MANAGING THE EMERGENCE OF A DYNAMIC CAPABILITY

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ABSTRACT

This paper seeks to provide insight in how to manage the emergence of a dynamic capability. We studied the operation of dynamic capabilities in two research groups. We found four coherent processes underlying the dynamic capabilities of the research groups: (1) a repeated project lifecycle process; (2) a co-evolutionary process of expertise development; (3) a dialectical process of balancing tensions; and (4) a teleological process of envisioning the future. These four processes are closely interrelated and operate in parallel. Based on our field studies, we propose three kinds of interventions to stimulate the emergence of a dynamic capability: (1) co-envisioning a future for the group and stimulating a collaborative culture; (2) developing a competence-enhancing HR strategy and (3) developing a facilitating management style. These incentives should be considered as a menu, with ingredients that can be ordered in any sequence.

Key-words: dynamic capabilities, management, process theory, research groups

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INTRODUCTION

The objective of this paper is to explore how managers of R&D-groups can manage the emergence of a dynamic capability. A dynamic capability has been defined as the capability of an organization to integrate, build, and reconfigure internal and external competences in order to respond to a dynamic environment (e.g. Eisenhardt and Martin 2000; Teece et al. 1997; Verona and Ravasi 2003). As a dynamic capability can provide a strong and sustained basis for a competitive advantage, it is very attractive for organizations to posses. This insight also holds for R&D-groups. R&D-departments in industrial firms have to provide valuable contributions to new product development. As knowledge and technology development is a worldwide enterprise, they can only provide valuable contributions as they integrate, build and reconfigure internal and external competences. Many R&D-groups in national research institutes have to acquire research contracts for which they compete with other research groups. Therefore also for these groups the possession of a dynamic capability can contribute to the achievement of a competitive advantage.

Dynamic capabilities are assumed to be embedded in or emerge from a set of specific and identifiable processes or routines, operating within an organization (Eisenhardt and Martin 2000; Teece et al. 1997; Salvato 2003; Wang and Ahmed 2007). Despite the recognition that dynamic capabilities are embedded in processes, existing literature does not provide a systematic description of the processes underlying a dynamic capability. Most of the empirical literature focuses on antecedents or outcomes of dynamic capabilities (e.g., Bierly and Chakrabarti 1996; Pavlou and El Sawy 2006; Wu 2006). Some studies have provided illuminating analyses of the operation of specific dynamic capabilities (Pablo et al. 2007; Rindova and Kotha 2001; Savory 2006), sometimes identifying several dynamic capabilities within a single organization (Daniel and Wilson 2003; Prieto and Easterby-Smith 2006). The empirical identification of a plethora of specific dynamic capabilities, however, raises questions about their connections, coherence and commonalities across organizations. Moreover, there is lack of research that investigates the dynamic capability processes over time (Prieto and Easterby-Smith 2006), limiting insight in the actual functioning of dynamic capabilities. Moreover, the theoretical idea that processes underlying dynamical capabilities consist of a set of repetitive routines is intriguing, but scarcely scrutinized. Therefore, we studied the operation of a dynamic capability within two research groups, using a process theory approach to explain change and development as unfolding through sequences of events (Langley 1999; Tsoukas and Chia 2002). Both research groups showed excellent performance over longer periods of time, while changing their core capabilities and integrating them in novel ways, suggesting the presence of a dynamic capability. We analyzed these dynamic capabilities using Van de Ven and Poole's (1995) process theory perspective, in order to theorize the generic process characteristics of dynamic capabilities. We found a dynamic capability to emerge from an integrated set of processes, operating at multiple levels: (1) a repeated project lifecycle; (2) a co-evolutionary process of expertise development; (3) a dialectical process of balancing tensions; and (4) a teleological process of envisioning the future. While the core of the dynamic capabilities was formed by repetitive routines embedded in the project life cycle, their emergence depended upon three additional non-routine processes as well. Together, these four processes reconfigure existing and new competences to adapt to a moderate dynamic environment. In addition, we found a number of management practices contributing to the emergence of a dynamic capability. In this paper we focus on the managerial implications that come forward from the operation of these processes in particular.

As we develop both theoretically and empirically in this paper, we explore three kinds of managerial interventions that stimulate the emergence of a dynamic capability in a research group: (1) co-envisioning a future of the group and stimulate a collaborative culture; (2) developing a competence-enhancing HR strategy; (3) introducing a facilitating management style. We will discuss how these interventions expand the literature of management of R&D-groups. This literature indicates that managers should focus on the development and implementation of a mission and collective ambition, collaboration with partners outside the group, specialization of the group and personnel management (Weggeman 1995; Badawy 1988; Farris and Cordero 2002; Cesaroni, Di Minin and Piccaluga 2004; Hargadon and Sutton 1997; James 2002; Nobelius 2004; Roberts 1988). Our goal is to understand the kind of managerial practices in each of these fields, providing incentives for the emergence of a dynamic capability or creating conditions to support the joint operation of the four processes. Empirical research into dynamic capabilities has predominantly focused on contextual conditions and antecedents of dynamic capabilities, implying managerial activities to realize these conditions. Examples are information technology (Fink 2007; Zhang 2007; Sher and Lee 2004; Lawson and Samson 2001), close relationships with the market (Daniel and Wilson 2003; Pavlou and El Sawy 2006; Ayuso et al. 2006) and innovativeness (Menguc and Auh 2006). These studies provided valuable insight in factors stimulating the emergence of dynamic capabilities, but did not directly focus on managerial interventions to stimulate the emergence of a dynamic capability.

This paper proceeds as follows. In the following section we describe the case study sites and the research methods that were used for data collection and analysis. Then we elaborate on the processes underlying the emergence of a dynamic capability, as it provides the background to discuss managerial implications. Subsequently we discuss the managerial practices we found and the managerial implications coming forward from the characteristics of the four processes. In the final section, we summarize key insights for managers and researchers.

THE STUDY

To advance theoretical understanding of the processes through which dynamic capabilities operate, we employed a process research approach, explaining change and development as unfolding through sequences of events (Poole and Van de Ven 1995; Mohr 1982). We employed qualitative research procedures (Eisenhardt 1989; Yin 2003), which were considered appropriate for the following reasons. A core objective of the study is to explore and to conceptualize processes, requiring an open and iterative approach to data collection and analysis (Langley 1999; Strauss and Corbin 1990). Further, qualitative research procedures make it possible to investigate phenomena in their natural context, in a way in which the relation between the relevant factors stays present and complexity is maintained (Yin, 2003).

