group. First, the new product group ensures the capacity of the organization to make the product by either making a first production run of the product or delivering the first system to a customer. Then the product is added to the portfolio of sold products. For instance, when CORA was launched the product launch consisted of delivering the first two systems to the French Meteorological Institute and then commencing the active sales of the product to other interested parties. In the case of RS 21 and RS 24 this meant that a first production run of the radiosondes were made and active sales of the sondes was commenced.

This routine is present in all of the NPD cases and the new product group initiates it. The routine ends the NPD project and moves its outcome to be part of the offering portfolio. After this, additional development to the finished product can be made but it is initiated through a separate project. Therefore, the function of the routine is to close the NPD project and subject its outcome to market feedback where its final success can be determined.

As a theoretical construct a product launch can be perceived both as an outcome of new product development as well as an activity belonging to it (highlighting its dual role as an outcome and as an activity). On one hand, it can be perceived as a resource allocation decision that steers the way in which the organization conducts its day-to-day activities and uses its resources. On the other hand, market launch has been identified as a proficiency of an organization to launch products to the market and to conduct the related marketing activities (Harmancioglu, Droge and Calantone 2009) and it can also include process development (Pisano 1997) to create a capacity for the organization to successfully produce the offering. With regards to this, launch relates to marketing, sales, distribution, promotion, R&D and engineering skills (di Benedetto 1999) where management has a central role in orchestrating these broad activities.

Acquiring a patent refers to a routine initiated by the new product group in which they apply and receive a patent for the new product or a component of it. The patent acquisition is done in conjunction with the NPD staff that had been involved in the development project. This routine is conducted to acquire protection for the intellectual property incorporated into the product. For instance, when HUMICAP was developed, Vaisala acquired patents for the crucial parts of the product so that the competitors could not copy it.

The routine is initiated by the new product group and it is codified in the operating principles of the group. Patenting is an infrequent routine within the array of outcome routines and pertains usually only to the most radical new

products that the company had developed such as HUMICAP and ELSA. Despite this, patenting had been a recurring way of operating for the company as it had a substantial portfolio of patents during the 1970s and 1980s.

Patenting has been widely used as an outcome measure of new product development (see Henderson and Cockburn 1994 for an example). It can also be understood as an act of codifying important knowledge into a form in which it can be protected and used as a resource. Thus, patenting serves a dual purpose as an outcome of NPD and as a mean of codifying and protecting organizational knowledge gained through exploration (e.g. Rosenkopf and Nerkar 2001). It also creates a new resource for the company that can be leveraged in other projects or sold to third parties.

Further development of the product refers to a routine to initiate a project to develop a launched product further. This can be perceived to be parallel to the routine of further developing an existing product or prototype identified to be pertinent to the ideation stage. For instance, after CORA was launched it was developed into MicroCora system and a variant that was sold to the FGGE project.

The function of this routine is to update an existing offering and to make it more coherent with the needs of the customers. In some instances the routine is also used to enhance the launched product that had deficiencies. Therefore, the routine serves two purposes that both aim at making the product more coherent with the needs of the customers.

Updating and further developing existing offerings was done for most of the offerings. It is lacking only from the NPD projects where either only one generation of the product was developed or where the product was superseded by a new generation of similar products such as in the case of RS 18 that was superseded by new and more up-to-date radiosondes.

Further development of a product can be conceived as a resource allocation decision to continue search activities on the vicinity of the launched product. Therefore, this activity can be perceived as continuation of development through local search by increasing search depth (e.g. Katila and Ahuja 2002). This kind of outcome transfers the core knowledge of the project from outcomes back into ideation so that it can be further extended. Therefore, the problem-solving cycle (Clark and Fujimoto 1991) is continued to enhance the product.

Investment into new production equipment refers to an investment in specific production technology that enabled mass-producing the offering. Therefore, it does not cover the general investments into production facilities and equipment that Vaisala did to a large extent during the period. Exercising this activity was commenced by the new product group based on the recognition that commercialization and/or mass production of the product was impossible without the specific investment.

For instance, when the new sonde batteries were developed it was imperative to invest 100.000 FIM into a battery-making machine that enabled testing different permutations of the amount of active ingredients to find an optimal solution and to enable the mass production of batteries that could be used in

the radiosondes that Vaisala makes. This action characterizes use of the rule well. Investments into product specific equipment were associated only to very far-flung initiatives, namely new sonde batteries and HUMICAP of which both were beyond the immediate competence areas of the company.

This type of activity can be perceived as the use of procedural heuristics (Bingham and Eisenhardt 2011) as it pertains to how the pursuit of an opportunity is executed. Investments into new production equipment can also be perceived as resource allocation decisions in which the management perceives that scaling up the production of the specific product can yield substantial benefits. Thus, this is largely an issue of optimizing resource allocation (Mahoney 1995). However, it is also a decision to invest in a specific path of development, which is a long-term irreversible decision (Teece, Pisano and Shuen 1997).

Becoming part of the new product evaluation refers to an activity where the new product group incorporates the new product as a part of the product portfolio against which new products and product ideas are evaluated. This activity is executed within the new product group to modify the criteria used to evaluate new products. Its main purpose was to make sure that different offerings would not directly compete with each other and new products could be developed to extend old offerings and product lines.

Most of the developed products ended up being incorporated into new product evaluation. This activity was missing only from products that had a distinct trajectory as either standalone products or as a single product family within a larger category of offerings.

While the other outcome activities relate largely to resource allocation and actualization of the NPD into different outcomes such as product launches and patents, this activity relates to the augmentation of the knowledge base of the new product group. Therefore, it can be perceived as simplification cycling through elaboration (Bingham and Eisenhardt 2011) that updates and creates more comprehensive evaluation heuristics that the management uses when evaluating products during the evaluation stage.

This concludes the section that identifies the main activities associated with the ideation, evaluation and outcome stages of new product development. Next I move into postulating mechanisms that the configurations of these activities could generate.

7. Postulating mechanisms

The recurring activities presented in the previous section described the routines and simple rules related to ideation, evaluation and outcomes. As suggested in the theoretical framework, this study aims to postulate mechanisms from the constellations of activities that take place in NPD projects in each of the stages. This section aims to fulfill this task.

Altogether we have now explicated the activities undertaken in each of the NPD projects and abstracted categories of routines and simple rules that can describe them. The next step is to subject the cases to qualitative comparative analysis (QCA) (Ragin 1989) to determine how the configurations of routines and simple rules could constitute mechanisms. This is done by first coding each of the cases for the presence or absence of each of the activities to produce a truth table of the configurations.

After a truth table has been generated for each of NPD cases, the cases are subjected to a minimization procedure provided by the Tosmana program (Cronqvist 2011). This gives the logically minimized configurations of activities that take place across the NPD cases vis-à-vis prime implicants. This is accompanied by case specific analysis to define which projects belong to a specific minimized configuration as some projects may contain concurrent explanations across prime implicants. This procedure enables the identification of central and peripheral components of the mechanisms across cases. Therefore, each of the configurations depicts how the constellation of activities enables the process to proceed from initial conditions into an outcome.

In depicting the configurations, I first describe the configuration of activities and the common denominators that the NPD projects share. After this, I move to postulating mechanisms that can underlie these configurations.

7.1 Postulating ideation mechanisms

Altogether five routines were identified in the previous section to be pertinent to the ideation stage. These routines were: 1) further development of existing product or prototype, 2) initiating a collaboration with a third party, 3) execution of a pre-study, 4) initiating a project to match customer needs and 5) initiating a development of a prototype. These routines or a constellation of them

were present in all of the 15 cases. Therefore, each of the NPD cases were coded for the presence and absence of the routines based on the NPD actions.

One outcome condition was also coded which was the transfer of the project into evaluation stage. Each of the projects was transferred to evaluation stage and therefore none of the projects disintegrated during ideation. Table 8 presents a truth table of the NPD routines on the ideation stage. Altogether 12 different configurations of NPD routines were identified.

Table 8: Boolean truth table of ideation configurations

Conditions					Outcome	Cases in configuration
E	C	S	N	P	O	
0	1	0	0	1	1	ELSA, Personal Dust Sampling Pump
1	0	0	0	1	1	RS restructuring
1	0	0	1	0	1	RS 21 and RS 24
0	1	1	0	1	1	METOX switch, SODAR, HUMICAP
1	0	1	0	0	1	CORA
0	0	1	0	0	1	New Sonde Batteries
1	0	1	0	1	1	NASTA
0	1	1	0	0	1	HATTARA
1	0	0	1	1	1	CK 12 Aviation radiophone
1	0	0	0	0	1	Electronic Microscope
0	0	1	0	1	1	Kemi lighthouse
0	1	1	1	1	1	MIDAS

0= condition abscent
1= condition present
E= Further development of existing product or prototype
C= Initiating a collaboration with a third party
S= execution of a pre-study
N= initiating a project to match existing customer needs
P=initiating a development of a prototype
O= project proceeded to evaluation stage

No contrary configurations were identified and therefore all the NPD cases could be used for further analyses and no additional conditions were necessary to be introduced. The conditions were then analyzed for necessity and sufficiency. On the level of configurations of conditions, each of the configurations is sufficient as they all enable the creation of a positive outcome. Neither of these configurations can be considered necessary, as there are other configurations that can lead to the outcome. On the level of single conditions, no single condition can be deemed neither necessary nor sufficient, as no single condition alone is able to create a positive outcome (sufficient) and no single condition is present in all the configuration leading to successful outcome (necessary).

Next a Boolean minimization algorithm of the Tosmana program (Cronqvist 2011) was applied to the truth table results. This generated logically minimal reduced expressions of the configurations of routines leading the NPD project to the evaluation stage. After this, the prime implicants were restructured based on case specific knowledge. This enabled excluding one prime implicant, further reducing the expressions and assigning cases to specific formulas based on case knowledge. The cases are assigned to specific prime implicants at this point to highlight the common characteristics between the projects. These assigned minimizations will also be further used in the next chapters when the postulated mechanisms are contextualized. Table 9 presents the procedure and findings.

Table 9: Boolean minimization table for ideation configurations

Cases included	All prime implicants, including partly concurrent explanations	Restructured prime implicants by using case specific knowledge	Cases assigned to prime implicant based on case specific knowledge	common denominator(s) between projects
RS restructuring, CORA, NASTA, Electronic microscope	Ecn	~~Ecn~~	none	
RS restructuring, RS 21 and RS 24, CK 12 Aviation radiophone, Electronic Microscope	Ecs	Ecs	RS restructuring, RS 21 and RS 24, CK 12 Aviation radiophone, Electronic Microscope	further development fo an existing product
METOX, SODAR, HUMICAP, New Sonde Batteries, Kemi lighthouse, HATTARA	eSn	Sn(e+c)	New Sonde Batteries, HATTARA, Kemi lighthouse, CORA, NASTA	Pre-study based project where customer need did not already exist
CORA, New Sonde Batteries, NASTA, Kemi lighthouse	cSn			
ELSA, Personal Dust Sampling Pump, METOX, SODAR, HUMICAP	eCnP	CPe(n+S)	ELSA, Personal Dust Sampling Pump, METOX, SODAR, MIDAS, HUMICAP	Collaboration with a third party combined with the creation of a prototype
METOX, SODAR, HUMICAP, MIDAS	eCSP			

Capital letter = condition present
Lowercase letter = condition abscent
Addition (+) = or

E= Further development of existing product or prototype
C= Initiating a collaboration with a third party
S= execution of a pre-study
N= initiating a project to match existing customer needs
P=initiating a development of a prototype

These reduced equations state the combinations of central NPD routines both present and absent that lead to an NPD project from the beginning of ideation into the evaluation stage, covering the process of ideation. As none of the formulas led to failure there was no need to check for the consistency of the solutions leading to failure. To better grasp each of the solution formulas and the postulated mechanism that underlies them, I next move to depicting them in detail.

7.1.1 Local search mechanism

The first formula for successful ideation contains the presence of further development of existing product or a prototype and the absence of initiating collaboration with a third party and the execution of a pre-study. Specifically the formula can be stated as:

$$Ecs \rightarrow proceeding\ to\ evaluation\ stage$$

This formula can be interpreted as explaining NPD projects that are firm-internal projects where the focus is on developing a commercial stand-alone extension to an existing product or prototype. In explaining the projects as-

signed to this prime implicant, the formula depicts a traditional extension of a product line or in one instance the extension of an existing prototype that had been in internal use into a commercial product.

The ideation stage proceeds through the development of the existing product. Thus no external collaboration or pre-studies are undertaken to undermine the process and the outcome it is intended to create.

The mechanism that is postulated to underlie this configuration relates to local search. The process begins from the recognition that there is an existing product or a prototype that could be enhanced. This raises awareness within the company above a threshold when a development project is initiated. The process ends when the project moves into the evaluation process conducted by the new product group. From the perspective of the functional routines of the mechanism, central component of the mechanism is the further development of an existing product that appears to overpower all other routines.

7.1.2 Exploratory search mechanism

The second formula for successful ideation contains the presence of the execution of a pre-study and the absence of initiating the project to meet customer needs, and either the absence of further development of an existing product or the absence of initiating a collaboration to meet customer needs. Specifically, the formula can be stated as:

$$Sn(e + c) \rightarrow proceeding\ to\ evaluation\ stage$$

This formula can be interpreted as explaining NPD projects that make use of a pre-study to orient the NPD project without the existence of a direct customer need. Therefore, the formula depicts the search for new kinds of solutions that could be developed into products in new product areas.

The ideation stage proceeds through a number of different paths that characterize the search for new solutions. Despite the fact that the configurations before the minimization procedure included the presence of other factors, the search for a new solution through a pre-study is the main driver of this process.

The mechanism that is postulated to underlie this configuration relates to exploratory search. The process begins from the recognition that there is an emerging business opportunity to which a product could be developed. This raises awareness within the company above a threshold when a development project is initiated. This is followed a pre-study that gauges the ways in which the new opportunity could be grasped through the development of a new product. The process ends by moving the product idea to the evaluation process conducted by the new product group.

From the perspective of the functional components of the mechanism, two crucial notions can be made. Firstly, responding to an existing customer need appears in none of the configurations from which the minimization was made.

This indicates that the mechanism focuses solely on the development of a product to a possible new need and that these two routines are almost mutually exclusive. Secondly, while all other routines are present in the baseline configurations, they have no central role and the execution of a pre-study drives the process.

7.1.3 External knowledge embodiment mechanism

The third formula for successful ideation contains the initiation of a collaboration with a third party, initiating the development of a prototype, the absence of the further development of an existing product and either the absence of initiating the project to match customer needs or the presence of executing a pre-study. Specifically, the formula can be stated as:

$$CPe(n + S) \rightarrow proceeding\ to\ evaluation\ stage$$

The formula can be interpreted as explaining NPD projects that capitalize on external knowledge in the ideation stage to produce a prototype that is not based on an existing product of the company. Therefore, the formula explains NPD projects where the organization exposes its NPD to external influences that are targeted towards the creation of a prototype that embodies these influences.

The ideation stage proceeds through a number of paths that characterize the process of collaboration. Despite the fact that the configurations before the minimization procedure contained all other conditions besides the further development of existing product, the integration of external and internal knowledge into a prototype characterize this configuration.

The mechanism that is postulated to underlie this configuration relates to exposing the organization to external influences and embodying these influences into a prototype. In all instances the process begins with a third party proposing collaboration with the focal company. When the collaboration is accepted, it is followed by the making of a prototype that incorporates knowledge from both Vaisala staff and the third party. The process ends by moving the prototype and associated knowledge to the evaluation process conducted by the new product group.

From the perspective of functional routines of the mechanism three crucial notions can be made. Firstly, initiating a collaboration with a third party appears to be mutually exclusive with the further development of an existing product. This indicates that in these kinds of instances Vaisala aims to guard their own intellectual property incorporated in products by not exposing them to third parties. Secondly, the execution of a prototype and the absence of existing customer need are present in the sub solutions. The presence of a pre-study acts in these projects as a step in the ideation stage, where a pre-study is done to orient the development of the prototype. The absence of an existing customer need characterizes the second sub solution by highlighting the no-

tion that the product that is being developed falls beyond the immediate customer base of the company and can be perceived as an attempt to extend operations into this area. Thirdly, while all other routines are present in the baseline configurations, they have no central role and the execution of a prototype with a third party.

7.1.4 Theoretical grounding for the mechanisms

Altogether three different ideation mechanisms were postulated. All the mechanisms relate to how knowledge is created and used to generate product ideas and prototypes. Two of these mechanisms relate to the search beyond the immediate knowledge domain and one relates to local search.

The local search mechanism is closely related to previous NPD activities. This is done to search for solutions from the domain of current expertise, as has been suggested by Nelson and Winter (1982). The local search mechanism relies on the knowledge of a specific technological domain on which development has been made. Therefore, it enhances the current technological knowledge in the specific area (Rosenkopf and Nerkar 2001) and incorporates this knowledge into the developed product idea that is later on subjected to evaluation. As an outcome, the ideation process leads to the generation of incremental innovations that rely on exploiting local knowledge in new products.

The two other mechanisms rely on exploring technologies that reside outside the immediate technological domain of the company but the way in which this exploration is conducted differs substantially. The exploratory search mechanism focuses on probing new technological possibilities in fields where customer needs did not already exist. Therefore, this kind of search relies primarily on technological boundary spanning (Rosenkopf and Nerkar 2001). With regards to the external knowledge embodiment mechanism, the focal company relies on embodying the knowledge of a third part into a prototype that can later on be evaluated. This kind of search relies largely on organizational boundary spanning (ibid.) where the focal organization exposes itself to external influences. This enables the organization to draw together the necessary competences to develop a new offering, as suggested by Van de Ven et al. (2008). Both of these ideation processes can lead to the creation of radically new innovations that rely on exploring new knowledge to generate product ideas and concepts.