We studied two groups that both showed the emergence of a dynamic capability. This choice was made to identify those processes underlying these dynamic capabilities, not the conditions differentiating the presence or absence of a dynamic capability. Both groups were part of a research organization "Food & Environment", consisting of several institutes working in the domains of agriculture, nature, fisheries, food quality and safety, and environmental management. Both groups, the Ecology Group and the Postharvest Group, met the criteria posed in the definition of a dynamic capability: they work in a dynamic environment with changing demands and show a high frequency of knowledge recombination and integration of evolving competences. Besides, we established that both groups had a

competitive advantage, based on a high quality of their research work and products experienced as extraordinary by clients. We used several sources to support the selection of groups from "Food & Environment": (1) reports of review committees were a source of information on research quality and client satisfaction, as they incorporated both perspectives of different stakeholders, including clients; (2) financial reports provided information on the economic performance of groups over time; and (3) interviews with executives of the board of directors of the institutes and group leaders focused on change and development in groups.

The development of a process-oriented explanation requires the selection of cases that support the systematic collection of comparative observations (Poole et al. 2000). Although some variety and contrast may be helpful, the approach focuses on the identification of processes, not on establishing parameters (of emergence or non-emergence) (Mohr 1982). Therefore we selected two cases in which a dynamic capability emerged and limited variation by focusing on two groups within "Food & Environment". This provided a context which was almost the same for both groups and focused variation on the contents of the field of research. We evaluated if we achieved saturation by the execution of the second case study, focusing on phenomena that were present in the first case study but not in the second. We did not find such phenomena, implying saturation.

The first field study took place in the Ecology Group (51 members), the second in the Postharvest Group (31 members). Although both groups are part of Food & Environment, they work in different research domains and are part of different institutes. The Ecology Group works in the field of landscape ecology and the Postharvest Group works in the field of post harvest physiology. Both groups conduct research in a multidisciplinary area. Their research is directed towards the development of new concepts, methods and approaches and provides science-based solutions for problems posed by clients. Both groups have developed a specific strategic position, focusing on innovative, complex problems, which require the flexible integration of distinct operational (functional) capabilities.

The groups operate in an environment characterized by a moderate level of dynamics. In the period that was taken into account for this study (1983-2001), "Food & Environment" experienced some major changes. "Food & Environment" changed from a directorate of the Ministry of Agriculture into an independent organization. This means that "Food & Environment became responsible for its own continuity and had to acquire research contracts. These include projects for the Ministry of Agriculture as well as for other clients. In the period between 1991 and 1998 all research groups (including the groups in this study) were directed to develop a market and client oriented approach, to work according to business economic rules, to develop marketing skills, and to develop a stricter system of research management (preventing a financial loss in the execution of projects).

Data collection was led by the principle of triangulation (Jick 1979). We used three kinds of techniques to collect data: observations, interviews, and documents. One of the authors participated in the Ecology Group for 17 weeks and in the Postharvest Group for 30 weeks (with an interruption of eight weeks). During these periods, he participated passively in the groups: he was co-located with a group and participated in coffee breaks, lunch and group meetings, but did not participate in the work activities of the group. In this period he walked the hall ways regularly to observe interactions between the group members.

Besides countless informal conversations with group members, more formal interviews were conducted with ten group members in the Ecology Group and eight group members in the

Postharvest Group. Interviewees were selected to tap into potential differences in perception resulting from gender, position, working experience in the group, specialism and membership of a sub-unit. Interviewees received a short introduction of the study in advance. The interviews were semi-structured (Kvale 1996). A predefined list of themes was discussed in the interview, including the interviewee's position and capabilities; involvement in projects; the activities undertaken within projects; the use of expertise within projects; interactions within the projects; the position of the group related to other groups, competitors and customers; the function of subgroups; important events and choices made in the past; the role of instruments and equipment; working conditions; strategy processes; and competence development. Interviewees were also provided with the opportunity to introduce topics during the interview. Each interview took between one and a half and two and a half hours. All interviews were tape-recorded and transcribed.

We also studied a large number of documents, referring to the past of the groups as well as to the present situation and near future of the groups. These documents included strategic plans, all annual reports between 1983 – 2001, project descriptions (about 120), descriptions of research programs (about 25), introduction programs for new group members, policy documents, government policy documents describing developments in the environment of the groups and various other documents. In the Ecology Group, also generic e-mail exchanges among group members were observed .

Data analysis was guided by key procedures to develop process-oriented explanations of change and development (Langley 1999; Poole et al. 2000). The first step was the identification of events and sequences of events. Events refer to actions or incidents occurring at a specific moment in time, like the decision of the group to develop additional expertise for the development of models in the strategic plan 1996-1999. Event identification employed qualitative coding procedures (Glaser and Strauss 1967; Miles and Huberman 1994).

We found three streams of events, operating at different levels. First, events occurred at the *group level*, including decisions to position the group, practices related to the hiring of new group members, decisions to organize the group and to strengthen the development of specific competences. We also identified instances of variation, selection and retention in the research lines in the field studies and we analyzed the sequence of strategy development, its execution, monitoring and evaluation. Second, we found events related to practices employed in the design, execution and ending of *projects* and in writing publications. We identified for instance project phases, and activities in projects related to project design and execution, including temporal dependencies in project phases and project activities. A third stream of events concerned *individual behavior*, including strategies to deal with tensions experienced in the design, execution and ending of projects.

The second analytical step focused on the identification of patterns in the streams of events, leading to an integrated narrative. We distinguished and characterized four underlying processes by asking six questions proposed by Poole et al. (2000) to determine which of the generative mechanisms operates. Next to the identification of each of the four process models we also related these processes to each other to present an integrated narrative on the emergence of a dynamic capability. We critically reflected on the coherence and interactions among the four processes in terms of their inputs and outputs and the specific role of each of the processes in the emergence of a dynamic capability. We stopped the process of data collection and coding, when the concepts were saturated, i.e. when new collection and analysis of data did not provide additional insight.

In the process of data analysis and collection we followed the procedures advocated by Yin (2003) and Eisenhardt (1989) to address reliability and validity concerns in case studies. With regard to data collection, we included multiple sources of evidence, established a chain of evidence and build a case study database by using Atlas.ti, a software package for qualitative analysis. Analysis systematically followed the explanation building approach (Yin, 2003), while considering multiple potential process theoretical explanations (Eisenhardt 1989). At the end of each field study the preliminary results were discussed with the group leader and presented to the whole group. These member checks (Swanborn 1996) yielded additional data and led to the refinement of results.

THE EMERGENCE OF A DYNAMIC CAPABILITY IN A RESEARCH GROUP

Dynamic capabilities

A dynamic capability has been defined as the capability of a research group to integrate, build, and reconfigure internal and external competences in order to respond to a dynamic environment. Both groups showed frequent recombination and integration of existing competences, while also renewing and creating competences, thus evidencing the operation of a dynamic capability.

The Ecology Group works in the field of landscape ecology. Its research focuses on the survival, sustainable development and extinction of populations of plants and animals (amphibians, insects, birds, and mammals), while taking into account the qualities of the landscape and habitat in which these species live. Central concepts in this group are the cutting up of areas in which species live and the connection of ecological niches to enable transfer between niches and thereby the survival of species. In 1983 the group started to explore the theme of landscape ecology, commencing with descriptive research concentrating on birds. By 2001 the group had theoretically and empirically developed the discipline of landscape ecology, through science-driven and applied research. The group had developed models, expertise on several species and environmental conditions affecting the survival of species, guidelines and norms for the spatial structure of landscapes enhancing survival of species, and methods to link research results to landscape design activities, applicable at a local, regional and national scale. The other group, the Postharvest Group, works in the field of post harvest physiology. This field focuses on research into the preservation of the quality of fresh harvested products. The group concentrates on fruits, vegetables, ornamentals, potted plants and potatoes. Key topics of their work are storage techniques, physiological processes, development of molecular markers and new packaging concepts. Clients choose for the Postharvest Group because of their ability to provide practical solutions in the field of post harvest physiology, based on scientific knowledge of physiological processes in fresh products, environmental factors and the decline of quality in the post harvest phase of the chain. This group also renewed itself repeatedly in the period 1983 – 2001. The most remarkable change regarding its field of research, was the development of expertise in genetic techniques to predict the decline of product quality based on genetic characteristics. The repeated renewal of competences in both groups resulted in a broad knowledge base in the early 2000s (Table 1).

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An analysis of the project portfolio of the groups in 2001 and the staffing of these projects and an analysis of publication behaviour also point at the operation of a dynamic capability, in particular with regard to the integration and reconfiguration of competences. Both groups worked in 2001 on approximately 60 projects. Some of these projects were small and took only a number of months; other projects were large and took a number of years. Compared to competitors, both groups focused more strongly on innovative projects that required the integration of a broad knowledge base. In the Ecology Group, in 2001, two or more researchers were involved in 95% of the projects and four or more researchers were involved in 47% of the projects. For the Postharvest Group these figures were respectively 82% and 29%.

Kimberly (Ecology Group), for instance, was involved in nine projects (Table 2). For two of these projects she acted as project leader. In seven of the projects she collaborated with one or more of the colleagues that were part of the same sub-group in the Ecology group, but who had a different role or complementary expertise. In eight of these projects Kimberly worked with researchers from other sub-groups. Table 2 shows that each of these projects was executed in different teams, driven by different objectives. Each of the staff members contributed different operational capabilities to the project (Table 3). Similar results were found for other researchers. Bruce, for example, not only participated in the projects with Kimberly, but also in four projects executed with other colleagues: one project with Jack, Stuart and Susan; one project with Susan and Vincent; one project with Ted, Susan, Ian and Steve and one project with Susan, Iris, Tamara, Sonia, Woody, Adam, Allan, Harry, Steve and Kim. These findings indicate that Kimberly and the other members of the Ecology Group recombine and integrate their distinctive operational capabilities in various combinations.

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An analysis of publications also shows the recurrent recombination and integration of knowledge. Data from the years 2001-2003 showed that 85% of the papers were co-authored, with few stable combinations of researchers. Kimberly, for instance, published nine papers in the period 2001 up to 2003. Of these papers she published one on her own, two with Stuart, one with Stuart and Jack, one with Stuart and Ken, one with Jack and John, one with Ian and John and two researchers from other groups, one with Rebecca and John and one researcher from another group and one paper with only researchers from other groups.

This analysis of project teams and co-authorship data shows that researchers did not collaborate with the same colleagues over and over again, but collaborated in ever changing combinations, depending upon the operational capabilities needed in the project. Thus, knowledge integration practice of the groups were both flexible and wide-ranging, responding to changing needs of clients in the environment of the organization. Both the renewal of capabilities and the continuous reconfiguration and integration of capabilities point at the operation of a dynamic capability. We identified four processes underlying the emergence of these dynamic capabilities. In the following sections we will discuss each of these processes and how they contribute to the emergence of a dynamic capability.

Four coherently working processes underlying the emergence of a dynamic capability

Three streams of events were distinguished in the data, operating at different levels: group level, project level and the level of individual behaviors. The first stream of events concerned

visions being formulated, goals being set, decisions being made and expertise development. This stream operates at the group level. The second stream of events we found addresses events at project level. This stream refers to practices employed in the design, execution and ending of projects, in writing (project related) publications and the integration and recombination of expertise in projects. The third stream of events concerned tensions, related to changing contextual demands and responses of the group. This stream addresses behaviors at the individual level. Further analysis of the three streams of events led to the identification of four underlying processes. These four processes operate coherently and together produce a dynamic capability: (1) a repeated process of the design, the execution and the ending of projects; (2) a process of balancing tensions; (3) a process of envisioning the future and (4) a process of expertise development.

The *first* process defines a repeated cycle of the design, the execution and the ending of projects. It incorporates the second stream of events (project level) and exhibits the characteristics of a life cycle process. We found that the execution of this project life cycle process became increasingly guided by social rules stressing the importance of the integration of internal and external knowledge. The *second* process is a process of balancing tensions, incorporating the third stream of events. Researchers were found to experience tensions, particularly in the design, the execution and ending of projects. These tensions were solved in a dialectical process, which was necessary to accommodate unforeseen events and to accommodate changing demands. The *third* process is a process that describes how the groups envision their future and define activities to realize this future. This process appeared to be a teleological process as it proceeds through goal setting, taking actions, monitoring and evaluating. It incorporates the first stream of events. The *fourth* process defines the development of expertise in the group, describing both the development and deepening of technical competences related to the field of research as well as research related competences. This process also incorporates events at group level (stream one). This process appeared to be co-evolutionary of nature. The characteristics of each of these four processes and the interaction between these processes have been summarized in figure 1.

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The contribution of each of the processes to the emergence of a dynamic capability
Each of the four processes provides a particular contribution to the emergence of a dynamic capability. This section discusses each of these contributions.

Repeated life cycle process
Central in the execution of projects was knowledge integration: compared to competitors, both groups focused more strongly on innovative projects that required the integration of a broad knowledge base. As stated, both groups were found to have a broad knowledge base at their disposal, in 2001 two or more researchers cooperated in at least 82% of the projects in both groups and an analysis of cooperation between researchers in projects (2001) and in writing publications (2001-2003) did not show a particular pattern of collaboration between researchers, implying that there is flexibility and scope in the knowledge integration practice of the groups.

Activities in the project life cycle that required interaction between researchers or between researchers and clients were guided by social rules. These rules enhanced interaction and stressed the relevance of knowledge integration. Examples of these rules are for instance

'involve the client in making a project proposal', 'involve the colleagues you need in your project' and 'be open and behave like a good colleague'.

The project life cycle contributed in two ways to the emergence of a dynamic capability. First, the project life cycle, and the activities embedded in this life cycle, enabled the combination of different capabilities in response to heterogeneous and changing stakeholder demands. This project life cycle was therefore a central element of the operation of the dynamic capabilities. Second, the project life cycle also contributed to the development of new competences and the deepening of existing competences. They include the development of new competences such as the development of knowledge of genetic characteristics of populations and its application in present and new models (Ecology Group). In addition to technical competences also research related social competences were developed, as for instance the capability to conduct participative, interactive research. Development and deepening of both kinds of capabilities supported the operation of the dynamic capabilities as they offered new opportunities to answer present and new stakeholder demands and thereby strengthened fit with the environment.