Delineating from March (1991), these three mechanisms also highlight the means through which Vaisala conducted exploration and exploitation in their NPD activities. Furthermore, Aspara et al. (2011) identified market/customer intelligence, brands/bonds and technologies/processes as the three resource classes through which exploration and exploitation can be conducted. Of these resource classes, ideation mechanisms rely mainly on technologies and processes. Despite initiation of a project to match customer need was among the conditions used in the QCA, it appears not to have a central role in any of the identified mechanisms. Thus, the mechanisms focus on developing new tech-

nologies from which new product ideas and concepts are developed. Therefore, the ideation stage can be said to be technology focused.

Overall the mechanisms and their actualization in the NPD projects suggest that NPD was perceived as an efficient mode of using the resources of the company. Furthermore, the heavy focus on exploratory search is in line with the strategic goals of the company to broaden their offering portfolio during the period of inquiry. The decisions to venture into specific areas of development were largely based on the new product groups' perception as, for instance, automatic weather stations were perceived important and therefore multiple projects were done on this area.

Interestingly, the local search mechanism focuses largely on radiosondes and on products that were discarded later on during evaluation. This could be taken to indicate that when NPD activities shift towards exploration, creating traction for local search can be challenging. However, local search provides coherence and orientation for the NPD activities that otherwise span both organizational and technology boundaries.

Finally, it is apparent that the exploratory search mechanism and external knowledge embodiment mechanisms are adjacent in their capacity for creating change. They both enable the company to broaden its technology base but through different means.

7.2 Postulating evaluation mechanisms

Altogether five simple rules were identified in the previous section to be pertinent to evaluation. These were: 1) product evaluation, 2) competition evaluation, 3) market evaluation, 4) product policy coherence and 5) risk evaluation. First, each of the NPD cases was coded for the presence and absence of the activities. One outcome condition was coded which was the decision to commercialize the product and move it to the outcome stage. Failure to do so led to the termination of the project. Of the 15 projects 13 were chosen for commercialization and moved to the outcome stage and two of the projects were terminated at this stage.

Table 10 presents a truth table of the NPD rules pertinent to the evaluation stage. Altogether 8 configurations of evaluation rules were identified.

Table 10: Boolean truth table of evaluation configurations

Conditions					Outcome	Cases in configuration
P	C	M	L	R	O	
1	0	1	0	1	1	ELSA
1	0	1	1	0	1	RS restructuring RS 21 and RS 24
1	1	1	1	0	1	METOX
1	0	1	1	1	1	CORA, SODAR, NASTA, HATTARA, MIDAS
1	1	0	1	0	1	New Sonde Batteries
1	1	1	1	1	1	HUMICAP, Kemi lighthouse
0	0	0	0	1	0	CK 12 aviation radiophone, Personal Dust Sampling Pump
0	0	0	0	0	0	Electronic Microscope

0= condition abscent
1= condition present
P= product evaluation
C= Competition evaluation
M= market evaluation
L=product policy evaluation
R= risk evaluation
O= product will be commercialized and moved into outcome stage

No contrary configurations were identified and therefore all the NPD cases could be used for further analyses and no further conditions were necessary to be added.

The conditions were then analyzed for necessity and sufficiency. On the level of configurations, the first six configurations can be considered sufficient as they lead to a positive outcome. None of these, however, can be considered necessary as there are alternate configurations that can lead to the same outcome. On the level of a single condition, product evaluation is the only necessary condition as it is present in all of the configurations that lead to a positive outcome. It, however, is not a sufficient condition as it alone is not capable of creating the outcome, i.e. lead the project into outcomes.

Next a Boolean minimization algorithm of the Tosmana program (Cronqvist 2011) was applied to the truth table results. This generated logically minimal reduced expressions of the configurations of rules leading the NPD project to either outcome stage or project termination. After this, the prime implicants were restructured based on case specific knowledge, which enabled assigning projects to specific formulas based on case knowledge. The cases were assigned to specific prime implicants at this point to highlight the common characteristics between the projects. These assigned minimizations will also be further used in the next chapters when the postulated mechanisms are contextualized. Table 11 presents the procedure and findings.

Table 11: Boolean minimization table for evaluation configurations

Cases included	All prime implicants, including partly concurrent explanations	Restructured prime implicants by using case specific knowledge	Cases assigned to prime implicant based on case specific knowledge	common denominator(s) between projects	Outcome
RS restructuring, RS 21 and RS 24, METOX, CORA, SODAR, NASTA, HATTARA, MIDAS, HUMICAP, Kemi lighthouse	PML	PML	RS restructuring, RS 21 and RS 24, METOX, HUMICAP, Kemi lighthouse, MIDAS, NASTA, HATTARA	Policy coherent offering to perceived markets	Commercialization
ELSA, CORA, SODAR, NASTA, HATTARA, MIDAS	PcMR	PcMR	ELSA. CORA. SODAR	Products to new markets with risk mitigation	Commercialization
METOX, New Sonde Batteries	PCLr	PCLr	New Sonde Batteries	Policy coherent internal strategic initiatives	Commercialization
CK 21 Aviation radiophone, Personal Dust Sampling Pump, Electronic microscope	pcml	pcml	CK 12 aviation radiophone, Personal Dust Sampling Pump, Electronic microscope	Failure in all areas related to the offering	*Project termination*
Capital letter = condition present Lowercase letter = condition abscent Addition (+) = or		P= product evaluation C= Competition evaluation M= market evaluation		L=product policy evaluation R= risk evaluation	

These reduced equations state the combinations of simple rules both present and absent that lead to an NPD project from the beginning of the evaluation stage either into outcome stage or project termination. This covers the process of evaluation. As one of the configurations led to failure, it was compared

against the formulas that led to success to reach a conclusion that the solutions are consistent. To better grasp each of the solution formulas and the postulated mechanism that underlies them, I next move to explaining them in detail.

7.2.1 Policy coherent evaluation mechanism to existing market

The first formula for successful evaluation consists of the presence of product evaluation, market evaluation and product policy evaluation. Specifically, the formula can be states as:

$$PML \rightarrow commercialization$$

The minimized formula of evaluation rules can be interpreted as explaining the selection of NPD projects where the management deems that a market for the product exists, the product itself is commercially viable and that it is coherent with the product policy of the company. Therefore, these products are deemed to be coherent with the kind of offerings the company wants to produce. In this type of evaluation the guiding idea is that the product follows the policy of developing technically excellent meteorological measurement devices and that a market for them exists.

The mechanism that is postulated to underlie this configuration of rules is labeled policy coherent evaluation mechanism to existing market. The process consists of the evaluation of the product to determine if it meets quality standards, evaluation of the market to determine that there are customers that can appreciate the product and assessment that the product is coherent with what Vaisala as a company does. Therefore, the new product group tries to approximate the external criteria that the identified customers would use in evaluating the product. The process ends when a decision is made to commercialize the product.

From the perspective of functioning components of the mechanism one additional notion can be made. While competition evaluation is present in many of the raw configurations, it still is not minimized into the descriptive formula. This could be explained by the strong impact that the three rules together exert.

7.2.2 New market evaluation mechanism

The second formula for successful evaluation consists of the presence of product evaluation, market evaluation, risk evaluation and the absence of competitor evaluation. Specifically, the formula can be states as:

$$\text{PcMR} \rightarrow \text{commercialization}$$

The configuration of evaluation rules can be interpreted as explaining a selection of NPD projects that were directed to new perceived markets and where the development risk had been alleviated through external financing. Therefore, these products were perceived to help the company in extending into unsure new markets where risk mitigation through external financing has a distinct role in enabling the selection of the product.

The mechanism that is postulated to underlie this configuration is labeled as new market evaluation mechanism. The process relates to expansion into new markets, which is explained by the lack of competitor evaluation and that the risk that arises from this is mitigated by external financing making risk evaluation essential. Therefore, the mechanism incorporates product evaluation to assess the technical quality of the offering, market evaluation to determine that there is indeed a market need and risk evaluation to determine that while previous operations in the specific market did not exist, this risk could be alleviated by external financing. The process ends when a decision is made to commercialize the product. It is possible to speculate that the lack of competitor evaluation could stem from the emerging nature of the market and technology, which inhibited making this kind of evaluation. Simultaneously, however, some kind of identifiable customer need already existed.

From the perspective of functioning components of the mechanism one additional notion can be made. The presence of risk evaluation and the absence of competition evaluation could be complementary and subsequently incomplete market knowledge is alleviated by decreasing the development risk. Therefore, the lack of competitor evaluation is mitigated primarily through risk evaluation and secondarily through the evaluation of market to determine that there is indeed customer need.

7.2.3 Policy coherent internal evaluation mechanism

The third formula for successful evaluation consists of the presence of product evaluation, competition evaluation, product policy evaluation and the absence of risk evaluation. Specifically, the formula can be stated as:

$$\text{PCLr} \rightarrow \text{commercialization}$$

The configuration of evaluation rules can be interpreted as explaining selection of NPD project where the new product group deems the new product as being more efficient at fulfilling needs than the products of third party providers. The product is also deemed to be coherent with the product policy as it fits into the offering portfolio of the company. The absence of risk evaluation can be explained by the comparison with third party offerings that determines the superiority of own product in comparison to third party offerings and therefore separate risk evaluation becomes unnecessary.

The mechanism that is postulated to underlie this configuration of rules is labeled as policy coherent internal evaluation mechanism. It relates to internal evaluation of own product versus third party offerings in fulfilling needs. The evaluation procedure consists of the evaluation of the product itself, the evaluation of the products coherence with the product policy and comparison to third party offerings to determine whether it fills the needs better than the third party offerings. The process ends when a decision is made to commercialize the product.

From the perspective of functioning components of the mechanism one central notion can be made. The presence of competition evaluation and the absence of risk evaluation appear to be complementary which could be explained by the comparison of own offering to third party offerings to determine its suitability. Counterpart of this combination is present in the new market evaluation mechanism.

7.2.4 Project termination mechanism

The formula for negative evaluation and project termination contains the absence (or the failure of the evaluation to lead into positive outcome) of product evaluation, market evaluation, product policy evaluation and competition evaluation. Specifically the formula can be stated as:

$$\text{pmlc} \rightarrow \text{project termination}$$

This formula can be interpreted as explaining a NPD project where the product met none of the evaluation criteria except risk evaluation that was present in some of the cases but was not minimized into the formula. Therefore, the NPD projects failed in almost all aspects of evaluation. This is interesting as partial success is completely absent from these cases. Thus the projects could be deemed as total failures when they were evaluated.

The evaluation stage proceeds in a straightforward manner as the different evaluation rules are applied during a short period of time. In some instances, such as when the electronic microscope was evaluated, the evaluation occurs during a single meeting where the new product group goes through the different evaluation rules and then decides to terminate the project.

The mechanism that is postulated to underlie this configuration relates to failure in ideation. The process begins when product development is deemed

to have proceeded to a stage where enough information has been gathered for the product to be evaluated. This puts the project into the agenda of the new product group, which then decides on the future of the NPD project. Through a meeting or a series of meetings the new product group goes through the different evaluation rules which leads them to deem the project unfit for commercialization and the project is subsequently terminated.

From the perspective of the functional components of the mechanism, the minimized configuration does not include a single present condition. Therefore, the projects could be deemed to have failed in all areas of evaluation. The only condition that is not minimized into the configuration relates to risk evaluation. Overall, this mechanism depicts the escalation of failure that had been allowed to continue to either making of a prototype with the help of external financing as is the case with CK 12 aviation radiophone and Personal Dust Sampling Pump or the termination of a project at a very early stage as it the case with the electronic microscope.

7.2.5 Theoretical grounding for the mechanisms

First, it is noteworthy that these mechanisms are a more homogeneous group compared to the ideation mechanisms that were very varied in their form and content. This might stem from the notion that evaluation as a function is more structured and formal. What this stage yields is configurations of evaluation rules that the managers apply when evaluating products and how these configurations can be typified.

It has also to be noted that each of the evaluation mechanisms that led the product into outcome stage included product evaluation. This is a strong indicator that the product itself creates grounds for its commercialization. Thus, it could be said that when managers deploy resources to ends they perceive most efficient, as suggested by Mahoney (1995), the viability of the product is on which they begin to configure the product to specific ends. Furthermore, product characteristics have been identified in the extant literature as a key success factor for new product performance (Henard and Szymanski 2001), which is also supported in the light of present findings.

These evaluation mechanisms relate largely to the pursuit of evolutionary and technical fitness by the management, which has been highlighted in the dynamic capability literature (e.g. Helfat et al. 2007; Teece 2007). Policy coherent evaluation mechanism to existing market and new market evaluation mechanism are directed towards increasing the evolutionary fitness of the company. Both of these strive towards extending the presence of the organization in both existing and new markets. The policy coherent internal evaluation mechanism is directed at increasing the technical fitness of the company by increasing efficiency in contrast to competitors. The final mechanism embodies the management's realization that the products neither increase evolutionary or technical fitness and therefore the projects have to be discarded.

Policy coherent evaluation mechanism to existing market increases evolutionary fitness by providing offerings to markets that the company knows or is operating in and is therefore aimed at increasing the growth of the company. This follows the suggestion of Helfat et al. (2007) of how dynamic capabilities create performance by inducing evolutionary fitness. The triad of product evaluation, market evaluation and product policy evaluation are primarily focused on fitting the product to the company and the market. This is done by selecting products that provide both internal fit with what the company does and external fit with the market environment. Therefore, it enables aligning products in relation to existing offerings of the company but also to the possibilities that the managers see to exist in the market. This follows the suggestion of Clark and Wheelwright (1993) that projects are not island in themselves but that they interact with other projects and that they have to match the operating organization to be effective. Therefore, what the managers aim at is attaining simultaneously internal and external fit (Siggelkow 2001).

The new market evaluation mechanism relates to selecting products to new market with risk mitigation. This incorporates the idea of evolutionary fitness through focusing on expansion into new markets. This follows the suggestion of Helfat et al. (2007) on how dynamic capabilities create performance by inducing evolutionary fitness through growth. The mechanism incorporates the presence of product evaluation, market evaluation and risk evaluation in addition to the absence of competition evaluation. Selection of these projects for commercialization can be described as what Eisenhardt and Brown (Brown and Eisenhardt 1997; Eisenhardt and Brown 1998) refer to as probes – tests of new and possible markets with low cost projects. Nature of the projects minimized in this configuration after case specific analysis also upholds this, as ELSA was an initiative to pursue opportunities in the weather satellite business, CORA was a project to tap into the emerging market of OMEGA radio navigation technology, and finally SODAR was a project to expand into weather radar business. Thus all the projects had far-reaching goals. By using external financing in the projects, Vaisala was also able to keep costs of the projects down, which also follows the suggestions Eisenhardt and Brown (Brown and Eisenhardt 1997; Eisenhardt and Brown 1998) with regards to probes.

The third evaluation mechanism, labeled as policy coherent internal evaluation mechanism, incorporated product evaluation, competition evaluation and product policy evaluation in addition to the absence of risk evaluation. This mechanism is directed towards increasing technical fitness of the company by enhancing the operational capabilities of the organization. In the project, which is left in this prime implicant after case specific evaluation, this is attained through cost efficient production of radiosondes. This is in line with the suggestion of Helfat et al. (2007) that technical fitness is manifested in how efficiently the company is able to produce its offerings.

The final mechanism embodies the absence or negative outcome from product, market, competition and product policy evaluations. When the product is incapable of increasing neither evolutionary nor technical fitness of the company, the product development project is terminated.

Overall, it is possible to conclude that the identified mechanisms embody the managers' pursuit to increase the evolutionary or technical fitness of the company through the selection of products that are capable of inducing these effects. Thus, evaluation pertains largely to the managers' decisions of resource allocation to causes they perceive efficient. To do this, they exercise different combinations of evaluation rules. How different outcomes are pursued depends on the mechanism in question.

7.3 Postulating outcome mechanisms

Altogether five recurring activities were identified in the previous section to be pertinent to the outcome stage. These were: 1) product launch, 2) adding product to evaluation portfolio, 3) further development of the product, 4) patenting of the product or its component and 5) investing into production equipment. These activities were present in 12 of the project as three NPD projects were terminated in the evaluation stage.

Table 12 depicts a truth table of the NPD activities on the outcome stage. Altogether 8 different configurations of NPD activities were identified to exist in the outcome stage.

Table 12: Boolean truth table of outcome configurations

Conditions					Cases in configuration
L	E	F	P	N	
1	1	0	1	0	ELSA
1	1	0	0	0	RS restructuring
1	1	1	0	0	RS 21 and RS 24, METOX, Kemi lighthouse, HATTARA
1	0	1	0	1	New sonde batteries
1	0	0	0	0	SODAR
1	1	1	1	0	CORA, NASTA
1	1	1	1	1	HUMICAP
1	0	1	0	0	MIDAS

0= condition abscent
1= condition present
L= product launch
E= added to evaluation portfolio
F= further development of the product
P= patenting of the product or its component
N= investment in production equipment

No contrary configurations were identified and therefore all the NPD projects could be used for further analyses and no new conditions were added to solve the contradictions. The conditions were then analyzed for necessity and sufficiency. On the level of configuration, each of the configurations is sufficient as they generate outcome(s). However, none of these is necessary, as other configurations can constitute outcomes as well. On the level of single conditions, product launch is the only necessary condition as it is present in each of the configurations. It can be also considered a sufficient condition as it alone is an outcome in the case of SODAR. Thus, on the level of single conditions, product launch appears to be central as it alone is an outcome.