Dialectical process of balancing tensions
Although the project life cycle guided the actions of researchers, it did not prescribe exactly how these subroutines had to be executed. Researchers still had options to choose one way or another. Individual researchers experienced tensions between conflicting demands regarding their internal interactions and interactions with clients and balanced these in a dialectical process. For example, the rules embedded in the project life cycle stipulated that researchers should involve the colleagues with the required expertise in their project. However, they sometimes encountered situations in which it was not clear beforehand that a specific colleague was needed. In this situation they approached this researcher for his participation at the moment his expertise was needed. However, the project leader also needed to make administrative arrangements because the administrative rules stated that only the researchers mentioned in the project plan were supposed to work on the project and could account their research time spent on the project. Project leaders solved this tension by allowing project members who had to be involved immediately in another project on which they were not allowed to account their time, to account the time on the project the researcher was already working on. This was corrected afterwards in discussions on the budgets of projects. Such solutions maintained the status quo between opposing demands.

The significance of this dialectical process for the emergence of a dynamic capability is that it provides a delicate synchronisation of tensions. This facilitated an effective and efficient process of knowledge integration and facilitated the smooth interaction with clients needed to provide high quality project results meeting client expectations. However, not complying with a dominant social practices was also found to be valuable on several occasions, as it prevented rigidity and strengthened fit with environmental demands by providing an incentive to adapt practices to changed circumstances. An example is the change in attitude regarding project results from "only the scientific result is important" in 1983 to "scientific, practical and financial results matter" in 2001. This capacity to change working practices was also an important contribution of this process to the continuated emergence of the dynamic capability.

The teleological process of envisioning the future
Long term developments were guided by, but not completely determined by a teleological process. This teleological process yielded visions of the future. It influenced the adaptation to

the environment and provided guidance in choices to be made, for instance in the acquisition of projects with respect to client groups.

The teleological process was most visible in the development, execution, monitoring and evaluation of strategic plans and year plans. These plans resulted in an envisioned future for the group, addressing products to be delivered, clients to be served, scientific and market positions to be achieved and research related competences to be developed. Examples, critical in the development of the Ecology group and the operation of the dynamic capability, were the choice of the Ecology Group to focus on the concept of meta populations and to develop models "to avert the drawbacks of empirical studies" (Annual report, 1987).

Although plans were made and the realization of those plans was evaluated, the actions realizing those plans were only partly driven by the teleological process. In particular two kinds of goals were achieved by (top down) actions embedded in this process. First, the composition of the staff and qualities of staff members. Second, the internal organization of the group. However, most goals were not achieved through intentional actions towards those goals in this process. Instead, the teleological process only provided a frame of reference. For example, the development of distinctive competences was achieved in the repeated life cycle process and the co-evolutionary process of expertise development. The teleological process provided a frame of reference by articulating the requirements posed to projects, for instance with regard to their scientific challenge. Another example is the goal for projects to provide a positive financial result which was achieved in the repeated life cycle process in combination with the dialectical process of balancing tensions (as this goal created tensions how to organize knowledge integration in a way that is also financially feasible). Because of its role as frame of reference for content related goals to be achieved bottom up, the role of the teleological process in the operation of a dynamic capability was moderate. Management cannot assure that the content related goals are accomplished as researchers meet all kinds of (new) opportunities, conditions and constraints.

Co-evolutionary process of expertise development
This process had two effects. Firstly, gaining a deep understanding in the field of research through the development of a body of expertise in the form of distinctive competences. Secondly, renewing distinctive competences. These effects define the contribution of this process to the emergence of the dynamic capabilities.

With regard to the development of a body of expertise, the development and application of models in the Ecology Group is an example in which the evolutionary characteristics, expressed in a pattern of variation, selection and retention, can be recognized. In the development of this body of expertise, this line of research interacted with other lines of research and competed for the available resources in the market. In this competition, selection criteria related to the external environment dominated selection criteria of an internal nature, expressing stronger evolutionary than teleological characteristics. In particular the presence of opportunities in the market (for themes in research), the financial coverage of all costs of a project and the scientific challenge in the content of a project (for the selection of projects) dominated other selection criteria. This reflects the dependency of the groups for a market willing to absorb their expertise.

Goals with regard to expertise development that came forward in the teleological process should therefore be interpreted as 'a frame of reference'. Whether the groups were really able to develop new competences and in what direction these competences were actually

developed did not depend on goal-oriented actions but on development of market needs and success of the group in the market.

Based on the practices of close interacting with the environment we interpreted the nature of expertise development as co-evolutionary, expressing a strengthening of the strategy of the group and its strategic choices through support from the environment (Lewin and Volberda 1999; Burgelman 2002; Fang and Wu 2006). The relevance of the co-evolutionary character for the operation of the dynamic capability is that it enhances fit between the group and the environment, in the present and the near future. In the present close interacting with the environment enhances fit with regard to the project results the group provides and thereby a higher appreciation for these products and a higher chance for new projects. For the near future it enhances fit as expertise development takes time. A new concept or research theme is not fully developed at once, but its emergence is characterized by gradual development, by the execution of a number of projects in time. Projects differ in duration: one and a half year in the Postharvest Group and two and a half years in the Ecology Group. For a (operational) technical competence to develop at least some projects have to be executed, therefore the average duration of projects implies that the time horizon for a theme of research to develop is at least three to five years. This means that the time to develop a distinctive competence takes quite a long time, considering the business environment in which the groups have to operate and the dynamics they experience. A strong linkage with the environment, an environment characterized by moderate dynamics in which changes develop more in a co-evolutionary and incremental way instead of in a revolutionary way allows this development process to cover such a time span.

More broadly, the significance of this co-evolutionary process of expertise development for the operation of a dynamic capability comes forward in two effects: the development of a deep understanding in the field of research and the renewal of distinctive competences. Both effects address the building of new (operational) competences, the linkage of competences (as for instance the competence in modelling and that in geographical information systems) and maintaining fit with the environment linking problems of stakeholders and competences present in the group. Due to their dependency on the market and the cost-structure, the groups cannot afford a mis-match between their operational competences and market needs.

MANAGERIAL IMPLICATIONS

In this section we propose three kinds of managerial interventions, based on and illustrated by the findings in the field studies. These interventions answer the question how managers can stimulate the emergence of a dynamic capability in a research group. But first we will argue that managers of R&D-groups can only stimulate or facilitate the emergence of a dynamic capability and not design for its emergence, due to the characteristics of the four processes underlying the emergence of a dynamic capability.

Our findings indicate, that the four processes are closely interrelated and operate in parallel. Because these four processes are composed of more than just routines, the emergence of a dynamic capability is not as neat and repetitive as literature argues (cf. Zollo and Winter 2002). To some extent the study shows that the emergence of a dynamic capability is a repeated, systematic collective activity as the four processes enabled the emergence of a dynamic capability for some years. But the study also shows that the emergence of a dynamic capability has a fluid character, it should not be understood as a static property or stable disposition, its emergence has to be achieved over and over again as an ongoing

accomplishment, emerging from people's everyday actions (cf. Orlikowski 2002). The combination of the four processes implies that there are severe restrictions to managing the emergence of a dynamic capability. The teleological process of envisioning the future and the repeated project life cycle process are more or less under managerial control. The other two processes however, the co-evolutionary process of expertise development and the dialectical process of balancing tensions, defy control. They cannot be "switched on" or directed by managerial intervention. This is based on the characteristics of these two processes: in both processes the central subject is a set of interacting entities (tensions in the dialectical process, fields of expertise in the evolutionary process) where the outcome of individual cases is unpredictable and in which conflict or contradiction is important to the change process (Poole and Van de Ven 2000). Of course managers can affect the context in which these processes emerge and can create conditions that support the joint operation of the processes we found in the field studies. Therefore, in the next part of this section we present three managerial interventions that stimulate the emergence of a dynamic capability. Related to the multilevel, multiprocess framework describing the emergence of a dynamic capability, the managerial interventions are more comprehensive than needed for the development of a 'normal' capability.

Intervention 1: co-envision a future for the group and stimulate a collaborative culture
The first intervention we propose is to co-envision a future for the group and to stimulate a collaborative culture. As stated, in the field studies we found that both groups defined a strategic plan with a horizon of about four years, further specified in year plans. In addition both groups worked on one or more research programs which lasted four years. These plans resulted in an envisioned future for the group, addressing products to be delivered, clients to be served, scientific and market positions to be achieved and research related competences to be developed. This envisioned future acted as a framework for the researchers, helping them to understand what the group stands for and guiding them in operational actions. When asked about the meaning of the ambition of the Postharvest group to realize a chain perspective for her day-to-day activities, Laura for instance stated in this respect,: "When you are designing a project for instance, you try to involve more actors that are part of that chain".

Group members fully participated in the development of the vision on the future of the group, leading to a higher fit between the individual ambitions of group members and those of the collective. The role of group management was to initiate vision development and co-envision a future for the group. Not only in the preparation of strategic plans or year plans, but also in regular group meetings. High fit between individual ambitions and those of the collective appeared to be supportive for the activities group members wanted to initiate. It enhanced their commitment to group ambitions and raised involvement in the accomplishment of group goals. The process of envisioning the future appeared to be more important than the documents in which the future of the groups was envisioned as many group members in both groups could not exactly reproduce the content of the documents but had a clear image of the future direction of the group. The relation between the ambition of the group and individual ambitions was strengthened even more by translating the collective ambition into individual contributions. Some examples were for instance an agreement with a group member to start a Ph.D. study to deepen his level of expertise (Ecology Group), an agreement with a researcher to participate in a subgroup focusing on measurement technology to broaden the expertise of the group in this field (Postharvest Group), and agreements with some group members with regard to the acquisition of projects, reflecting personal ambitions to deepen these capabilities (Ecology Group).

Central in the vision statements of both groups were the solutions provided for clients and an approach to the field of research: the central theory the group applies, important scientific methods, the kind of solutions the group offers. These were not envisioned in isolation, but based on the present body of knowledge of the group and knowledge of trends and future needs of clients. This vision was worked out in several directions. Firstly, with regard to initiatives aimed at acquiring additional expertise in fields that had to be strengthened to realize this envisioned future. Secondly, with regard to selection criteria for newly acquired projects. For the groups the criterion of the presence of a scientific challenge and meeting the criterion of fit with defined lines of research for the future were very important (table 4). Thirdly, with regard to the development of a competence-enhancing HR strategy (next section). Fourthly, with regard to cultural characteristics of the group: both groups addressed a strong orientation towards clients, supported by a collaborative culture in the group.

== = = = = INSERT TABLE 4 ABOUT HERE == = = = = = = = =

The groups involved clients in the establishment of plans, especially by discussing draft plans in advisory committees in which important stakeholders participated. An important contribution of stakeholders in this process was that they provided a quick reference to what they thought they needed in the near future and the extent to which they thought the group would be able to supply them with knowledge to anticipate emerging opportunities or future problems. In this respect, commitment of stakeholders provided the groups with a more stable basis to develop new competences, to strengthen research lines and to diminish expertise for which there was no demand in the near future. Besides, this practice enhanced trust among clients, by making clear how expectations were paid off.

The groups enhanced a collaborative culture in several ways. Firstly, by stimulating the commitment of employees to the group and not to one of its organizational clusters. Weakening the role of organizational clusters (to solely a practical home base) and strengthening the role of the group strengthened commitment to the group. Secondly, by stimulating group members to meet each other in meetings in diverse compositions, with a frequency of two to four times a month. Thirdly, by discussing projects in the acquisition, design, and execution phase. Fourthly, by stimulating group members to ask for help and support. Fifthly, by evaluating the composition of teams, stimulating group members to collaborate in differently composed teams, taking into account the expertise that is needed to execute the project successfully. Sixthly, by stimulating group members to give each other feedback (in addition to feedback from management). Seventhly and finally, by discussing collaborative behavior in assessments.

Co-envisioning a future for the group and stimulating a collaborative culture affect the operation of the four processes underlying the emergence of a dynamic capability. This intervention directly affects the teleological process, providing an envisioned future and a frame of reference. It affects the co-evolutionary process by providing selection criteria for projects to be acquired. In addition it affects conditions that enable the development of competences in three to five years, especially by committing stakeholders to lines of research. Furthermore it affects the process life cycle with regard to the process quality with which this process is executed, as it stimulates the development of social rules that support knowledge integration. This collaborative culture provides a context for solving tensions in the dialectical process, stimulating an effective and efficient process of knowledge integration and facilitating smooth interaction with clients.

Intervention 2: develop a competence-enhancing HR strategy
The second intervention we propose is to develop a competence-enhancing HR strategy. The HR-strategy in both groups concentrated on four aspects that enhanced competence development: (i) the recruitment of new group members with the desired competences, orientation and background; (ii) the selection process of new group members working in the group with a temporary contract; (iii) stimulating (scientific) quality through specialization and (iv) stimulating a broad availability of group members.

The managers of the groups stimulated the deepening and broadening of expertise (aspects iii and iv), leading to T-shaped profiles. The deepening of expertise enabled researchers to become an expert, and contributed to the further enhancement of the scientific profile of the group. This practice also allowed the group to acquire more complex projects in which expert-expertise in one or a number of fields was a core issue. This practice did not only contribute to the ambitions of the group, but also met ambitions of the individual researcher, as many researchers did want to develop a position in science by specialization. Development of specialist profiles was enhanced by stimulating researchers to start a Ph.D. trajectory and hiring Ph.D. students, aiming for an average of one Ph.D. thesis a year. Besides the deepening of scientific expertise, some researchers choose to develop their profile towards research management (for instance by leading more complex projects) or marketing: they were seconded to a large client, especially to gain more knowledge of the world of the client.