Next a Boolean minimization algorithm of the Tosmana program (Cronqvist 2011) was applied to the truth table. This generated logically minimal reduced expressions of the configurations of outcome activities. After this, the prime

implicants were restructured based on case specific knowledge which enabled assigning projects to specific formulas based on case knowledge. The cases were assigned to specific prime implicants at this point to highlight the common characteristics between the projects. These assigned minimizations will also be further used in the next chapters when the postulated mechanisms are contextualized. Table 13 presents the procedure and findings.

Table 13: Boolean minimization table for outcome configurations

Cases included	All prime implicants, including partly concurrent explanations	Restructured prime implicants by using case specific knowledge	Cases assigned to prime implicant based on case specific knowledge	common denominator(s) between projects
RS restructuring, RS 21 and RS 24, METOX, Kemi lighthouse, HATTARA, SODAR, MIDAS	Lpn	Lpn	RS restructuring, RS 21 and RS 24, SODAR	New products that resulted only in the lauch of the product
New Sonde Batteries, MIDAS	LeFp	LeFp	New sonde batteries, MIDAS	Stand alone products that were further developed
ELSA, RS restructuring, RS 21 and RS 24, METOX, Kemi lighthouse, HATTARA, CORA, NASTA,	LEn	LEn	ELSA, METOX, Kemi lighthouse, HATTARA	New products that affected future development
CORA, NASTA, HUMICAP	LEFP	LEFP	HUMICAP, NASTA, CORA	Patented products that were sedimented to the offering portfolio

Capital letter = condition present
Lowercase letter = condition abscent
Addition (+) = or
L= product launch
E= added to evaluation portfolio
F= further development of the product
P= patenting of the product or its component
N= investment in production equipment

These reduced equations state the combinations of central NPD activities both present and absent that constitute outcomes and cover the process of outcomes. To better grasp each of the solution formulas and the postulated mechanism that underlies them, I next move to explaining them in detail.

7.3.1 Product launch mechanism

The first formula for a successful outcome consists of the presence of product launch and the absence of patenting and investing into new production equipment. Specifically, the formula can be stated as:

$$Lpn \rightarrow outcome$$

The configuration of outcome activities can be interpreted as explaining the outcome of selected NPD project only on the basis that they have been launched through exercising product launch routine. Therefore, product launch alone induced an outcome.

The mechanism that is postulated to underlie this configuration is labeled product launch mechanism. Launch of the product alone creates new produc-

tion routines, ties resources of the company in producing the specific offering and in many instances servicing them for a number of years. The process begins from the point where evaluation of the product has been made and ends into a point where the product is officially launched into the market. As a result of this, the company has to manufacture and service the equipment that they have just launched which affects the future production activities of the company. Therefore, the product launch routine affects mainly the production resource allocation of the company, as it does not result into intellectual property in the form of patent or investment into new production equipment. Both of these are absent conditions in the formula. Also what is noteworthy that these products do not have a large role in extending the knowledge base of the company or the way in which Vaisala would develop products in the future.

From the perspective of the functional components of the mechanism, product launch alone appears to be enough to lead into an outcome. All the other possible activities that are present in the raw configurations appear to be secondary to the single routine of product launch.

7.3.2 Standalone product launch and redevelopment mechanism

The second outcome formula consists of the presence of product launch and further development of the product and the absence of adding the product to the evaluation portfolio and patenting of the product. Specifically, the formula can be stated as:

$$LeFp \rightarrow outcomes$$

The configuration of outcome activities can be interpreted as explaining the launch of standalone products that were then further developed by the company. However, the absence of patenting and influence on the development of future products rules out the possibility that the products would have had impact on other products or the knowledge base of the company.

The mechanism that is postulated to underlie this configuration of outcome activities is labeled standalone product launch and redevelopment mechanism. The process beings at the point when evaluation of the project has been made. This first leads up to the launch of the product and thereafter to further development. Therefore, the mechanism affects the company through altering the day-to-day production routines and consumes both production and NPD resources (and affects therefore the future use of resources that the company has).

From the perspective of the functional components of the mechanism the product launch in association with further development, which opens up a unitary technological trajectory that the company thereafter follows. However, this trajectory still proliferates further but remains rather rigid.

7.3.3 Future evaluation altering product launch mechanism

The third outcome formula consists of the presence of product launch, adding the product into the new product evaluation, and the absence of investment into production equipment. Specifically the formula can be stated as:

$$LEn \rightarrow outcomes$$

The configuration of outcome activities can be interpreted as extending the current offering portfolio with a new offering and steering the future NPD activities by adding the product into the new product evaluation. Therefore, the product alters the production routines of the company as new types of products are being manufactured but also the rules of the new product group are altered when evaluating NPD projects. However, the absence of investment into production equipment can be interpreted as highlighting that the product itself does not create a rigid trajectory that is tied to production equipment of the company.

The mechanism that is postulated to underlie this configuration of activities is labeled future evaluation altering product launch mechanism. It pertains to the launch of a product and the altering effect that the launch has on the future new product evaluation. The process begins when evaluation of the product has been made. This leads to the launch of the product, which is accompanied by adding the product into product evaluation by the new product group to update the evaluation procedure. Therefore, the mechanism affects the productive resource allocation and production routines as well as the evaluation rules of the new product group. Therefore, this mechanism has an impact on how the company conducts new product evaluation in the future.

From the perspective of functional components of the mechanism the product launch in association with the product being added to the evaluation of new products alters how the company evaluates its new products in the future and therefore the overall technological trajectory the company is moving in.

7.3.4 Trajectory altering product launch mechanism

The fourth outcome formula consists of the presence of product launch, adding the product into the new product evaluation, further development of the product and patenting of the product. Specifically the formula can be stated as:

$$LEFP \rightarrow outcomes$$

The configuration of outcome activities can be interpreted as instances where the product was launched and it also altered the intellectual capital and future product development. The products altered the intellectual capital by creating a new resource (patent), affected how new products would be evaluated in the

future and also created a distinct trajectory for the product through the further development of it.

The mechanism that is postulated to underlie this configuration of outcome activities is labeled trajectory altering product launch mechanism. It relates to the launch of a product that alters the intellectual capital of the organization through patenting, affects the future product development through further development of the product and the future evaluation of new products. The process begins from the point when evaluation of the product has been made. This leads to the launch of the product, accompanied by further development of the product, patenting of the product or a part of it and adding the product to the future evaluation of new products. Therefore, the mechanism affects the production routines of the company, NPD activities through the further development of the product, resource base of the organization by lending it a patent and also affects how the new product group evaluates new products.

From the perspective of functional components of the mechanism, this mechanism has the broadest impact as it affects both the intellectual capital and operational procedures of the company. Therefore, it creates the broadest single impact on the company of these outcome mechanisms.

7.3.5 Theoretical grounding for the mechanisms

The outcome mechanisms reveal the impact that specific product development projects had on the company. From the outset product launch routine is the common denominator between all the mechanisms and it can also function alone as a mechanism. Therefore, all of the mechanisms have an impact on the operational capabilities of the organization by at least altering production capabilities. This is in line with the suggestion of Winter (2003) that dynamic capabilities alter the operational capabilities of the company. Each of these mechanisms could be perceived as a manifestation of reconfiguring as desired which was earlier highlighted as the function of dynamic capabilities (see Zahra, Sapienza and Davidsson 2006) as they alter how production of goods is done. However, the mechanisms can induce much more than just reconfiguration of production, as they can affect the knowledge base of the company in multiple forms and future product development activities by altering the evaluation rules.

The product launch mechanism induces the baseline effect on the organization – product launch. Actualization of this mechanism can therefore be perceived as success in reconfiguring as desired (Zahra, Sapienza and Davidsson 2006). However, it does not induce any other changes on the organization.

Standalone product launch and redevelopment mechanism incorporates the reconfiguration as desired but also affects future product development. Therefore, it also induces new search activities in the domain of current expertise, as has been suggested by Nelson and Winter (1982). It also enhances current technical knowledge in a specific area (Rosenkopf and Nerkar 2001) and breeds more variation in this area without affecting other products or product

areas. This can be said to affect the ideation phase of the new product development capability by providing move options. In doing so, it can be conceptualized as experience accumulation (Zollo and Winter 2002) that spark the actualization of new search routines within the company.

The future evaluation altering product launch mechanism induces reconfiguration as desired but also affects how future products are evaluated *vis-à-vis* how evaluation functions. Therefore, it affects evaluation of new products by providing new conditions on which the internal and external fit of products can be evaluated. Therefore, through this mechanism the new product group does simplification cycling through elaboration (Bingham and Eisenhardt 2011) to update evaluation criteria of new products. In practice the new product group adds the new product into the product portfolio against which new products are evaluated in the evaluation stage. This can enhance the evolutionary fitness of the company by providing better grounds for evaluating products and thus enhancing the evaluation phase of the new product development capability through updating. In doing so, it also represents a form of knowledge articulation mechanisms that Zollo and Winter (2002) identified as being central for the development of dynamic capabilities as it alters how evaluation functions.

Finally, trajectory altering product launch mechanisms fulfill reconfiguration as desired but alters also future ideation and evaluation. It affects future ideation by providing new resources to it through patenting and new grounds for ideation in the form of further development of the product. It also affects future evaluation of new products by providing new conditions on which the internal and external fit of a product can be evaluated in the form of simplification cycling through elaboration (Bingham and Eisenhardt 2011). Both of these enhance the evolutionary fitness of the company by altering both ideation and evaluation stages of the new product development capability. Delineating from the previous discussion, this mechanism embodies the experience accumulation mechanism (Zollo and Winter 2002) in the form of new search activities and the knowledge articulation mechanism (ibid.) in the form of altering how future products are evaluated.

To draw this discussion together, each of the mechanisms lead to reconfiguration as desired. However, apart from the product launch mechanism, each of the mechanisms has a distinct impact on the development of the new product development capability by either affecting ideation or evaluation. Thus, these mechanisms induce what Zollo and Winter (2002) would label replication – diffusing the newly created knowledge to the organization. Depending on the mechanism in question, this can take many roles.

Now that I have outlined mechanisms for ideation, evaluation and outcomes, it is time to move into depicting how these mechanisms function together. First, I discuss how the mechanisms together can help us understand product development on the project level in the next chapter, which is followed by an examination of how the mechanisms explain organizational change in the subsequent chapter.

8. Understanding new product development capability on the project level

Now that I have postulated mechanisms for ideation, evaluation and outcomes, it is timely to examine how these mechanisms function on the NPD project level. This yields us an understanding of how the new product development capability is actualized through the NPD projects and how this functions. In doing so, I first examine how the new product development process can be understood. This is followed by considerations of the roles of different mechanisms in actualizing the capability on the project level. Finally, I look at the capability as a manifestation of success paths through which new products are developed.

8.1 New product development capability as problem solving processes

Brown and Eisenhardt (1995) identified three main approaches for researching new product development. These were the rational plan approach that sees development as rational transformation of inputs into outputs, the communication web approach that seeks to understand success via communication that takes place, and the disciplined problem solving approach that focuses on the processes through which successful products are developed. In researching organizations' capability to develop new products, all of these approaches have received a fair amount of attention. The current research primarily subscribes to the last stream of research as my focus is on understanding the processes through which new products are developed and embodied in distinct mechanisms, each of which address a distinct problem.

From this perspective, ideation can be seen as a problem solving activity to garner ideas and thereafter create a product concept or a prototype that embodies this idea. I doing so, ideation depicts how these problems are addressed either through creation or application of knowledge (Iansiti 1998). The different ideation mechanisms lend paths for creating a product concept that specifies the function, structures and message that the product would embody (Clark and Fujimoto 1989) and product planning that translates the concept into specific facets of the product (Clark and Fujimoto 1991). Each ideation

mechanism has a distinct function, as on one hand local search is inherently aimed at improvement through further development of existing products or prototypes. Exploratory search and external knowledge embodiment mechanisms, on the other hand, are guided by a vision to extend operations into a new market by generating knowledge of a specific domain and creating product concepts/prototypes to them.

Whereas ideation embodies the initial concept of the product, the different evaluation mechanisms define how the product could be established into the offering portfolio of the company, revealing the vision of the management on the role of the product. This is guided by the company policy of either providing solutions to meteorological measurement problems or creating products that are new to the market. Based on this, the policy coherent evaluation to perceived market and policy coherent internal evaluation appear to embody the first principle and the new market evaluation appears to embody the second principle. Therefore, the minimized configurations of simple rules define how the management perceives the product as a possible part of the offering portfolio of the company. What is also noteworthy is that the pervasiveness of policy coherent evaluation to existing market emphasizes the centrality of evaluating product integrity (Clark and Fujimoto 1991) with regards to both internal integrity (how the product functions in itself) and external integrity (how the product fits customer needs) which is then augmented with considerations on product policy coherence that upholds both of these dimensions.

Based on these notions, it is possible to suggest that each product goes through two stages of visioning on what the product would be. First, in the kind of ideation is undertaken and secondly in how the product is evaluated as a possible part of the offering portfolio. It also highlights the role of management in both ideation and evaluation as their role in ideation is to give initial direction as to how the idea could be conceptualized and next during evaluation in positioning the product into the offering portfolio of the company.

8.2 The role of different mechanisms in new product development capability

Each set of mechanisms has a distinct function in actualizing the new product development process that I wish to explore here. In doing so, I begin from ideation mechanism, proceed to evaluation mechanisms and end the discussion to outcome mechanisms.

The three ideation mechanisms can be conceptualized as enabling either the strengthening of the current knowledge base of the company (local search), widening the knowledge base (exploratory search), or creating pockets of knowledge outside the current knowledge base (external knowledge embodiment). This affects the outcomes that the mechanisms can generate. Local search appears only to deepen the current technological knowledge, which can explain why they only lead to either product launch or project termination.

Therefore, the immediate knowledge domain can only provide small improvements that do not have a substantial impact on the company and its future product development.

External knowledge embodiment appears to be capable of resulting in all different forms of outcomes. The meager outcomes in some instances can be attributed to the challenges that arise from collaboration. Especially two factors seem to affect the outcomes external knowledge embodiment can generate. Firstly, timing appears to be central as it hindered the outcomes of both SODAR and the Personal Dust Sampling Pump projects, leading them either into project termination or only to product launch. This coincides with the notion that speed is an important factor for the successful utilization of absorptive capacity (Zahra and George 2002). Secondly, capacity of the third party also has an impact on the outcomes external knowledge embodiment can generate. This is well exemplified in the development of the Personal Dust Sampling Pump in which University of Tampere was incapable of fabricating the product in a sufficient form. Research quality has also been identified in the absorptive capacity literature as being a central factor for successful collaboration (Bishop, D'Este and Neely 2011). These both are natural challenges when working with third parties in new product development. When both of these challenges can be mitigated the propensity of success can increase.

Exploratory search appears to have a tendency to always induce change in the organization, whether creating possibilities for new ideation, affecting how projects are evaluated or both. Therefore, it has the largest potential to affect product development activities of the organization and the product development process itself. As the organization conducts the search, the propensity of success and effects on the organization itself can be greater than if a third party would be involved.

Evaluation mechanisms induce stability to the organization and the new product development process by tempering the impact that proliferating search could have. Thus, evaluation aligns these activities to the organization. A strong indication of this is that the most frequent mechanism was policy coherent evaluation to existing market. Therefore, the interrelationship of prolific search combined with strict evaluation appears to enable the creation of new and different offerings that are still aligned with the company. Effective evaluation also enables the termination of projects that are not perceived to be efficient use of the productive resources of the company, which follows suggestions of Mahoney (1995) on the role of management in optimizing resource allocation.

The ideation and evaluation stages appear to have a very different focus in the new product development process. Whereas search activities are intensely technology oriented and none of the mechanisms directly incorporate responding to customer needs, the needs of the customers are central in the evaluation stage. To contrast, Danneels (2002) highlighted that successful new product development stems from the linking of technological competences with customer competences. In the current study linking these competences rather appears to be sequential as technological competences are exercised

first and after this the customer competences are used to evaluate the product. It is possible to speculate whether this sequential use of the competences opens up a wider search space for the company and enables the development of products that customers are not yet capable of articulating. If so, this could enable the company to gauge wider range of technological opportunities than would be possible by just following the immediate needs of the customers. Effective and customer focused evaluation could thereafter ensure the selection of products that indeed provide benefits to customers. In many instances the development of the product was started and after initial development had been made a prospective customer for the product was found. Therefore, this calls into question whether customers are even able to articulate their needs before some kind of initial solution is provided to them in markets where the offerings are complex and oftentimes completely new.

The outcome mechanisms enable parsing out the impact that specific products have on the company. Excluding the product launch mechanism, each of the mechanisms resulted into learning and change in the organization. Therefore, outcomes can be perceived as a learning process and a feedback loop through which the managers learn from their past decisions and alter their future activities. On one hand, this can be understood as simplification cycling (Eisenhardt, Furr and Bingham 2010) through which managers alter product evaluation rules. Outcomes also alter future product development through further development of the launched products. In this manner outcomes can affect both ideation and evaluation. This enables exercising the new product development capability as a cyclical process, as outcomes feed the process with new ideas and adjusts the evaluation criteria and therefore enhance the new product development process.

Each set of new product development activities identified in this research have received attention in the extant literature in one way or another. Despite this, how the mechanisms function together has received only scant attention. Zollo and Winter (2002) have extensively discussed how dynamic capabilities change through learning and Rosenkopf and Nerkar (2011) have discussed different forms of search but an integrative perspective has still been missing. This is what I have tried to provide here by explicating the role of ideation, evaluation and outcome mechanisms in actualizing new product development capability. From this examination I would like to highlight that neither ideation, evaluation nor outcome mechanisms alone are sufficient in explaining how the new product development capability functions but rather they have to be examined together to get a broader picture of how organizations develop products and how this activity is able to change the organization itself. However, I do realize the challenges of accomplishing this task within the confines of a journal article, which is the dominant mode in which these issues have been discussed.

What is also noteworthy is that many of the mechanisms share common features. This raises the question whether slight alteration of activities can bring about large changes in the mechanisms. This could indicate that different potential mechanisms can reside in a capability without them being constantly

actualized. This would mean that the capability in itself could be extended through the introduction of new activities that can unlock potential mechanisms within the capability. This can partly be seen in the present findings as local search was extended with new activities that gave rise to exploratory search and external knowledge embodiment mechanisms. This provides an illustrative example to the idea brought up by Loasby (2010) that "…effectiveness of any particular capability depends both on the elements that are included and on the particular ways in which they are connected: the combination may be worth more than the sum of its elements – or less, as has been often discovered" (p. 1308).

Now that I have explicated the role of different kinds of mechanisms, it is timely to move into depicting how the different mechanisms in combination with each other actualize the product development process. This is where I will proceed next.

8.3 Success paths of new product development

Now that I have discussed the characteristics of different mechanisms, I can proceed to depicting how these mechanisms function as sequences and provide explanations of the specific NPD projects. This enables me to uncover what Woodside and colleagues (Woodside, Ko and Huan 2012) have labeled key success paths – how sequences of different elements are sufficient in explaining an outcome. Therefore, this enables us to understand the different ways in which the new product development process is actualized. To do so, I proceed from ideation mechanisms into depicting the evaluation and outcomes to highlight paths through which the capability is actualized on project level. I do this in turn for each of the ideation mechanisms starting from local search, followed by external knowledge embodiment and finally exploratory search mechanism. In presenting the key success paths, I first provide a graphical representation of the possible mechanism paths and thereafter explain them.

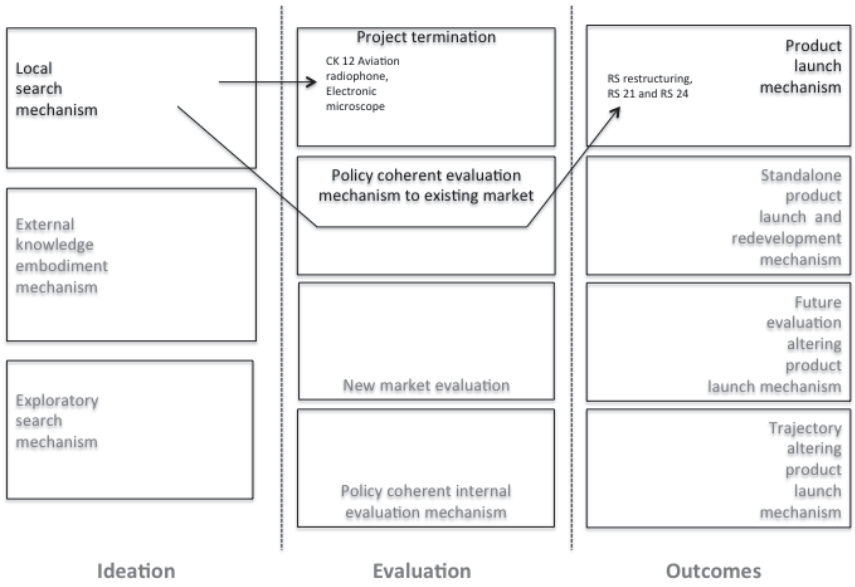


Figure 9: Sequence of mechanisms starting from local search

Figure 9 depicts the sequences of mechanisms that local search can induce. The local search mechanism produces two possible paths, one leading to project termination in the evaluation stage and the second leading to product launch mechanism. Based on the paths it is possible to note that local search was only capable of leading to either project termination or launch of a product that did not have any impact on the other NPD activities of the company. Therefore, local search projects of the company inherently breed stability (but also failure) as they are incapable of altering how the organization conducts new product development activities. The projects that resulted into a product launch mechanism were extensions to an existing product line and therefore did not induce more significant effects. This is further emphasized by the notion that they were evaluated as policy coherent products to existing markets. The two terminated projects were both discarded at the early stages of development as the gains yielded by completing the projects were perceived to induce only meager outcomes for the company, draining resources that could be used for more efficient causes. This follows the suggestions of Mahoney (1995) that managers try to optimize the resource allocation decisions of the company. In effect this supports the notion that the management is capable of assessing projects and willing to terminate the projects they see unfit for the company.

Local search appears to have a tendency to breed terminated projects or projects that extend an already existing product line. Thus, local search does not appear to be a strong driver of success when a project is identified as a central NPD project. Local search appears to be a possible core rigidity of the company (Leonard-Barton 1992) as all the products are based on existing products or technologies of the company and give no new direction for new product devel-

opment activities. Next I proceed into depicting the success paths that external knowledge embodiment can generate.

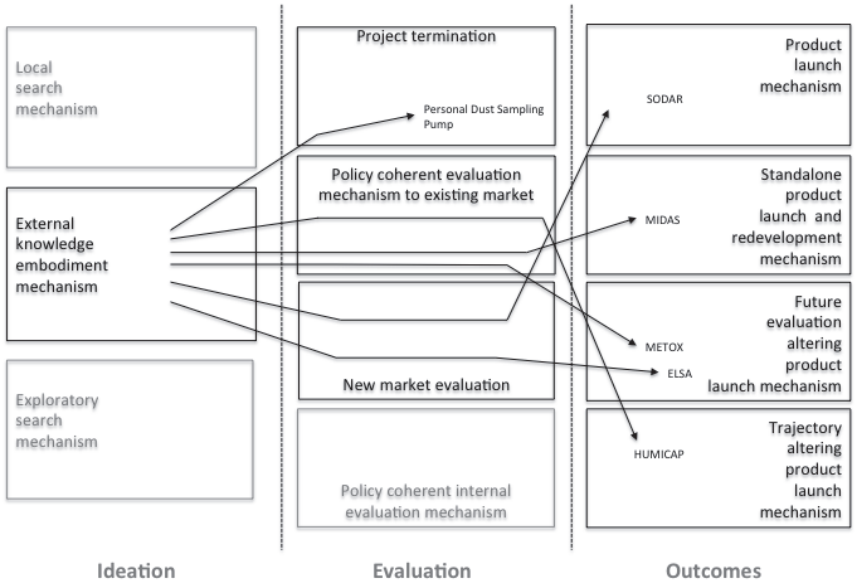


Figure 10: Sequence of mechanisms starting from external knowledge embodiment

Figure 10 depicts the sequences of mechanisms that external knowledge embodiment mechanism can induce. External knowledge embodiment is capable of yielding all possible forms of outcomes as well as project termination during the evaluation stage. With regards to evaluation, the paths include all other evaluation mechanisms except policy coherent internal evaluation mechanisms. This highlights the role of collaboration that is inherently directed towards creating new market offerings rather than increasing the internal efficiency of the company. The paths underline the unstable nature of collaboration process that can yield both trajectory altering change as well as project termination. The only terminated project can be explained through the incapacity of the third party in fabricating a product that would have been perceived as worthwhile to pursue further. The NPD project that leads to product launch mechanism was selected as a probe (Brown and Eisenhardt 1997; Eisenhardt and Brown 1998). The reason behind why the product led only to product launch mechanism can be traced back to the timing of the use of the probe. The launch of the product stalled for six years and therefore was not able to gauge the market potential as the market had already formed. All the other projects led the product to be incorporated into the future development activities of the company either in the form of further development or alteration of future product evaluation.

External knowledge embodiment mechanism appears to have varied effects on the company, ranging from project termination into trajectory alteration.

This can be largely attributed to the notion that the company is dependent on a third party in the development of the product. Two factors appear to affect the meager impact that some of the projects had. Firstly, timing appears to be central as it hindered the outcomes of both SODAR and the personal dust sampling pump, leading them either into project termination or only product launch. Secondly, incapacity of third parties to provide what was intended hindered the effect of this mechanism. This is well exemplified in the development of the Personal Dust Sampling Pump in which the University of Tampere was incapable of fabricating the product in a sufficient form. These both are natural challenges when working with third parties in new product development. In projects where these two factors function properly, it is possible to reach outcomes that result in changes in the new product development of the company. Next I proceed into depicting the success paths that exploratory search can generate.

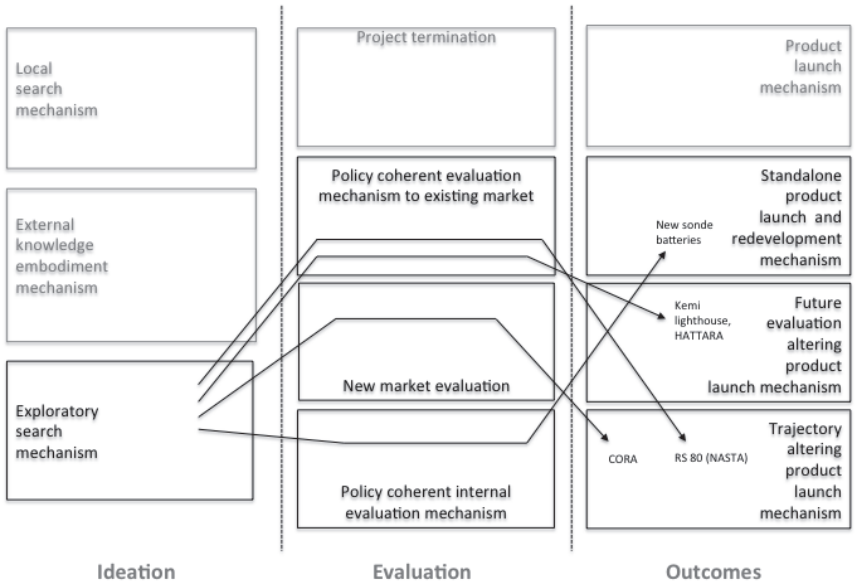


Figure 11: Sequence of mechanisms starting from exploratory search

Figure 11 depicts the sequences of mechanisms that exploratory search can generate. Exploratory search appears to have a tendency to induce change in the organization, whether creating possibilities for new ideation, affecting how projects are evaluated or both of them. Therefore, learning within the organization always appears to accompany further changes, whereas absorbing external knowledge can in some cases be only embodied into a single product. Exploratory search therefore drives the organization to change one way or the other.

Identification of these success paths does not provide a rule for riches as different ideation and evaluation mechanisms can combine to provide very different outcome mechanisms. These non-linear success paths that the mecha-

nisms form together do not provide a linear process that the rational plan approach to new product development would assume, but rather a mode of operating that leans towards disciplined problem solving (see Brown and Eisenhardt 1995) in which the ideation and evaluation both induce some kind of vision on what the product could be. These findings also raise the point that the mechanisms are not highly interdependent and therefore they can combine quite freely. This is in line with the suggestions of Van de Ven and colleaques (Van de Ven et al. 2008) that innovation processes rarely follow strict linear paths. This also provides evidence of the fungibility of dynamic capabilities that has been highlighted by Eisenhardt and Martin (2000) as different mechanisms can be substituted with each other to reach the same outcome.

While the success paths highlight the fungibility of the new product development capability, some general tendencies can be drawn. Firstly, local search is only able to generate either terminated projects or launched products that have no other impact. Therefore, local search in itself is only able to extend existing product lines and not create more pertinent changes in the organization. Secondly, external knowledge embodiment is capable of inducing all different forms of outcomes, where incapacity of the third party and incorrect timing appear to be hindering factors for the creation of more widespread impact. Finally, exploratory search appears to have a tendency to always change the organization in some way. This is logical as when an organization learns new ways of operating, its trajectory is altered through learning.

Now that I have examined how the mechanisms function on the new product development project level, it is timely to examine how they function on the aggregate level to change how the organization operates. This is where I will proceed next.

9. Understanding new product development capability on the firm level

Now that I have examined the role of different ideation, evaluation and outcome mechanism and how they combine to explain new product development capability on the project level, it is timely examine how the new product development capability functions on the firm level. In doing so, I first focus on organizational change with regards to organization strategy and structure and how they affected the way in which the capability was exercised. This is followed by a depiction of how exercising the capability in itself changed throughout the period. Finally, I will focus on how the utilization of the capability led Vaisala to become a multiproduct firm.

9.1 Organizational change and new product development capability

It is inherent in the dynamic capability discussion that a firm is an actor that is not only a taker of what the environment provides but also an active entity which is capable of shaping its own future (Teece, Pisano and Shuen 1997; Eisenhardt and Martin 2000). This highlights the role of managers in actualizing change processes of the organization (Augier and Teece 2009; Teece 2007; Teece and Pisano 1994). Teece, Pisano and Shuen (1997) in their seminal article highlighted that exercising dynamic capabilities is a form of strategy that emphasizes efficiency through renewing competences to achieve greater congruency with the business environment. Therefore, it is also timely to examine how the organization and strategy of Vaisala changed throughout the period.

At the early stages of the period of inquiry Vaisala operated in a single market with a number of highly similar products and the product development was aligned towards keeping up a good position in the market. This could be perceived as maintenance of high technical fitness (Helfat et al. 2007). It was attained by the constant development of new radiosondes and by partaking in international sonde comparisons where the Vaisala products were oftentimes labeled as reference sondes in the market. This is what happened, for instance, to RS 16 which was the predecessor of RS 18. This can be perceived as a situa-

tion in which the company exercised its core capability (Leonard-Barton 1992) in designing and producing high quality radiosondes.

At the beginning of the 1970s the management became aware of the risk that their core capability could turn into a core rigidity and hamper the future success of company. These events together generated legitimization for the pursuit of previously distant opportunities. A number of critical events can be perceived to have driven the organization to these changes.

The first critical event that led to these changes was the death of the founder (and CEO) of the company Vilho Väisälä and the appointment of new CEO Yrjö Toivola. Toivola had been the deputy managing director of the company since 1963 and he had previously also been the research and development director of the company. Yrjö Toivola had a strong personal goal in making the most out of the technological potential of the company. As Michelsen (2006, p. 140) noted, "he had an insatiable appetite for new technology". Following Schroeder et al. (2000), these events can be perceived as an internal shock that could be speculated to have initiated the change and led to the proliferation of new product development projects aimed at expanding into new markets through product development. While, it had been previously known that operating in a single market was a risk, this shock stimulated people to confront the issue.

The second critical event was the transformation of the new product development organization. In 1969 the product development department was transformed into a project management organization where people were assigned to specific projects. This streamlined the department that had previously been growing rapidly. As a consequence the department had also been suffering from a lack of clear responsibilities and that projects were handed over from person-to-person as distinct tasks were completed. This was to be amended by the change in the new product development organization. This change coincides with the notion of Schroeder et al. (2000) that innovation initiatives oftentimes require the restructuring of the organization for the projects to materialize.

The changes in the new product development department were followed by the founding of the new product group in 1971 that supervised new product development projects. Its task was to decide on activities related to new product development such as what products would be developed and how they would be prioritized. Therefore, responsibility for supervising new product development was moved from head of the product development department into being a responsibility of the new product group. This centralized the power to the top management of which the new product group consisted of. These two organizational changes altered the architecture of the development process (Clark and Wheelwright 1993) and increased the direct involvement of top management in making new product development related decisions that has been highlighted in the Minnesota Innovation Research Program studies (Schroeder et al., 2000) as a frequently occurring phenomenon in innovation initiatives. Furthermore, it could be speculated that centralization of new product development under one instance increased the efficiency of develop-

ment, as suggested by Adler et al. (1995). Centralizing decision-making under the control of the top management could have also alleviated challenges that may arise when resource controllers and managers of new product development activities are two distinct parties (Dornblaser et al., 2000; Van de Ven and Polley 1992).

The third critical event happened at the end of 1971 when a new research and development plan was laid out for a period from 1972 to 1982. In the plan it was explicitly stated that Vaisala had to span beyond the radiosonde market if it wanted to ensure its survival. This can be perceived as a vocalization of the change efforts that the new CEO and the organizational changes strived towards. Overall, the research and development plan can be conceptualized to be an aggregate project plan (Clark and Wheelwright 1993) that depicted how new product development should be conducted during the decade and which outlined the new development strategy. Therefore, it depicted the means through which new products should be developed and the goal towards which the company should strive towards i.e. the expansion into new markets beyond radiosondes. In line with the idea of aggregate project plan (Clark and Wheelwright 1993), the plan also laid out projects that would be developed during the planning horizon such as ground equipment for radiosondes and automatic weather stations.

As a result of these changes, from 1972 onwards the organization embraced two new concurrent search strategies depicted by the exploratory search mechanism and external knowledge embodiment mechanisms that altered how the organization exercised its new product development capability. Rationale behind the two concurrent strategies could be attributed to the need for change in which external knowledge embodiment was a mode of search that could not be directly managed, whereas the organization itself could be steered to focus on exploratory search. These two can be perceived to complement each other as they both expand the possible search space of the company and therefore aid the company in its attempt to expand beyond its current market. Using both inside and outside sources of technology are not mutually exclusive but rather they can both have a role in the broader technology strategy (Clark and Wheelwright 1993). These strategies and the shift towards them could provide one answer to the question Greve (2013) posed on whether organizations pursue multiple strategies and how this could function. As it is ex ante not possible to predict what products could be successful, the use of different means and intensity of search had to be increased. This converges with the notion of Tripsas and Gavetti (2000) that search processes are connected with the how the managers see the new search space. From this perspective both of the new search strategies tackle the same issue but from a different perspectives. Subsequently, both of the new search strategies could be understood as different forms of feedback strategy, whereas the old strategy rather embodied a momentum strategy. These follow the suggestions of Greve (2013) in classifying different strategies.