As the groups operated in a context in which they were strongly dependent on the market, it was also important that group members were widely available for projects. For if a researcher could not participate in a project (with a budget), he or she made costs that were not financially covered. To anticipate fluctuations and changing demands in the market, the groups needed members who were specialists in their field (to provide quality) and who also had broad availability to minimize the differences between the expertise required by the market and the expertise currently at the disposal of the group. Therefore group-management evaluated how group members were involved in projects. Sometimes they stimulated the involvement of a group member other than the specialist, in order to provide an opportunity for another group member to develop a broader field of expertise.

In addition to the deepening and broadening of expertise, the development of T-shaped profiles also supported the development of a practice in which researchers wanted to involve each other in projects in order to integrate knowledge. The strategy to stimulate researchers to develop a specialist profile created differentiated expertise profiles. Combined with needs for integrated expertise in the environment, it became important to integrate expertise in the design and execution of projects. This promoted the development of social rules stressing a need for interaction and stressing the relevance of knowledge integration. The strategy to stimulate a broad availability of researchers helped to develop a better understanding of the expertise of colleagues and to develop a mutual language. Besides, the development of T-shaped profiles reduced the risk of researchers becoming pigeon-holed (Perrow 1970) in one area or end up in a specialty that was being phased out.

In the process of selecting and hiring new group members (aspects i and ii), group-management did not only focus on the expertise that was needed, but also on research-related competences and attitudes. New group members were hired on a temporary basis, sometimes by deliberately searching for students or a Ph.D.-candidate. The advantage of this strategy was that management and group members could evaluate the fit of the new candidate in the group, and that the new candidate could be indoctrinated with the social rules that regulated

collaboration between group members and collaboration with the client from a somewhat uneven position. Furthermore, new group members were socialized carefully, for instance by assigning a mentor who accompanied each new group member for the first half year to get to know the group and learn about the practice of the group and the field of research. In addition, participation in group meetings enabled the new group members to learn about the social rules as these were made explicit in these meetings in discussing projects.

This competence enhancing HR strategy affects the operation of the four processes underlying a dynamic capability. It directly affects the operation of the teleological process, as the HR strategy is part of the activities embedded in this process. It affects the co-evolutionary process by providing conditions for collective expertise development as group ambitions and individual ambitions are matched to a large extent and as it stimulates the development of T-shaped profiles of individual researchers. Furthermore it affects the process life cycle with regard to the process quality with which this process is executed, as it stimulates the development of social rules that support knowledge integration. This collaborative culture provides a context for solving tensions in the dialectical process, stimulating knowledge integration and facilitating smooth interaction with clients.

Intervention 3: develop a facilitating management style

The third intervention we propose is to develop a facilitating management style. In support of a climate in which the researcher takes many initiatives (fitting with the envisioned future that has been accomplished bottom up) and in which researchers search for and apply each other's capabilities, management of the groups adopted a facilitating leadership style. This style reflected a practice in which individual initiatives which strengthened the fit between individual motives and goals of the group and which stimulated collaborating behavior were rewarded. As many researchers were more focused on the content of projects than the financial aspects, group management facilitated also financial control, providing support in making the state of affairs with regard to budgets transparent and providing support in ending projects in time and within budget.

Another facilitating aspect of management work in both groups was that they organized resources for expertise development. In order to stimulate the development of both general and more specific expertise, both groups needed resources that they could devote to projects by themselves. This diminished the dependence on clients as a number of these projects were relevant for the development of expertise, but did not directly provide solutions to clients. Besides, it stimulated researchers to work on the accomplishment of the envisioned future. It also provided the group with a means to develop new, interesting concepts that could be used to persuade the stakeholders in the niche.

Finally management facilitated the work of the groups by strengthening the recognition of distinctive competences for clients. Researchers were regrouped a number of times, related to changes in the demands for expertise in the market. This 'relabeling' of researchers however, did not affect the cooperation between the teams that were established. The researchers did not develop a strong orientation towards their team, but still identified themselves with the group as a whole. The groups chose to follow their environments in organizing teams and attributing labels to teams. The groups lagged some time with regard to their structure, related to the environment and their envisioned future: the choices made by the groups with regard to their organization fitted with the expectations of the stakeholders concerning the kind of expertise they had to offer. Therefore, structure facilitated the execution of the strategy, and

therefore interventions in structure were experienced as formalizing a practice that had already developed.

This intervention directly affects the teleological process, in particular addressing its style of execution. It affects the co-evolutionary process by providing resources for expertise development. In addition it affects the competence-profile of the groups recognized by clients. As this profile is supposed to affect decision making of clients, it also affects the co-evolutionary process of expertise development. Furthermore the management style is part of the context for balancing tensions in the dialectical process. It addresses the shared responsibility of group members for the wellbeing of the group in making decisions. It does hardly affect the process life cycle. Providing resources enables the start of new projects, but that in itself does not affect the process life cycle.

DISCUSSION

We have provided an empirically grounded theory on the processes underlying the emergence of a dynamic capability. In this study we also found a number of management practices that supported the operation of these four processes and therefore contributed to the continuated emergence of a dynamic capability. In this paper we have translated these findings into three interventions that can be picked up by managers of R&D-organizations to stimulate the emergence of a dynamic capability. By discussing these three interventions we answer the question how to manage for the emergence of a dynamic capability. This study is substantive (Glaser and Strauss 1967) however, implying that one should not attempt to explain the emergence of a dynamic capability outside the immediate field of study, as there are no data of situations outside this field of study. The substantive area in which this research is grounded is defined by the context in which the research groups involved in this study operate. We did not find indications that the specific area of research of Food & Environment affected our results. Furthermore, the study was focused on developing theory how a dynamic capability emerges and not on testing theory. As our findings include managerial aspects and as the four processes underlying the emergence of a dynamic capability also have managerial consequences, we feel we can contribute to the development of insights regarding the management of the emergence of a dynamic capability. Nevertheless, the exploratory character of this study also means that our results need to be explored further.