The change of the organization can be understood as a realignment of organizational form by changing the configuration of structures and products that

define the organization as an entity (Rindova and Kotha 2001). In light of the current evidence, the organizational form was realigned when the new CEO was appointed and the need for change was vocalized in the new research and development plan. This change in management appears to be the centrifugal change out of which the other changes proliferated from. Organization structures were changed by reorganizing the new product development department to a project organization and by instating the new product group to supervise its activities. What resulted from these was a change in the new product development processes, which are highlighted by the emergence of two new search mechanisms – exploratory search and external knowledge embodiment. They reveal the means through which the organization tried to achieve its new goals. This follows the notion of Greve (213) that capabilities depict what organizations do, whereas strategy depicts what the capabilities are intended to do. Morphing of the organizational form drove the change in the new product development capability. Therefore, change in strategy and the new product development organization was what realigned the new product development capability towards the search for new opportunities. This follows the notion of Clark and Wheelwright (1993) that creating a development strategy and changing the development process can act as starting points for building a capability. The role of management in this process was central as they were the architects of this change and the change process in itself highlights how they constructed the capability. This follows the notion of Makadok (2001) that the primary contribution of managers in building capabilities is to act as the architects that construct them.

At the end of the period of inquiry, Vaisala also did a similar transformation as the organization was changed into a matrix organization and the central new product group was dissolved into each of the four product areas. This was preceded by a change in strategy which emphasized keeping the current product areas and developing new applications to them. Therefore, the period of inquiry can be seen as a phase through which the company tried to realign itself to the market by altering its strategy, structures and the capabilities that follow from them. When this transformation was perceived by the management to be completed, the organization changed to a new structure that emphasized stability and efficiency. Following Rindova and Kotha (2001) the period and the changes that Vaisala did can be conceptualized as continuous morphing by changing the organization structure that enabled the company to exercise its dynamic capability in a new way. When the managers perceived that the change process had been completed and the organization had been realigned to the market, the organization transformed into a new form that emphasized exploitation of the generated opportunities.

9.2 Transformation of the new product development capability

Now that I have examined changes that led to the transformation of the organization, its strategy and how these changes drove changes in the new product development processes, it is timely to examine how new product development mechanisms depict these changes. Figure 12 presents a graphical illustration of the timeline of the studied period and how each of the ideation, evaluation and, outcome mechanisms manifest during this period.

It should be also noted that five additional events were placed on the timeline accompanied by three notions on the changes that exercising the capability generated. The events pertain to the appointment of a new CEO who emphasized the need to develop new products, the emergence of an official new product group to supervise development, the explicit recognition that Vaisala had to span beyond the radiosonde market (made in the research and development plan in 1971), the transformation of the production organization in 1976 and the transformation of the organization in 1981.

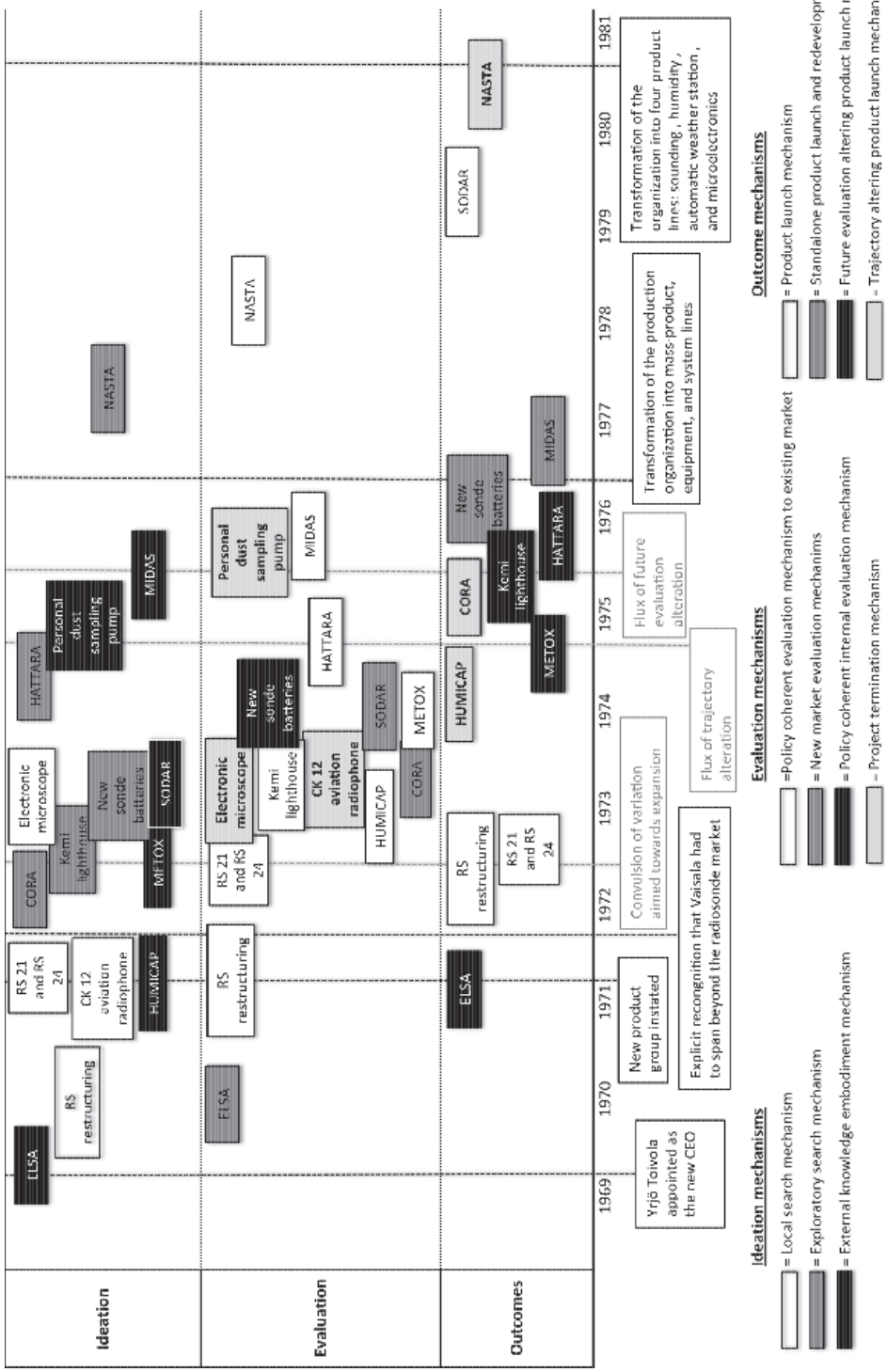


Figure 12: Manifestation of the mechanisms throughout the period of inquiry

The three key events at the early stages of the period of inquiry created impetus for the development of new products. This follows the suggestion of Schroeder et al., (2000) that a shock such as change in management or financial crises can propel innovations into flight. What this shock generated was a sudden increase in exploratory search, leading to the reduction of local search to only one project after the recognition of the need to expand into new markets and even that project was terminated in the evaluation stage. Thus, it appears that local search was largely traded in for exploratory search. This convulsion of search for completely new products lasted only four years as after 1976 only one major exploratory search project was initiated. This does not indicate that local search was completely suspended but rather that the central NPD projects were directed towards expansion into new knowledge domains. This change is well exemplified by a notion made in the research and development plan for 1972-1982:

> "Product ideas have to be sieved through as a group work. In the idea generation, we could use systematic and thorough search one business domain at a time." Research and development plan 1972-1982 (p. 4), dated 1.11.1971

With regards to external knowledge embodiment, the rate of projects also increased after 1972 as Vaisala aimed to deepen their collaboration with third parties. This is exemplified well by a notion made in the research and development plan for 1972-1982:

> "As general notion with regards to new product development activities, let it also be marked down as a fact that a small company (like Vaisala) has a weakish competence base (maybe except meteorology and sondescience) so we have to advance cooperation with "wiser" [parties] such as HUT, VTT, consultants etc." Research and development plan 1972-1982 (p. 4), dated 1.11.1971

The role of third parties in new product development of the focal company could also have another significant effect on development activities. A small company such as Vaisala has a limited capacity for development at any given point in time. If we follow the idea of Adler et al., (1995) that new product development organization consist of limited engineering resources that can only undertake a certain number of jobs at a time, then third parties can temporarily augment the resource base by extending the amount of work that can be undertaken at a given point in time. This in turn can be used to augment the search space that the focal company can gauge. Therefore, usage of third parties in the development of new product ideas can temporarily expand the search capacity of the company.

However, it must be noted that while the company had extensive collaboration with external research institutions, it was usually the third parties that approached Vaisala with new projects. Thus, projects with third parties were something that could not be directly increased but instead the propensity for collaborations could be increased by deepening relationships. This mechanism

therefore is contingent on third parties and out of reach for direct managerial actions.

The convulsion of exploratory and boundary spanning search could be explained by the notions that ideas tend to proliferate into several ideas during the innovation process (Schroeder et al., 2000). This could explain why numerous projects were undertaken to develop automatic weather stations and to expand the sounding line. What is more, Van de Ven and Polley (1992) also suggested that actions can create new goals. This could explain, for instance, the way in which automatic weather stations were developed as the successful development of a single weather station was continued by a new project that expanded into a new area in the automatic weather station market and therefore led into new development projects. Therefore, the first projects in new product areas could have created momentum for the execution of subsequent projects.

In the early stages of the period of inquiry Vaisala exercised local search to keep a strong foothold in the radiosonde business. After realizing the need to grow beyond the radiosonde market the traditional sonde business was still considered important, as it was cheap compared to other options. It was also perceived to provide either a stable market or a market with minor growth. The only major project in this domain was initiated in 1977 when the development of RS 80 was initiated through exploratory search. It eventually became the standard radiosonde for the company. Especially with regards to extending the sounding line to ground equipment, the development process can be perceived as linking the newly developed equipment with the already existing radiosondes. This follows the suggestion of Schroeder et al., (2000) that the old and new innovations exist side-by-side and they are linked and integrated with each other.

With regards to the evaluation mechanisms, no clear changes can be seen. This could be interpreted in the light that the managers did already have evaluation rules that they utilized to select projects for commercialization. This could be based on the notion that the new product group consisted of the top management of the company who already had previous experience in evaluating and selecting projects for commercialization. However, it is noteworthy that policy coherent evaluation to an existing market is the dominant form of evaluation. In conjunction with the large changes in ideation, this evaluation mechanism could be speculated to induce stability to the company by enabling the commercialization of products that fit both the company and the market it was intended for. Furthermore, Van de Ven (1986) has suggested that in complex decision-making situation people are prone to retain certain evaluation criteria, which in the current study can be understood though the evaluation mechanisms that repeat over time.

The differing search mechanisms and more stable evaluation mechanisms provide interesting insights into how these processes are structured. This interplay of ideation and evaluation appears to provide the organization an opportunity to incorporate structured and less structured elements into the new product development process. Therefore, the search for new product ideas and

concepts can function on a less structured basis[1] and drift towards new directions which was what happened when the organization started to search for new types of products, whereas evaluation is a more formal process of exercising evaluation rules that cluster to certain mechanisms and remain fairly constant throughout time. Eisenhardt, Furr and Bingham (2010) discussed how organizations balance between efficiency and flexibility through the structures that govern action and how organizations drift towards efficiency through structuring. The interplay of ideation and evaluation in the present study provides an example of how the destabilization and change in one component of a process can alter the whole process and therefore increase flexibility of new product development. Furthermore, if the processes are understood as configurations, as is done in this study, flexibility increases through the way in which different activities are combined throughout the new product development process. Therefore, the way in which activities are combined becomes central and can mitigate the downsides that structures can cause.

With regards to outcomes, two central notions can be made. Firstly, projects that led into only a product launch mainly occurred at the early stages of the period as local search projects were drawn to a close. SODAR, in this respect, deviates from the other projects but this can mainly be attributed to the lag that its introduction took, which decreased its potential as a probe. Therefore, after 1972 only one project did not change the new product development by either altering ideation or evaluation.

Secondly, what is interesting is that future evaluation altering product and trajectory altering product launch mechanisms appear to mainly cluster to a period from 1974-1976 when products aimed at new markets were commercialized. This can be understood as a period of readjustment of evaluation rules when the wave of products intended for new markets were introduced. Thus, there appears to be time lag in the updating of evaluation rules. This adds an interesting boundary condition for the effectiveness of evaluation rules as they are updated when the product development project is drawn to a close and the outcome of the evaluation can be evaluated. This might not be so crucial in entering new markets that Bingham and Eisenhardt (2011) studied as the pace can be less hectic but in context where exercising evaluation rules are frequent, the rules may be not as up to date and therefore affect the evaluation process.

These changes highlight the possibility of the organization to realign its search efforts completely by realizing the potential residing in its capability to develop products. This coincides with the notion of Loasby (2010) that the potential of a capability is only demonstrated in performance but it does not shun away the potential that a capability has that is not constantly actualized, giving capabilities potentiality to match changing circumstances.

To conclude, whereas on the project level, the mechanisms appear to be very fungible and have few recurring patterns, such is not the case with the actual-

[1] This can be seen from the varied raw configurations that the ideation stage truth table contained which are still minimized into concise prime implicants used to postulate mechanisms.

ization of the mechanisms on the firm level. Most significantly this is manifested in the change of ideation mechanisms towards exploratory search and external knowledge embodiment.

9.3 New product development capability and the emergence of a multiproduct firm

New product development capability was defined in terms of the processes through which a company develops new products. From the outset, this does not take into account what kind of role the products have for the company. However, as is evident from the findings, the capability also enabled Vaisala to transform into a multiproduct firm with three distinct product lines. Therefore, it is timely to analyse the rationale of how utilizing the capability can set companies into such a trajectory. In doing so, I draw from the ideas presented by Teece (1980; 1982) on the emergence of a multiproduct firm that is based on the idea of efficiency.

At the beginning of the 1970s the managers of Vaisala recognized the need for seeking growth beyond the radiosonde market, as it would no longer enable fast growth. This was explicitly stated in the research and development plan for the decade. Therefore, the managers recognized the limits of growth that their current market imposed on them and the possibility of seeking growth elsewhere. This converges with the notion of Teece (1982) that companies seek growth by diversifying beyond immediate markets when their existing market no longer provides enough fast growth. Therefore, the growth-seeking motive provides one answer as to why Vaisala was to expand beyond the radiosonde market. Exploratory search and external knowledge embodiment were the means to achieve this outcome. However, minimization of risk related to operating in a single market was also a contributing factor in this decision, as it had been long known that operating in a single market posed a threat to the company.

In assessing how Vaisala was to address the challenge of expansion, the management perceived that the company could use its knowledge of products and product development in other areas besides making radiosondes. In doing so, they recognized that the boundaries of searching for new product opportunities would be limited to the meteorology market. This follows the suggestion of Teece (1982) that in any given time the knowledge of the company could be directed to several different ends. Limiting the search activities to a specific market would enable the company to utilize intrafirm transfer of knowledge to aid in the development of new business areas, as was suggested by Teece (1980). In doing so, the previous knowledge in how to develop radiosondes could be leveraged when developing automatic weather stations and also when ground equipment for radiosondes was developed. Therefore, utilization of knowledge also relates to the transfer of knowledge with regards to the means through which products can be developed.

Based on the research and development plan laid out for the 1970s, it is also possible to understand how the expansion was to be made. It is evident that the company would diversify primarily through de novo entry as the firm-internal search for new products was constantly highlighted as the mean through which this expansion was to be made. This took effect in the form of using exploratory search to expand into new product areas. Therefore, it can be speculated that exploratory search was perceived as being more efficient use of the companys' resources than local search. If we look at the success rates of these two search strategies during the period, it appears that exploratory search could yield more consistent success, at least with regards to products that were launched.

However, Vaisala also collaborated with third parties to develop new products such as ELSA and HUMICAP. These projects appear to lie somewhere between market transactions and company-internal actions. This type of interaction between two parties could mitigate the challenges related to knowledge transfer, while simultaneously augmenting the search capacity of the company. Therefore, what they provide is an influx of knowledge that the focal company would not have been able to generate by itself. Simultaneously, they also extend the array of search activities as third parties utilize their knowledge of how to develop products for the benefit of the focal company.

In addition to providing an overview of what drove Vaisala to become a multiproduct firm, the development of each of the three product lines followed a unique lineage. Therefore, a closer examination of them can provide us with additional insight into how multiproduct firms emerge. Overall, what the following analyses highlight is that efficiency, which was noted by Teece (1980; 1982) as the central reason for the emergence of a multiproduct firm, is not only about how organization is internally arranged but also how congruent the actions of the organization are with its operating context and its changes.

The sounding line

The development of the sounding line largely follows the idea of Teece (1980; 1982) that intrafirm transfer of knowledge of products and ways to develop products can give rise to a multiproduct firm. As a concequence complementary technological knowledge can be used to develop products in associated product areas (Helfat 1997), which can be seen from the interrelationships that the products in this product line had. What this kind of diversification enables is that the company can exploit knowledge generated in one area to the other areas as well, while simultaneously exploring for new possible products in these areas. What this resulted into was that the sonde line was augmented with ground equipment that could be jointly developed with radiosondes and subsequently each product area could benefit from each other. Eventually this led the product line into being split into two sublines: sonde line and equipment line. Therefore, the development of closely related products can increase the efficiency of product development as the knowledge can be leveraged in multiple fronts.

While the previous discussion highlights how intrafirm knowledge transfer can explain the emergence of this product line, customers and their needs could have also contributed to the emergence of these product lines. If we follow the notion that organizations are efficiency driven, the way in which they serve their customers can also increase their efficiency. The rationale behind this argument is as follows: A single product company can rarely fully serve a market or a customer, especially in markets where multiple products can be combined together to serve customer needs. As customers can demand systems and not only components (Teece 2007), it may necessitate becoming a multiproduct firm in order to respond to these customer needs. While customers themselves can combine different offerings together to make systems, conducting such integration in part by the seller can lower the risk for the buyer and present a profit opportunity for the seller. Therefore, provision of systems in which the functional components share mutual interdependence can act as a rationale for becoming a multiproduct firm. This can be seen in the development of the sounding line, which ended up consisting of both radiosondes and ground equipment that could be used together. For instance, without the capacity to provide such systems Vaisala would not have been selected to provide the equipment for the FGGE project run by WMO that provided a quarter of the turnover of Vaisala in 1977. Also the existing customers for radiosondes present the company with an opportunity to cross-sell ground equipment. Therefore, responding to customer needs could also provide one rationale for the emergence of a multiproduct firm. While responding to customer needs is not central routine in any of the search mechanisms, the interrelationships between different products could indicate this as a rationale for diversification as the products were made compatible with each other.

Automatic weather station line

From the outset, the development of the automatic weather station line appears to follow the idea of utilizing fungible organizational knowledge (Teece 1982) and intrafirm transfer of knowledge (Teece 1980) to develop new products. The development of the first automatic weather station (Kemi lighthouse) was largely aided by knowledge on how to make different kinds of meteorological measurement equipment.

However, as the dynamic capability concept in itself was conceived to explain how organizations are capable of either matching or creating market change (Eisenhardt and Martin 2000), one could speculate whether technological and market changes contributed to the development of this product area. This is especially interesting from the perspective that Teece, Pisano and Shuen (1997) have suggested in which dynamic capabilities enable increasing efficiency of the company by increasing congruency of the focal companys' actions with the operating context.

Vilho Väisälä had already tried to build an automatic weather station in the 1950s and 60s but suitable technology did not exist at that time (Michelsen 2006, p. 146). However, when technological possibilities and market for these

products emerged, Vaisala started developing the product line. Therefore, this can be understood as an act of matching market changes. In this sense, contextual changes could drive companies towards becoming multiproduct firms, especially in markets where technological change necessitates that a company keeps up with the changes of the market. Therefore, the changing business context could push an organization towards becoming a multiproduct firm for it to be better aligned with the market and to keep up with the market.

Humidity measurement line

The development of the humidity measurement line deviates largely from the other two product lines in its underlying logic. If we follow the assumption that managers are profit-seeking (Augier and Teece 2009; Teece 1982) and that they try to capture opportunities that rise from the absence of certain markets, then the profit opportunity that rises from capturing these opportunities can create impetus for becoming a multiproduct firm. The development of the humidity measurement line largely follows this logic as HUMICAP was developed through external knowledge embodiment that opened up an economic opportunity that the managers were capable of understanding and seizing.

The product line was initiated by a single product that embodied external knowledge and enabled Vaisala to span into a totally new product area, which the company could not have done on its own. This leads us to question whether the product and the product line was an anomaly? While the humidity measurement product line consists of a single product, similar attempts were also made with products such as ELSA and SODAR in the sounding line and with the Personal Dust Sampling Pump project. These projects focused on knowledge absorption (Zahra and George 2002) through which external knowledge was acquired, assimilated, transformed and exploited by the focal company. What these projects therefore provided was profit opportunities in which the company could leverage third party knowledge.

These kinds of joint development projects with third parties appear to lie midway between market transaction and company-internal action as was noted before. What they enable is the acquisition of external knowledge and the use of this knowledge for entering into new markets. Therefore, they enable the company to tap into exogenous developments in science and technology that Teece (2007) highlighted as being one form through which companies sense new opportunities. At the same time as the external knowledge embodiment projects were aimed at the development of a prototype, the challenges associated with transferring knowledge between the parties can be mitigated as the knowledge is embedded in the prototype. This can be understood as a form of assurance that the project will yield what was intended.

This concludes the discussion on new product development capability at the firm level. Next we will proceed to the discussion section.

10. Discussion

10.1 What the new product development capability enables

At this point, we transition into discussing what the capability enables the company to achieve. In doing so, I wish to focus on two main factors, firstly the evolutionary and technical fitness that the capability provides and secondly on the rationale of diversification into new markets.

In assessing how well a capabilities function, Helfat et al. (2007) proposed two yardsticks: evolutionary fitness and technical fitness. Evolutionary fitness was conceptualized as how well the company is able to survive and possibly grow by modifying its day-to-day activities (ibid.). As Vaisala largely traded local search for exploratory search and external collaboration in the new product development process, it is evident that they tried to realign themselves to the meteorology equipment market but also span beyond it. These efforts were mainly successful as most of the developed products were launched to the market. This is in line with the notion made earlier that the effects of dynamic capabilities have to be associated with the capability of the organization to reconfigure as desired because using performance as an outcome would necessitate the presence of dynamic capabilities in all high performing companies and result in performance tautology (Zahra, Sapienza and Davidson 2006). Through these considerations it can be concluded that new product development capability can enhance evolutionary fitness.

Eisenhardt and Martin (2000) stressed that when assessing the function of dynamic capabilities focus has to be given on the outcomes they generate. Thus, if we look at the how the company evolved, we can note that Vaisala was able to grow its turnover tenfold during the period, stay profitable after 1971 and expand from one product line into three product lines. While direct evidence on the performance impact of the new products cannot be given, they certainly had an important role as year after year the role of new products were emphasized in the annual reports as a major contributor to growth. Also from this perspective it could be said that the new product development capability enabled the company to increase its evolutionary fitness.

At this point, it could also be asked why Vaisala sought to expand into new markets instead of trying to excel in the radiosonde market, which was the second issue I wanted to discuss. An answer to this question can be provided from considerations on the rationale behind a multiproduct firm. Following

the suggestions of Teece (1980; 1982) this expansion was done to seek faster growth by using intrafirm transfer of knowledge with regards to technology and how to develop new products, and therefore the expansion was primarily sought through de novo entry. These factors concentrate primarily on how the organization is internally organized for efficiency.

In addition to these findings, I explored additional explanations for the emergence of a multiproduct firm. Whereas the factors that Teece (1980; 1982) proposed largely focus on endogenous reasons for the emergence of a multiproduct firm, I highlighted three complementary explanations that stem from exogenous reasons that could explain the emergence of a multiproduct firm. These were: 1) responding to customer needs, 2) responding to contextual changes and 3) capturing profit opportunities. These all relate to how efficiently an organization operates in its context.

Whereas Teece (1980; 1982) stressed the internal efficiency of an organization as a driver for the emergence of a multiproduct firm, they way in which a company aligns itself to external changes and opportunities could also result in the emergence of a multiproduct firm. Therefore, the first two factors relate to how efficiently an organization aligns itself with the market, whereas the third factor relates to how efficiently and organization utilized opportunities in the market. These factors have been highlighted by Teece (2007) as modes of sensing market opportunities with regards to customer needs, tapping into supplier and complementor innovations and tapping into the developments in exogenous science and technology. Therefore, one could raise the question whether the transformation into a multiproduct firm could also stem from factors that enable a company to operate more efficiently within its operating context.

10.2 Routines, simple rules, mechanisms and capabilities

There is a persistent conundrum in the dynamic capability discussion that relates to how structures such as routines or simple rules enable a company to change. As Eisenhardt and Bingham (2010) noted, organizations tend to drift towards more structures that increase efficiency on the cost of flexibility. This would result in the weakening of dynamic capabilities that focus on altering structures. If dynamic capabilities function through actions that are guided by structures, how can they induce change? In this section I try to outline one possible answer that amends this contradiction.

Both the simple rule and routine perspectives already provide some answers to this question. First, routines have been conceptualized to contain both ostensive and performative elements (Pentland and Feldman 2003). Therefore, exercising a routine always breeds variability as the performance of a routine differs between instances. Secondly, the simple rule perspective stresses that the rules provide a semi-structure to guide action and therefore there is both variability in exercising the rules as well as simplification cycling that alters

the rules (Bingham and Eisenhardt 2011). These certainly provide one piece of the puzzle. However, the second question that arises is: If we look at the routines and simple rules only from the perspective of structure, how could they enable change? This is a relevant question as we rarely incorporate variability in how a specific type of activity is defined and rather focus on the repetitive elements.

On one hand, Winter (2003) defined dynamic capabilities as consisting of routines, inferring a relationship between a capability and routine. On the other hand, Bingham and Eisenhardt (2011) stress that managers develop portfolios of simple rules with which they make decisions and that these form the microfoundations of dynamic capabilities. These both posit that there can be a number of different structures that together constitute a capability. What the postulated mechanisms highlight is that in many instances the co-presence of different routines/rules formed the new product development mechanisms. For instance, in the external knowledge embodiment mechanism the production of a prototype can be perceived to increase the effectiveness of the routine of collaboration. Interestingly, some routines appear not to be central in any of the mechanisms, such as initiation of a project to match customer need in the ideation stage, while in some of the projects it was still exercised. It is possible to speculate that if the market would be more mature and stable, this routine could become more central.

Based on these thoughts, could it be that routines and simple rules both of which are guided by a structure have combinatory effects that enhance or decrease their effectiveness? If so, the mechanism oriented perspective could be a way to build a meta-layer between recurring activities and capabilities to increase our understanding of how routines/simple rules create capabilities through their combinatory and mutually reinforcing effects. The ability to combine different capabilities has already been noted as being a particularly important capability (Loasby 2010) and therefore it can be speculated whether if this logic should also be applied to how the capabilities themselves are constructed. Some indications of this kind of perspective have already been made as Salvato (2009) already noted that capabilities function as collectives.

If the amalgamate of structures creates a platform for change, do managers have an active role in configuring structures? The dynamic capability discussion has highlighted the role of managers in combining and integrating resources and capabilities (e.g. Augier and Teece 2009; Galunic and Eisenhardt 2001). This appears to be at least partly true with regards to the mechanisms examined here as for example collaboration in the studied projects was channeled mainly towards building a prototype. By doing so, the managers strived to attain concrete benefits from the collaboration.

I wish to add a caveat to these suggestions as the creation of change extends in the present study primarily to ideation. Therefore, examining how structures combine together and create change through mutually reinforcing effects warrants further study. Furthermore, this serves as an opening on the discussion of the role of mechanisms in the dynamic capability discussion to which I move next.

10.3 Mechanism-based theorizing in the capability perspective

The extant mechanism-based theorizing in the dynamic capability discussion is largely aimed towards complementing the prevalent rational plan approach. In doing so, it provides theoretical mechanisms through which inputs are transformed into outputs. Therefore, mechanisms such as resource allocation (Tripsas 1997), pace of experience (Eisenhardt and Martin 2000), capability building (Makadok 2001) and experience accumulation (Zollo and Winter 2002) have been proposed. These all embody the idea of a mechanism as a piece of theory that explains a component process of a larger system, a perspective to mechanisms highlighted by Stinchcombe (1991). In doing so, the mechanism functions as a theorized automaton that transforms inputs into outputs.

When extant mechanisms are compared to the mechanisms that have been postulated in this study, a number of points of divergence appear that are discussed here. In the extant literature mechanisms are used as means to operationalize a top-down approach to theorizing in which mechanisms fill gaps in the larger theory. Conversely, my approach has rather been one that starts from the bottom and builds upwards. Thus, I argue that the present approach can highlight some challenges related to the prevalent theorizing on mechanisms related to capabilities.

When I compare the mechanisms postulated in this study to the extant mechanism theorizing in the capability discussion, I can highlight that the currently postulated mechanisms pertain to more micro-level phenomena and get us closer to how an organization functions. From this perspective mechanisms are rather empirically grounded representations that describe how processes come about and generate outcomes. When we keep in mind that mechanisms are fungible, this raises a question on the extant mechanism related theorizing. Are the theorized mechanisms only categories of mechanism that describe processes on a very abstract level? I would suggest that the mechanisms that have been identified in the extant literature mainly pertain to abstract categories of mechanisms rather than specific mechanisms that can produce the intended transformation. Therefore, empirical fieldwork on the different mechanisms can yield a more nuanced perspective of the mechanism that enables organizational transformations.

Based on my findings I suggest that the mechanism-oriented research in the capability discourse could benefit greatly from also focusing on micro-mechanisms. This would enable building empirically grounded examinations of the micro-mechanisms that underlie dynamic capabilities. It would also complement the studies that use mechanisms solely as a tool for abstract theorizing. For instance, while ideation, evaluation and outcomes each could be labeled as higher order mechanisms, a more nuanced examination can reveal the different forms of mechanisms that pertain to each of the three stages.

By using mechanism as abstract conceptualizations, we can broadly understand the transformation that the mechanisms entail. However, this abstract conceptualization of mechanisms easily masks the fact that mechanisms can

be fungible (different mechanisms result into the same outcome). Thus, under these very abstract mechanisms lie a plethora of more nuanced forms of the mechanism that can describe different modes of how the mechanism functions. For instance, many of the identified evaluation mechanisms lead from identical initial conditions into identical outcomes and therefore one could conflate them into a single evaluation mechanism. This, however, would lead us to overlooking the nuances that distinguish each of the mechanisms and the actual process where the different components have varying roles. Therefore, based on my findings I argue that many of the identified mechanisms in the capability discourse could be looked from a more micro-level approach to distinguish the different mechanisms that are conflated into these higher order mechanisms. This would also ground the mechanisms closer to events.

The extant mechanism discussion uses mechanisms as kind of stable entities that transform inputs into outputs and largely withholds from theorizing of the components that constitute the mechanism. The current approach uses configurations of recurring activities to postulate mechanisms that in different combinations can give rise to different outcomes. It is specifically these emergent potentials that I perceive to be what dynamic capabilities aim to explain as the central promise of the discussion has been to understand how new and innovative forms of competitive advantage can be created (see Teece, Pisano and Shuen 1997). How this could be attained was already highlighted in the previous subsection on how mechanisms could be used as a meaningful meta-level between routines and capabilities to understand the effects that the co-presence of different mechanisms could have.

In understanding how dynamic capabilities function, different authors have used various kinds of constitutive components to depict what factors give rise to dynamic capabilities. Teece (2007) identified capacities as microfoundations of dynamic capabilities, Winter (2003) utilized routines as the constitutive elements of capabilities and Eisenhardt and Martin (2000) lean towards simple rules. I would argue that the focus on mechanisms could provide a valuable integration of these perspectives. It would enable us to identify recurring activities as the baseline from which capabilities are built. Studying how these activities are combined together enables us to understand the processes through which these activities are combined. This, in turn, can be explained by the mechanisms that depict the processes. By doing so, we could also examine whether certain combinations of activities have complementary effects. These mechanisms together depict how capabilities are actualized. This perspective also clearly distinguishes capabilities, mechanisms and recurring activities into their own domains and forms a hierarchy. Therefore, a mechanism-oriented approach could be used as an integrative starting point for further inquiries that bridges the different domains of interest. This would, however, necessitate that mechanisms are also used in empirical fieldwork so as to avoid the problem of them only theoretically explaining the connection between antecedents and outcomes.

This concludes the discussion section in which I have tried to explicate what kind of outcomes the new product development capability can induce and how

the interplay of routines, rules, mechanism and capabilities can deepen our understanding of the inner workings of dynamic capabilities. Next I proceed into the conclusion section to draw together the findings of this study.

11. Conclusion

Our journey is at an end and now it is timely look back at what has been done. In doing so, we first take a look back at the research questions and explicate the theoretical contribution of this study. This is followed by managerial implications. Lastly, I discuss the shortcomings that this research might have and what future avenues for research might have been opened.

11.1 Research contributions

At the beginning of this inquiry I set out to understand how dynamic capabilities, specifically the capability to develop new products, function through the mechanisms that animate these change processes. At that point I already noted that the mechanism discussion in the dynamic capability discussion has been theoretically driven and empirical studies that embrace this perspective are lacking. Therefore mechanisms have been used as abstract pieces of theory through which inputs are transformed into outputs. To investigate the functioning of mechanisms of new product development capability, I outlined three research questions that I sought to address. Now it is timely to address these questions in light of the findings.

The first question that I set out to answer related to the kinds of mechanisms that pertain to the new product development capability. Through the empirical inquiry I was able to postulate altogether 11 different mechanisms that pertain to the ideation, evaluation and outcome stages. Table 14 presents these postulated mechanisms.

Table 14: Postulated mechanisms

Ideation	Evaluation	Outcomes
Local search mechanism	Policy coherent evaluation mechanism to existing market	Product launch mechanism
Exploratory search mechanism	New market evaluation mechanism	Standalone product launch and redevelopment mechanism
External knowledge embodiment mechanism	Policy coherent internal evaluation mechanism	Future evaluation altering product launch mechanism
	Project termination mechanism	Trajectory altering product launch mechanism

In addition to postulating the mechanisms, I also examined the nature and functioning of the mechanisms themselves. While the outlined mechanisms are idiosyncratic to Vaisala, the mechanism types on the general level can provide us with some of the archetypical mechanisms that can explain how companies develop new products. This is evident when keeping in mind that many of the mechanisms draw parallels with existing research. For instance, on one hand the external knowledge embodiment mechanism draws parallels with the concept of absorptive capacity (Cohen and Levinthal 1990; Zahra and George 2002) as both relate to how an organization is able to use external knowledge in its own operations. On the other hand, the evaluation mechanisms depict different types of selection heuristic (Bingham and Eisenhardt 2011; Bingham, Eisenhardt and Furr 2007) configurations.

When postulating the mechanisms I was able to highlight how mechanisms emerge as configurations of recurring activities. This provided one answer to the question of how stable structures such as routines or simple rules can create change. Thus, when we focus on conjunctural causation we can start to understand the mutually strengthening effects that certain combinations of routines/rules can generate. This opens up a new avenue for understanding how the constitutive elements of dynamic capabilities function. Thus, I extend the idea that dynamic capabilities function as systems where certain combinations have mutually reinforcing effects (Loasby 2010) into studying the constitutive elements of capabilities and not only the combinations of capabilities. Therefore, the challenge that structures create rigidity and efficiency (Bingham and Eisenhardt 2010) could be surpassed by the capacity to configure and reconfigure the structures rather than by just removing structures vis-à-vis routines and simple rules.