This study shows a dynamic capability as a singular, integrated set of processes. The integrated multiple process perspective enables us to relate existing findings on (managerial) activities and conditions for dynamic capabilities to the specific processes underlying the emergence of a dynamic capability. For instance with regard to (managerial) activities, the development of close relations with stakeholders and the market, including the development of new channel capabilities to reconfigure the service process (Prieto and Easterby-Smith 2006; Daniel and Wilson 2003; Pavlou and El Sawy 2006), are part of the practices employed in the co-evolutionary process of expertise development (personal contacts of researchers with stakeholders to discuss new concepts and relate them to problems stakeholders experience) and the teleological process of envisioning the future (in which the research groups consulted stakeholders with regard to new and continuated lines of research in strategic plans). Similarly, ‘a rapid cycle of strategy development and implementation’ (Daniel and Wilson 2003) specifies guidelines for the teleological process of envisioning the future, and an activity as ‘coordinating activities’ (Pavlou and El Sawy 2006) refers to the repeated project life cycle on the one hand (project management as a specific form of coordination) and the process of envisioning the future on the other hand (group management and management of

group development as a form of coordination). Such activities describe or detail parts of the underlying processes. Thus these activities found in previous studies, can be located in our integrated process framework.

With regard to conditions, organizational intelligence (Lawson and Samson 2001), stakeholder dialogue and stakeholder knowledge integration (Ayuso, Rodríguez and Ricart 2006) for instance, are conditions that are particularly related to the development of concepts and the testing of their viability in personal contacts with stakeholders (co-evolutionary process of expertise development) and consulting stakeholders before making choices with regard to new and continuated research lines (teleological process of envisioning the future). We also found that vision and strategy (Lawson and Samson 2001) is important in the teleological process of envisioning the future, as is past experience (King and Tucci 2002) for the co-evolutionary process of expertise development. Finally we found culture and climate (Lawson and Samson 2001), valuing expertise (Dougherty et al. 2004), social capital (Blyler and Coff 2003) and superior matching (Kor and Mahoney 2005) as important conditions, particularly related to the repeated project life cycle and referring to the social practices applied in the repeated project life cycle in particular. Thus this study confirms previous findings on conditions and antecedents necessary for the emergence of a dynamic capability and relates these to managerial interventions in R&D-groups.

Table 5 summarizes key insights of this study for managers, along with suggestions for academic researchers that can lead to a verification, elaboration, and if necessary, a correction of these insights.

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The first insight is that the emergence of a dynamic capability can not be managed or designed for in a way in which the emergence is guaranteed. This is due to two reasons. The first reason is the combination of processes underlying the emergence. The teleological process of envisioning the future and the repeated project life cycle process are more or less under managerial control. The other two processes however, the co-evolutionary process of expertise development and the dialectical process of balancing tensions defy control. They cannot be "switched on" or directed by managerial intervention. They need a specific context in order to emerge. This limits the intentional character of a dynamic capability (Helfat et al. 2007). Moreover, the participative management style we found in the studies implies that next to the manager of the group a substantive number of (senior) researchers also bear managerial responsibilities. The linking pin between these researchers and the manager is the envisioned future of the group. Based on this vision they individually and collectively make decisions regarding the acquisition, the design and execution of projects. These not only affect the performance of the group in the short term, but also in the long term as they create path-dependency, for instance by a choice for expertise development into models and three types of ecological landscapes instead of expertise development into forest birds or butterflies (Ecology Group). Furthermore, the field studies suggest that change and development are not necessarily a consequence of outside pressures or interventions by management, but can also be the result of experiments, improvisation, expansion, or opportunistic behaviour. Although the project life cycle guided the actions of researchers, it did not prescribe exactly how the subroutines in this process had to be executed. In balancing tensions in the dialectical process researchers still had options to choose one way or another. Interpreting change as endogenous to the practice of the group means that managers can induce change, but that it is not clear beforehand how these incentives are embedded in the practice. They will become part of the

continuous stream of variation in the practice and will be interpreted and modified by the individual researcher in order to make them fit within the practice. Supporting Tsoukas & Chia (2002), the result therefore is not predictable, complex, and evolving, rather than predictable, simple, and established at once. This is the second reason why one can not design for the emergence of a dynamic capability.

Academic research can help to explore if the results we found are also valid for R&D-groups working in another context or for other organizations in which professional knowledge workers develop, share, apply and integrate knowledge. Are our results limited to the type of R&D-groups defined in our case studies of are they valid for a wider range of groups? Another issue is that we do not know if our findings also hold for other change processes in groups of professional knowledge workers in which dialectical or evolutionary processes have an important role. The characteristics of these two processes suggest that the manageability of change based on these processes is seriously restricted, but to what extend?

The second insight is that the study suggests that managers can stimulate the emergence of a dynamic capability by creating conditions that support the joint operation of the processes we found in the field studies. Developing close relationships with stakeholders in the market is an example (affecting the co-evolutionary process of expertise development and the teleological process of envisioning the future), providing a platform to develop and test new concepts (related to problems experienced by stakeholders) and to consult stakeholders related to the further development of the group. Another example is the development of a joint vision on the future (teleological process), based on an interactive process including the participation of all researchers. This will stimulate researchers to decide in favour of the strategic goals of the group (for instance in acquiring projects, repeated project life cycle) and thereby to develop the desired position with regard to distinctive operational competences and the desired position in the market. Managers can also facilitate the joint operation of the processes by stimulating social practices enhancing researchers to share and integrate their expertise (repeated project life cycle), develop a competence-enhancing HRM strategy and organize resources for expertise development (both co-evolutionary process of expertise development). The three interventions discussed in the previous section create these conditions.

We have not found evidence for a meta process that explains how the emergence of a dynamic capability comes about: you start with step A, next you make intervention B, after the period of a year you introduce C, etcetera. We have found that all four processes involved operate at the same time. Therefore, our interventions should be considered as a menu, with ingredients that can be ordered in any sequence. Related to the literature addressing the management of R&D-groups, our findings address all four fields of managerial attention: the development and implementation of a mission and collective ambition, collaboration with partners outside the group, specialization of the group and personnel management (Weggeman 1997; Badawy 1988; Farris and Cordero 2002; Cesaroni, Di Minin and Piccaluga 2004; Hargadon and Sutton 1997; James 2002; Nobelius 2004; Roberts 1988). However, the proposed interventions address managerial actions more to the point and by combining several management aspects (as for instance promoting the development of T-shaped profiles and promoting a collaborative culture) in the interventions and by relating the interventions to the four processes we deepen and expand literature and enhance our understanding. Our findings stressing the relevance of a facilitating and participative management style seem to contrast the findings of Donaldson and Rush et al. (1995). They found business planning vital for enabling R&D organizations to survive change and progress despite uncertainty. Their perspective reflects a stronger focus on planning and control, implementing, auditing and

monitoring a business plan regularly. Our findings are more similar to those of Weick (1987): strategy inferred from successful actions that develop through experimentation or is discovered by luck. The participatively developed vision provides direction, but in their actions researchers meet new opportunities, conditions and constraints. These provide limitations but also new opportunities that fuel the envisioning of the future for the group.

Academic research can explore the boundaries of these results with regard to the kind of groups or organizations for which these findings hold. These boundaries also include the kind of interventions and the kind of management style. Are the management style and management practices we found absolutely necessary or are there other styles and practices possible that provide the same conditioning and emergence enhancing results? Academic research should also provide additional insights into the applicability and completeness of our findings and should close the management cycle with regard to the emergence of a dynamic capability: not only looking backward, analyzing what happened in the emergence of a dynamic capability (as we did), but in applying this knowledge in stimulating for the emergence of a dynamic capability.