What is also noteworthy is that many of the mechanisms share common features. This raises the question whether slight alteration of routines/rules can bring about changes in the mechanism themselves. Therefore, it could be possible that the introduction of new routines/rules could unlock potentialities that organizational capabilities hold. This highlights the idea brought up by

Loasby (2010) that the combination of elements of which capabilities are constitutive of can be more than the sum of its parts. Answering the first question created grounds for addressing the two subsequent questions to which I move on to next.

The second research question that I set out to answer relates to understanding how the mechanisms explain the successful use of new product development capability on the project level. To answer this question I first examined the different sets of mechanisms. In doing so, I concluded that the ideation and evaluation mechanisms are both distinct problem-solving processes where through ideation the initial product concepts are developed which are then positioned into the offering portfolio of the company in the evaluation stage. Outcomes reveal the impact that the ideation and evaluation mechanisms generated together.

Next I examined the nature and relationship of the different sets of mechanisms. The relationship of ideation and evaluation mechanisms provided fruitful understanding into how the new product development capability can function. Ideation stage was very technology intensive whereas the customer perspective was brought in as an important consideration in the evaluation stage. In contrast to Danneels (2002) who argued that successful new product development stems from linking technological competences and customer competences, the present study highlights the possibility of sequentially exercising them. In doing so, I speculated whether the technology-oriented search could open up a wider search space for the company and enable the development of offerings that customers are not yet able to articulate. The customer-focused evaluation could thereafter ensure that the commercialized products do indeed match customer needs.

Finally, to answer the second research question I examined key success paths (Woodside, Ko and Huan 2012) of mechanisms to understand how the mechanisms animate the new product development process in the new product development projects. In doing so, I tried to analyze how the capability functions as a system: particular combinations and patterns that define the effectiveness of the capability (Loasby 2010). The identified success paths proved to be very varied. This provided empirical support for the notion of Eisenhardt and Martin (2000) that dynamic capabilities are fungible. However, despite the apparent fungibility of the success paths I was able to draw out tendencies on the outcomes that certain mechanism paths can generate. Local search always led into project termination or merely a product launch, whereas exploratory search always induced a product launch and some other effect on the organization. The success paths of external knowledge embodiment highlighted both the risks and benefits of working with a third party where actions cannot be fully controlled. Now I can proceed into addressing the third and final research question.

The third research question that I set out to answer relates to understanding how the mechanisms explain the successful use of new product development capability on the firm level. In doing so, I examined what led the organization

to transform, how the capability in itself transformed and how the company transformed into a multiproduct firm.

In examining the transformation of the organization I highlighted how the new product development capability can be used to operationalize strategy through altering search mechanisms and how multiple search strategies can be used simultaneously. The organization's transformation was highlighted as a realignment of the organizational form in which the new product development capability and its transformation was the main driver. This can be seen as a process of continuous morphing (Rindova and Kotha 2001).

After examining the transformation of the organization and how it drove change in the new product development capability, I transitioned to examine how the capability in itself changed. This enabled me to highlight how it is possible to transform search activities towards new search domains. The interplay of ideation and evaluation mechanisms provides insight into how organizations could balance efficiency and flexibility within new product development process. The search mechanisms can drift towards new directions, which was what happened when the search for new types of products was started. Still the evaluation remained fairly constant. Therefore, this destabilization in one part of the process can enable a company to increase flexibility of the process, providing one answer to the question of how organizations could balance efficiency and flexibility set out by Eisenhardt, Furr and Bingham (2010).

Next I transitioned to examine how the new product development capability contributed into the transformation of Vaisala into a multiproduct firm. In doing so, seeking faster growth, the intrafirm transfer of knowledge and de novo entry were identified as factors that drove the change, as has been suggested by Teece (1980; 1982). In addition to this, I highlighted three complementary explanations related to exogenous reasons that could also explain this phenomenon. These were responding to customer needs, responding to contextual changes and capturing profit opportunities. What these factors highlighted was that efficiency also relates to how an organization aligns its activities to the context it functions in, not only on the firm internal organization of activities.

With regards to the effects that the new product development capability can induce, the findings provide support for the notion that the capability is able to increase evolutionary fitness of the company (Helfat et al. 2007). I also highlighted that the capability could affect growth and that it enables the organization to reconfigure as desired (Zahra, Sapienza and Davidsson 2006) which in this study is associated with the successful development of new products.

The present study is among the few studies that provide empirically grounded examination of the mechanisms of dynamic capabilities and their internal functioning in a product development context. Thus, whereas the existing studies provide a top down approach into understanding mechanisms, I examined them from a bottom up perspective to understand their inner workings. This drew to my attention the notion that the existing mechanism based research is fairly abstract and that the proposed mechanisms may rather be cat-

egories of mechanisms. As means to mend this, I proposed that mechanism could be used as a meta-layer between recurring activities and the capabilities themselves. Therefore, I called for a more nuanced understanding into how mechanisms are construed and used, and also proposed that mechanism based theorizing can provide for a level of analysis that could integrate differing perspectives.

11.2 Managerial implications

The capability-based theorizing instructs managers to focus on how efficiently the day-to-day operational capabilities and change related dynamic capabilities are exercised. The present study provides managerial insight into how the change related capabilities could be exercised through new product development. Specifically, I wish to explicate four key insights.

Firstly, in times when efficiency has been heralded as the law of the land, I suggest how this could be toned down to increase effectiveness of development processes. As can be seen from the findings, coupling efficient evaluation with looser search activities with certain core elements can enhance efficiency. These search activities can also drift to increase effectiveness.

Secondly, in technology-oriented industries listening to the customer for the outset can hinder the development of completely new products. As can be seen from the findings, customer orientation could be brought in when product concepts are being compared rather than from the beginning of development. This can enable the creation of products that can cater for the latent needs of customers that they might be incapable of articulating in a market where technological change is rapid.

Thirdly, product development can channel the organization's need to transform and this transformation can come as bursts. This means that the management is in the dark for periods of time when new products are under development and market feedback from them cannot yet be received. This highlights the need for managerial persistence when a new direction has been assumed but market feedback from the change has not yet been generated.

Fourthly, collaboration with universities and public research institutions can greatly accelerate product development activities of small and medium sized companies. This enables companies to tap into external knowledge which would otherwise be impossible. To do so, establishing strong presence and correctly aligning the interests of the different parties can provide successful development projects.

11.3 Limitations and future research

There are a number of limitations in this study as well as future avenues for research that I now wish to discuss. Let us first focus on the limitations. Firstly, as with all mechanisms related studies, we can only postulate mechanisms and never fully uncover them. This might be one of the reasons why mechanisms oriented empirical fieldwork has been slow to emerge in the dynamic capability discussion. Our understanding of the mechanisms is always only partial and inferential, despite how we approach the issue. However, I perceive that through the use of multiple methods of analysis and an extensive data set, the postulated mechanism is a good representation of the activities of the organization that I studied.

Focus on routines and simple rules homogenizes the activities that organizations do into categories of repetitive action. Transition from routines/simple rules into mechanisms even further simplifies the activities of the organization. Through this simplification we can understand recurring activities but simultaneously I may have ignored other constructs that could explain the phenomena that do not share such repetitive patterns. However, as my focus is on understanding the processes that give rise to a mechanism, this is a factor that has to be accepted. I perceive that this focus can lend findings that are both managerially and theoretically valuable and therefore this limitation should be acceptable.

As this study focuses on the change of a single company, the findings of course can only have a very limited generalizability. Therefore, it would be very valuable to study these mechanisms in other contexts as well as extend the array of mechanisms that were identified here. This would lend a more comprehensive picture of the mechanisms that can underlie the capability of an organization to develop new products.

Qualitative comparative analysis as a method also provides challenges. As the Boolean minimization procedure treats each configuration as a distinct entity, slight changes in the truth table can greatly affect the prime implicants. This is especially true with small samples such as the present one. Therefore, one could question the stability of the findings that the method can give. When doing the analyses I was very knowledgeable of this and as I had to adjust the coding of the cases I tried to remain perceptive of the changes that any slight alteration in coding would generate in the prime implicants. Despite the alterations to the coding that I made when certain projects were reanalyzed in light of new evidence, there was fairly little change in the prime implicants. Therefore, I tried to minimize the effects that the minimization procedure might have in distorting the findings. Furthermore, I also used extensive amounts of case specific knowledge when assigning cases to configurations, which pressed me to test whether the prime implicants really represent the essence of the development projects. Through this I also tried to mitigate the fact that there were concurrent explanations for many of the cases.

While historical archival data enables an informed examination of the activities of organizations, the data is always to an extent clinical. Therefore, the

nuances of decision-making and the affective side of management are largely missing from the documentation. However, other methods that could be used to study the phenomenon also have limitations as interview-based research can suffer from hindsight bias and attribution bias (Huber and Power 1985). Therefore, I perceive this as an acceptable limitation in part of the data and approach.

With regards to future research, the present study provides a number of new avenues. Specifically, I want to outline four avenues for further research that I perceive to be most worthwhile. Firstly, the mechanism-oriented perspective could be further used to construct a meta-layer between recurring activities and capabilities to understand whether they have complementary effects that direct inference from a routine/simple rule to a capability might have missed. This gives expansive potential into studying factors that accelerate and decelerate the change processes of organizations.

Secondly, there are a number of studies in the dynamic capability field that theorize on mechanisms. In light of the present findings, many of these are probably only higher-order classes of mechanisms. Therefore, unveiling what these classes of mechanisms contain can give depth to the whole discussion and grant us a deeper understanding of dynamic capability concept itself. Overall, the dynamic capability discussion would benefit greatly from empirically grounded examinations on the mechanisms that pertain to this class of capabilities. Currently these studies are few.

Thirdly, the current findings lend insight into how organizations on one hand balance between efficiency and flexibility in a single process and on the other hand how technological knowledge and customer knowledge is used during the new product development process. Studying how different capabilities balance these differences would provide us valuable insights into the nature of the processes through which capabilities are actualized.

Fourthly, as the present study focuses on a business-to-business company that sells high-technology equipment, it would be worthwhile to examine the new product development capability in other contexts such as within companies that produce fast moving consumer products. This would lend us further insight into new product development capability as the operating context and market situation affect how the capability functions.

References

Adler, P. S. (1995). Interdepartmental Interdependence and Coordination: The Case of the Design/Manufacturing Interface. *Organization Science*, 6 (2), 147-167.

Adler, P. S., Mandelbaum, A., Nguyen, V., & Schwerer, E. (1995). From Project to Process Management: An Empirically-based Framework for Analyzing Product Development Time. *Management Science*, 41 (3), 458-484.

Al-Amoudi, I., & Willmott, H. (2011). Where constructionism and critical realism converge: Interrogating the domain of epistemological relativism. *Organization Studies*, 32 (1), 27-46.

AMA Dictionary (accessed January 10, 2014), [available at http://www.marketing power.com/_layouts/dictionary.aspx?dLetter=P]

Aspara, J., Tikkanen, H., Pöntiskoski, E., & Järvensivu, P. (2011). Exploration and exploitation across three resource classes: Market/customer intelligence, brands/bonds and technologies/processes. *European Journal of Marketing*, 45 (4), 596-630.

Atuahene-Gima, K. (2005). Resolving the capability—rigidity paradox in new product innovation. *Journal of Marketing*, 69 (4), 61-83.

Atuahene-Gima, K., & Evangelista, F. (2000). Cross-Functional Influence in New Product Development: An Exploratory Study of Marketing and R&D Perspectives. *Management Science*, 46 (10), 1269-1284.

Augier, M., & Teece, D. J. (2009). Dynamic capabilities and the role of managers in business strategy and economic performance. *Organization Science*, 20 (2), 410-421.

Barczak, G., Griffin, A., & Kahn, K. B. (2009). Perspective: trends and drivers of success in NPD practices: results of the 2003 PDMA best practices study. *Journal of Product Innovation Management*, 26 (1), 3-23.

Befani, B., Ledermann, S., & Sager, F. (2007). Realistic Evaluation and QCA Conceptual Parallels and an Empirical Application. *Evaluation*, 13 (2), 171-192.

Belenzon, S., & Patacconi, A. (2013). Innovation and firm value: An investigation of the changing role of patents, 1985–2007. *Research Policy*, 42 (8), 1496-1510.

Berg-Schlosser, D., De Meur, G., Rihoux, B., & Ragin, C. C. (2009). Qualitative comparative analysis (QCA) as an approach. In *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Technigues*, Rihoux, B., & Ragin, C. C. (eds.), Thousand Oaks: Sage.

Bhaskar, R (1998). *The Possibility of Naturalism: A Philosophical Critique of the Contemporary Human Sciences*. (3rd ed.), Oxon: Routledge.

Bhaskar, R (2008). *A Realist Theory of Science*. (3rd ed.), London: Verso.

Bingham, C. B., & Eisenhardt, K. M. (2011). Rational heuristics: the 'simple rules' that strategists learn from process experience. *Strategic Management Journal*, 32 (13), 1437-1464.

Bingham, C. B., Eisenhardt, K. M., & Furr, N. R. (2007). What makes a process a capability? Heuristics, strategy, and effective capture of opportunities. *Strategic Entrepreneurship Journal*, 1 (1-2), 27-47.

Bishop, K., D'Este, P., & Neely, A. (2011). Gaining from interactions with universities: Multiple methods for nurturing absorptive capacity. *Research Policy*, 40 (1), 30-40.

Bloch, M (1953). *The Historian's Craft*. New York: Vintage Books.

Brown, S. L., & Eisenhardt, K. M. (1995). Product development: past research, present findings, and future directions. *Academy of Management Review*, 20 (2), 343-378.

Brown, S. L., & Eisenhardt, K. M. (1997). The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly*, 42 (1), 1-34.

Bruni, D. S., & Verona, G. (2009). Dynamic marketing capabilities in science-based firms: An exploratory investigation of the pharmaceutical industry. *British Journal of Management*, 20 (s1), S101-S117.

Bunge, M. (2004). How does it work? The search for explanatory mechanisms. *Philosophy of the Social Sciences*, 34 (2), 182-210.

Calantone, R. J., Cavusgil, S. T., & Zhao, Y. (2002). Learning orientation, firm innovation capability, and firm performance. *Industrial Marketing Management*, 31 (6), 515-524.

Calantone, R. J., & di Benedetto, C. A. (1988). An integrative model of the new product development process: an empirical validation. *Journal of Product Innovation Management*, *5* (3), 201-215.

Calantone, R. J., Harmancioglu, N., & Droge, C. (2010). Inconclusive Innovation "Returns" : A Meta - Analysis of Research on Innovation in New Product Development. *Journal of Product Innovation Management*, 27 (7), 1065-1081.

Carr, E. H. (1961). *What is History?*. New York: Vintage Books.

Cavusgil, S. T., Calantone, R. J., & Zhao, Y. (2003). Tacit knowledge transfer and firm innovation capability. *Journal of Business & Industrial Marketing*, 18 (1), 6-21.

Clark, K. B., & Fujimoto, T. (1989). The power of product integrity. *Harvard Business Review*, 68 (6), 107-118.

Clark, K. B., & Fujimoto, T. (1991). *Product Development Performance: Strategy, Organization, and Management in the World Auto Industry*. Boston: Harvard Business School Press.

Clark, K. B., & Wheelwright (1993). *Managing New Product and Process Development*. New York: The Free Press.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 35 (1), 128-152.

Collis, D. J. (1994). Research note: how valuable are organizational capabilities? *Strategic Management Journal*, 15 (S1), 143-152.

Cooper, R. G. (1988). Predevelopment activities determine new product success. *Industrial Marketing Management*, 17 (3), 237-247.

Cooper, R. G., & Kleinschmidt, E. J. (1986). An investigation into the new product process: steps, deficiencies, and impact. *Journal of Product Innovation Management*, 3(2), 71-85.

Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (1999). New product portfolio management: practices and performance. *Journal of Product Innovation Management*, 16 (4), 333-351.

Corsano, W. A., & Heise, D. R. (1990). Event structure models from ethnographic data. in C. Clogg (ed.), *Sociological Methodology***,** Cambridge: Basil Blackwell.

Cronqvist, L. (2011). Tosmana-tool for small-N analysis [version 1.3.2]. Trier.

Danermark, B., Ekström, M., Jakobsen, L. Karlsson, J.C. (2012). *Explaining Society: Critical Realism in the Social Sciences*, Oxon: Routledge.

Danneels, E. (2002). The dynamics of product innovation and firm competences. *Strategic Management Journal*, 23 (12), 1095-1121.

Day, G. S. (1994). The capabilities of market-driven organizations. *Journal of Marketing*, 58 (4), 37-52.

Day, G. S. (2011). Closing the marketing capabilities gap. *Journal of Marketing*, 75 (4), 183-195.

Deeds, D. L., DeCarolis, D., & Coombs, J. (2000). Dynamic capabilities and new product development in high technology ventures: an empirical analysis of new biotechnology firms. *Journal of Business Venturing*, 15 (3), 211-229.

di Benedetto, C. A. (1999). Identifying the key success factors in new product launch. *Journal of Product Innovation Management*, 16 (6), 530-544.

Dornblaser, B. M., Lin, T-M, & Van de Ven, A. H. (2000). Innovation Outcomes, Learning, and Action Loops. In *Research on the Management of Innovation: The Minnesota Studies*, Van de Ven, A. H., Angle, H. L., & Poole, M. S. (eds.), New York: Oxford University Press.

Durand, R., & Vaara, E. (2009). Causation, counterfactuals, and competitive advantage. *Strategic Management Journal*, 30 (12), 1245-1264.

Dyer, W. G., & Wilkins, A. L. (1991). Better stories, not better constructs, to generate better theory: a rejoinder to Eisenhardt. *Academy of Management Review*, 16 (3), 613-619.

Easton, G (2010). Critical realism in case study research. *Industrial Marketing Management*, 39 (1), 118-128.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14 (4), 532-550.

Eisenhardt, K. M., & Brown, S. L. (1998). Competing on the edge: strategy as structured chaos. *Long Range Planning*, 31 (5), 786-789.

Eisenhardt, K. M., Furr, N. R., & Bingham, C. B. (2010). CROSSROADS-Microfoundations of Performance: Balancing Efficiency and Flexibility in Dynamic Environments. *Organization Science*, 21 (6), 1263-1273.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: opportunities and challenges. *Academy of Management Journal*, 50 (1), 25-32.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they?. *Strategic Management Journal*, 21 (10-11), 1105-1121.

Eisenhardt, K. M., & Sull, D. N. (2001). Strategy as simple rules. *Harvard Business Review*, 79 (1), 106-119.

Evanschitzky, H., Eisend, M., Calantone, R. J., & Jiang, Y. (2012). Success Factors of Product Innovation: An Updated Meta - Analysis. *Journal of Product Innovation Management*, 29 (S1), 21-37.

Feldman, M. S., & Pentland, B. T. (2003). Reconceptualizing organizational routines as a source of flexibility and change. *Administrative Science Quarterly*, 48 (1), 94-118.

Fleetwood, S. (2004). An ontology for organization and management studies. in *Critical Realist Applications in Organization and Management Studies*, Fleetwood, S. & Ackroyd, S. (eds.), London: Routledge.

Fleetwood, S. (2005). Ontology in Organization and Management Studies: A Critical Realist Perspective. *Organization*, 12 (2), 197-222.

Gaddis, J. L. (2002). *The Landscape of History: How Historians Map the Past*. New York: Oxford University Press.

Galunic, D. C., & Eisenhardt, K. M. (2001). Architectural innovation and modular corporate forms. *Academy of Management journal*, 44 (6), 1229-1249.

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management*, *19* (2), 110-132.

Golder, P. N. (2000). Historical method in marketing research with new evidence on long-term market share stability. *Journal of Marketing Research*, 37 (2), 156-172.

Grant, R. M. (1996). Prospering in dynamically-competitive environments: organizational capability as knowledge integration. *Organization Science*, 7 (4), 375-387.

Greve, H. R. (2013). Microfoundations of management: Behavioral strategies and levels of rationality in organizational action. *The Academy of Management Perspectives*, 27 (2), 103-119.

Griffin, L. J. (1993). Narrative, event-structure analysis, and causal interpretation in historical sociology. *American Journal of Sociology*, 98 (5), 1094-1133.

Griffin, A. (1997). PDMA research on new product development practices: updating trends and benchmarking best practices. *Journal of Product Innovation Management*, 14 (6), 429-458.

Harmancioglu, N., Droge, C., & Calantone, R. J. (2009). Strategic fit to resources versus NPD execution proficiencies: what are their roles in determining success? *Journal of the Academy of Marketing Science*, 37 (3), 266-282.

Hedström, P., & Swedberg, R. (1998). Social mechanisms: An introductory essay. in *Social Mechanisms: An Analytical Approach to Social Theory*, Hedström, P., Swedberg, R. (eds.), Cambridge: Cambridge University Press.

Hegel, G. W. F. (1837/1997), *Reason in History*. New Jersey: Prentice Hall.

Heise, D. R. (1989). Modeling event structures. *Journal of Mathematical Sociology*, 14 (2-3), 139-169.

Helfat, C. E. (1997). Know-how and asset complementarity and dynamic capability accumulation: the case of R&D. *Strategic Management Journal*, *18* (5), 339-360.

Helfat, C. E., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D. J., & Sidney, G. Winter (2007) *Dynamic Capabilities: Understanding Strategic Change in Organizations*. Oxford: Blackwell Publishing.

Helfat, C. E., & Peteraf, M. A. (2003). The dynamic resource-based view: capability lifecycles. *Strategic Management Journal*, 24 (10), 997-1010.

Henard, D. H., & Szymanski, D. M. (2001). Why some new products are more successful than others. *Journal of Marketing Research*, 38 (3), 362-375.

Henderson, R., & Cockburn, I. (1994). Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal*, 15 (S1), 63-84.

Huber, G. P., & Power, D. J. (1985). Retrospective reports of strategic-level managers: Guidelines for increasing their accuracy. *Strategic Management Journal*, 6 (2), 171-180.

Hurley, R. F., & Hult, G. T. M. (1998). Innovation, market orientation, and organizational learning: an integration and empirical examination. *Journal of Marketing*, 62 (3), 42-54.

Iansiti, M. (1998). *Technology Integration: Making Critical Choices in a Dynamic World*. Boston: Harvard Business School Press.

Iggers, G. G. (1997). *Historiography in the Twentieth Century: From Scientific Objectivity to the Postmodern Challenge*. Hanover: University Press of New England.

Jacobides, M. G., & Winter, S. G. (2012). Capabilities: Structure, agency, and evolution. *Organization Science*, 23 (5), 1365-1381.

Janatuinen, T. (1986). *Fifty Years of Environmental Measurement*. Vaisala.

Katila, R., & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of Management Journal*, 45 (6), 1183-1194.

Ketonen, P (2005). Ilmatieteen laitos ja Vaisala – monimuotoista yhteistyötä vuosikymmenten ajan. in *Kaisaniemestä Kumpulaan: Tutkimusta, Havaintoja ja Ihmisiä Ilmatieteen Laitoksella*. Nevanlinna, H. (ed.), Helsinki: Yliopistonpaino.

Khurana, A., & Rosenthal, S. R. (1997). Integrating the fuzzy front end of new product development. *Sloan Management Review*, 38 (2), 103-120.

Langerak, F., Jan Hultink, E., & Robben, H. S. (2004). The role of predevelopment activities in the relationship between market orientation and performance. *R&D Management*, 34 (3), 295-309.

Langley, A. (1999). Strategies for theorizing from process data. *Academy of Management Review*, 24 (4), 691-710.

Lawson, B., & Samson, D. (2001). Developing innovation capability in organisations: a dynamic capabilities approach. *International Journal of Innovation Management*, 5 (03), 377-400.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal*, 13 (S1), 111-125.

Littler, D., Leverick, F., & Bruce, M. (1995). Factors affecting the process of collaborative product development: a study of UK manufacturers of information and communications technology products. *Journal of Product Innovation Management*, 12 (1), 16-32.

Loasby, B. J. (2010). Capabilities and strategy: problems and prospects. *Industrial and Corporate Change*, 19 (4), 1301-1316.

Lyyra, M. (2005). Kosteuden mittalaitteet Vaisalan menestyvänä tuoteperheenä. in *Keihäänkärkiä – kolmetoista kertomusta suomalaisesta huipputeknologiasta*, Helsinki: Nord Print Ab.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2 (1), 71-87.

Mahoney, J. (1995). The management of resources and the resource of management. *Journal of Business Research*, 33 (2), 91-101.

Maggitti, P. G., Smith, K. G., & Katila, R. (2013). The complex search process of invention. *Research Policy*, 42 (1), 90-100.

Makadok, R. (2001). Toward a synthesis of the resource - based and dynamic - capability views of rent creation. *Strategic Management Journal*, 22 (5), 387-401.

Menguc, B., & Auh, S. (2006). Creating a firm-level dynamic capability through capitalizing on market orientation and innovativeness. *Journal of the Academy of Marketing Science*, 34 (1), 63-73.

Michelsen, K-E. (2006). *Global Innovator – The Story of Vaisala*. Vaisala.

Moorman, C. (1995). Organizational market information processes: cultural antecedents and new product outcomes. *Journal of Marketing Research*, 32 (3), 318-335.

Mäki, Uskali (2012). Realism and antirealism about economics. in *Handbook of the Philosophy of Science*, Mäki, U. (ed.), Oxford: North Holland.

Nelson, R. R., & Winter, S. G. (1982) *An Evolutionary Theory of Economic Change*. Cambridge: Belknap.

O'Connor, G. C., & DeMartino, R. (2006). Organizing for radical innovation: an exploratory study of the structural aspects of RI management systems in large established firms. *Journal of Product Innovation Management*, 23 (6), 475-497.

Olson, E. M., Walker, O. C., Ruekerf, R. W., & Bonnerd, J. M. (2001). Patterns of cooperation during new product development among marketing, operations and R&D: Implications for project performance. *Journal of Product Innovation Management*, 18 (4), 258-271.

Ozer, M. (1999). A survey of new product evaluation models. *Journal of Product Innovation Management*, 16 (1), 77-94.

Pajunen (2004). *Explaining by mechanisms – A study of Organizational Decline and Turnaround Processes*. Doctoral Dissertation, University of Tampere.

Pajunen, K. (2005). Comparative causal analysis in processual strategy research: a study of causal mechanisms in organizational decline and turnarounds. *Advances in Strategic Management*, 22, 415-456.

Pajunen, K. (2008). The nature of organizational mechanisms. *Organization Studies*, 29 (11), 1449-1468.

PDMA (2004). "The PDMA Glossary for New Product Development" (accessed September 19, 2013) [available at http://onlinelibrary.wiley.com/doi/10.1002/9780470172483.gloss/pdf].

Pentland, B. T. (1999). Building process theory with narrative: From description to explanation. *Academy of Management Review*, 24 (4), 711-724.

Peteraf, M., Di Stefano, G., & Verona, G. (2013). The elephant in the room of dynamic capabilities: Bringing two diverging conversations together. *Strategic Management Journal*, 34 (12), 1389-1410.

Pisano, G. P. (1997). The Development Factory: Unlocking the Potential of Process Innovation. Boston: Harvard Business Press.

Ragin, C. C. (1989). *The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies*. Berkeley: University of California Press.

Rihoux, B., Ragin, C. C. (2009). Crisp-Set Qualitative Comparative Analysis. in *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques*, Rihoux, B., & Ragin, C. C. (eds.), Thousand Oaks: Sage.

Rindova, V. P., & Kotha, S. (2001). Continuous "morphing": Competing through dynamic capabilities, form, and function. *Academy of Management Journal*, 44 (6), 1263-1280.

Robin, S., & Schubert, T. (2013). Cooperation with public research institutions and success in innovation: Evidence from France and Germany. *Research Policy*, 42 (1), 149-166.

Rosenkopf, L., & Nerkar, A. (2001). Beyond local search: boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal*, *22* (4), 287-306.

Salvato, C. (2009). Capabilities unveiled: The role of ordinary activities in the evolution of product development processes. *Organization Science*, 20 (2), 384-409.

Savitt, R. (1980). Historical research in marketing. *Journal of Marketing*, 44 (4), 52-58.

Sayer, Andrew (2010). *Method in Social Science: A Realist Approach*. (revised 2nd ed.), London: Routledge.

Schelling, T. C. (1998). Social mechanisms and social dynamics. in *Social Mechanisms: An Analytical Approach to Social Theory*, Hedström, P., Swedberg, R. (eds.) Cambridge: Cambridge University Press.

Schreier, M., Fuchs, C., & Dahl, D. W. (2012). The Innovation Effect of User Design: Exploring Consumers' Innovation Perceptions of Firms Selling Products Designed by Users. *Journal of Marketing*, 76 (5), 18-32.

Schroeder, R. G., Van de Ven, A. H., & Scudder, G. D., & Polley, D. (2000). The Development of Innovation Ideas. In *Research on the Management of Innovation: The Minnesota Studies*, Van de Ven, A. H., Angle, H. L., & Poole, M. S. (eds.), New York: Oxford University Press.

Schumpeter, J. A. (1934/2004). *The Theory of Economic Development: An Inquiry Into Profits, Capital, Credit, Interest, and the Business Cycle*. New Jersey: Transaction Books.

Siggelkow, N. (2001). Change in the presence of fit: The rise, the fall, and the renaissance of Liz Claiborne. *Academy of Management Journal*, 44 (4), 838-857.

Skinner, W. (1974). The focused factory. *Harvard Business Review*, 52 (3), 113-121.

Slater, S. F., & Narver, J. C. (1995). Market orientation and the learning organization. *Journal of Marketing*, 59 (3), 63-74.

Slotegraaf, R. J., & Atuahene-Gima, K. (2011). Product development team stability and new product advantage: The role of decision-making processes. *Journal of Marketing*, 75 (1), 96-108.

Song, X. M., Montoya-Weiss, M. M., & Schmidt, J. B. (1997). Antecedents and Consequences of Cross-Functional Cooperation: A Comparison of R&D, Manufacturing, and Marketing Perspectives. *Journal of Product Innovation Management*, 14 (1), 35-47.

Song, X. M., Neeley, S. M., & Zhao, Y. (1996). Managing R&D-marketing integration in the new product development process. *Industrial Marketing Management*, 25 (6), 545-553.

Stake, R. E. (1995). *The Art of Case Study Research*. Thousand Oaks: Sage.

Staloff, D. (1996). *The Search for a Meaninful Past: Theories Interpretations of Human History*. The Teaching Company.

Steel, D. (2004). Social mechanisms and causal inference. *Philosophy of the Social Sciences*, 34 (1), 55-78.

Steinmetz, G. (1998). Critical Realism and Historical Sociology: A Review Article. *Comparative Studies in Society and History*, 40 (1), 170-186.

Stinchcombe, A. L. (1991). The conditions of fruitfulness of theorizing about mechanisms in social science. *Philosophy of the Social Sciences*, 21 (3), 367-388.

Stuart, T. E., & Podolny, J. M. (1996). Local search and the evolution of technological capabilities. *Strategic Management Journal*, 17 (S1), 21-38.

Subramaniam, M., & Venkatraman, N. (2001). Determinants of transnational new product development capability: Testing the influence of transferring and deploying tacit overseas knowledge. *Strategic Management Journal*, 22 (4), 359-378.

Teece, D. J. (1980). Economies of Scope and the Scope of the Enterprise. *Journal of Economic Behavior and Organization,* 1 (3), 223-247.

Teece, D. J. (1982). Towards an economic theory of the multiproduct firm. *Journal of Economic Behavior & Organization*, 3 (1), 39-63.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28 (13), 1319-1350.

Teece, D., & Pisano, G. (1994). The dynamic capabilities of firms: an introduction. *Industrial and Corporate Change*, 3 (3), 537-556.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, 18 (7), 509-533.

Tripsas, M. (1997). Surviving radical technological change through dynamic capability: Evidence from the typesetter industry. *Industrial and Corporate Change*, 6 (2), 341-377.

Tripsas, M., & Gavetti, G. (2000). Capabilities, cognition, and inertia: Evidence from digital imaging. *Strategic Management Journal*, 21 (10-11), 1147-1161.

Van de Ven, A. H. (1986). Central Problems in the Management of Innovation. *Management science*, 32 (5), 590-607.

Van de Ven, A. H., & Polley, D. (1992). Learning while innovating. *Organization Science*, 3 (1), 92-116.

Van de Ven, A. H., & Poole, M. S. (2000). Methods for Studying Innovation Processes. In *Research on the Management of Innovation: The Minnesota Studies*, Van de Ven, A. H., Angle, H. L., & Poole, M. S. (eds.), New York: Oxford University Press.

Van de Ven, A. H., Venkatraman, S., Polley, D., & Garud, R. (2000). Processes of New Business Creation in Different Organizational Settings. In *Research on the Management of Innovation: The Minnesota Studies*, Van de Ven, A. H., Angle, H. L., & Poole, M. S. (eds.), New York: Oxford University Press.

Van de Ven, A. H., Polley, D. E., Garud, R., & Venkataraman, S. (2008). *The Innovation Journey*. New York: Oxford University Press.

Verona, G., & Ravasi, D. (2003). Unbundling dynamic capabilities: an exploratory study of continuous product innovation. *Industrial and Corporate Change*, 12 (3), 577-606.

Vogel, R. (2012). The visible colleges of management and organization studies: A bibliometric analysis of academic journals. *Organization Studies*, 33 (8), 1015-1043.

Vorhies, D. W., & Morgan, N. A. (2005). Benchmarking marketing capabilities for sustainable competitive advantage. *Journal of Marketing*, 69 (1), 80-94.

Wang, C. L., & Ahmed, P. K. (2007). Dynamic capabilities: A review and research agenda. *International Journal of Management Reviews*, 9 (1), 31-51.

Williamson, O. E. (1999). Strategy research: governance and competence perspectives. *Strategic Management Journal*, 20 (12), 1087-1108.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal*, 24 (10), 991-995.

Winter, S. G. (2013). Habit, deliberation, and action: Strengthening the microfoundations of routines and capabilities. *The Academy of Management Perspectives* 27 (2), 120-137.

Witkowski, T. H., & Jones, D. B. (2006). Qualitative historical research in marketing. in *Handbook of Qualitative Research Methods in Marketing*, Belk, R. W. (ed.), Cheltenhamn: Edvard Elgar Publishing.

Woodside, A. G., Ko, E., & Huan, T. C. T. (2012). The new logic in building isomorphic theory of management decision realities. *Management Decision*, 50 (5), 765-777.

Yin, R. K. (2003). *Case Study Research: Design and Methods*. Thousand Oaks: Sage Publications.

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, 27 (2), 185-203.

Zahra, S. A., Sapienza, H. J., & Davidsson, P. (2006). Entrepreneurship and dynamic capabilities: a review, model and research agenda. *Journal of Management Studies*, 43 (4), 917-955.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, 13 (3), 339-351.

Zott, C. (2003). Dynamic capabilities and the emergence of intraindustry differential firm performance: insights from a simulation study. *Strategic Management Journal*, 24 (2), 97-125.

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