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TABLES & FIGURES

Figure 1: The coherence between the processes underlying the emergence of a dynamic capability

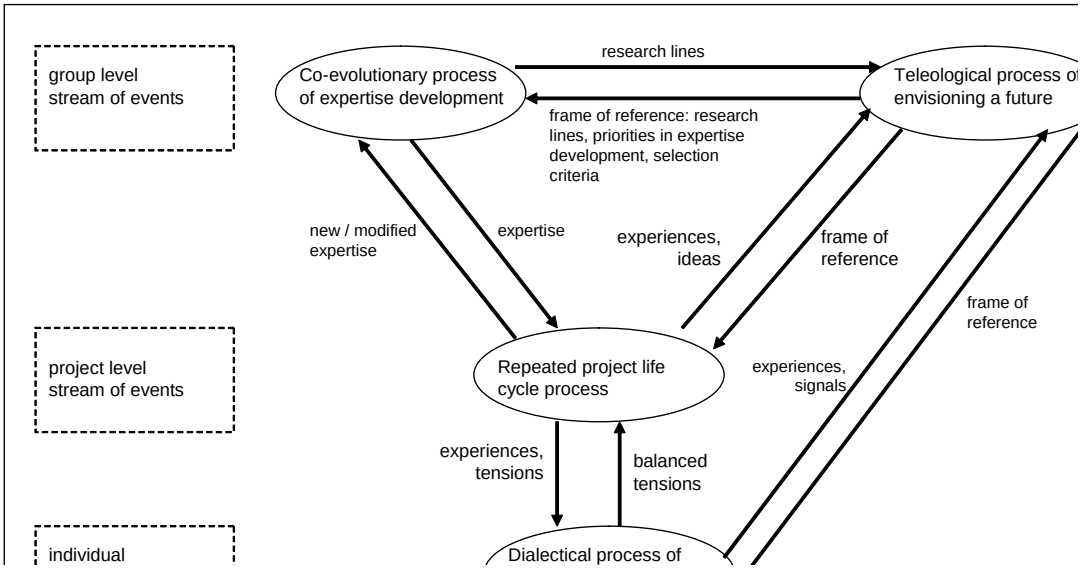

Table 1: Examples of distinctive capabilities applied in a wide range of application areas

Ecology Group

Examples of capabilities

- Development of models that describe accumulated knowledge about the survival of meta-populations of valuable species (plants & animals) in a particular ecological system
- Application of these models for a wide range of problems to predict effects of measures for a wide range of valuable species and for various spatial levels
- Development of norms and conditions for the habitat of a species in order to survive
- Development of guidelines through which knowledge of meta-populations of valuable species related to characteristics of a habitat can be translated for application in local landscape planning processes
- Development and application of process descriptions of fragmentation and de-fragmentation of landscapes related to measures in environmental management (in nature areas and culture landscapes)
- Development and application of knowledge of indicator species, that stand for the survival and wellbeing of a collection of species (of valuable plants or animals)

Postharvest Group

Examples of capabilities

- Development of knowledge of biological processes that take place in fresh harvested products related to the environmental conditions (as for instance temperature, light, air composition, the presence of other products) under which they are stored and transported
- Development and application of methods to prevent or solve problems in the decline of quality of fresh harvested agricultural products in the chain from grower to consumer (cut flowers, potted plants, bulbs, vegetables)
- Development and application of methods to prevent or solve problems in the decline of quality of potatoes and fruits (particularly apples and pears) during storage
- Development of measurement methods to measure the current quality of fresh harvested products and to predict the decline of quality during the remaining post harvest period of this product

Table 2: Characteristics of the projects Kimberly worked on in 2001

Kind of project	Collaboration with colleagues from her own sub-unit	Collaboration with colleagues from other sub-units
Cutting up of landscape related to dispersion of species no. A		Howard, Helen, Cindy
Cutting up of landscape related to dispersion of species no. B	Philip, Adam	Howard, Stephanie
Cutting up of landscape related to dispersion of species no. C	Philip, Bruce	Katy, Rebecca, Ian
Development of guide lines	Philip	Rebecca, Ken
Diversity in agricultural landscapes	Philip, Bruce	Stephanie, Cindy, Donald, John
Dispersion of bird specie A		Ian
Development of international nature areas	Adam, Harry, Bruce	Ian, Brian, John
Development of instruments no. A	Philip, Iris, Adam, Alan, Harry, Bruce, Steve, Jack	Rebecca, John
Development of instruments no. B	Philip, Harry, Steve, Jack	

Table 3: operational capabilities of the researchers involved in the projects Kimberly worked on in 2001

Researcher	Expertise profile
Howard	Landscape ecology in general
Katy	Landscape ecology in general
Helen	Knowledge of fauna species
Rebecca	Spatial networks, population dynamics, knowledge of fauna species
Stephanie	Ecology of plants, population dynamics
Cindy	Ecology of plants (particularly forest plants)
Donald	Knowledge of vegetations, sea dykes, landscape ecology
Ian	How to apply models
Brian	How to apply models, landscape planning
John	Very broad and deep knowledge of landscape ecology
Philip	Development of models
Iris	Programming (development of models)
Adam	Programming (development of models)
Alan	Programming (development of models), quality of models
Harry	Programming (development of models), quality of software
Bruce	Geographic information systems
Steve	Geographic information systems
Jack	Spatial networks, expertise of one particular set of models
Kimberly	Population dynamics, measures of landscapes, development of models
Ken	Urban ecology

Table 4: Selection criteria for research themes, projects and the loss of expertise

I. For research themes
   a. fit with the mission of the group
   b. opportunities in the market
   c. present level of maturity of expertise on the topic in the group

II. For projects
   a. Strategy / goals of the group
   b. Financial coverage of all costs of a project
   c. Scientific challenge in the content of a project
   d. Present level of maturity of expertise in the group
   e. Complexity and size of a project

III. For the loss of expertise from the group
   a. No continuation – in the long term - of a market for this expertise

Table 5: Insights from managing the emergence of a dynamic capability for managers & researchers

Insight	For managers	For researchers
Is it manageable?	The emergence of a dynamic capability is not manageable, due to: - the characteristics of the processes underlying the emergence - the required management style	Are these results also valid for R&D-groups working in another context and for other organizations with a large share of knowledge workers? Can de results be elaborated to other change processes?
Can the emergence be stimulated?	Based on our findings we propose three kinds of interventions: a) co-envision a future for the group and stimulate a collaborative culture b) develop a competence enhancing strategy c) implement a facilitating management style	Are these interventions also valid for other kinds of organizations? What kind of organizations and under what conditions? Are there other management practices or management styles that can lead to the same results? Apply these insights in stimulating the emergence of a dynamic capability