A Multi-Level Model for Organizational Ambidexterity in the Search Phase of the Innovation Process

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Innovation is one of the most critical means in supporting and improving the competitive position of the firm, in particular, and a firm's survival and growth depend greatly on its ability to balance the exploitation of existing knowledge with the exploration of new possibilities, by building ambidexterity capability. While different alternatives to realize the simultaneous reconciliation of exploration and exploitation at an operational level have been proposed, how organizations build ambidexterity capability is not fully understood. The aim of this paper is thus to explore how exploration and exploitation balancing can be achieved in practice. We decided to focus on the early phase of the process where firms search for new ideas with which to renew themselves. To this end, we analysed the search phase of a highly innovative technology-based company by investigating structural design choices combined with the presence of specific roles and searching practices. The results show how the exploration and exploitation balancing act can actually be achieved and maintained through a multi-level approach that integrates both the operational and the strategic levels. Our findings thus contribute to the organizational ambidexterity literature, by proposing a first interpretative model for dealing with ambidexterity in the search phase of the innovation process.

Introduction

Nowadays, firms are strongly challenged by global competitive pressures in a context that often becomes unstable as a result of changes that are difficult to foresee. Innovation has thus become an increasingly central 'tool' to enhance competitiveness because it is by innovating activities that firms succeed in addressing the needs of both the customers of today and tomorrow (Boer, Kuhn & Gertsen, 2006). In particular, the success of every innovative action is rooted in the early phase of the process (Brown & Eisenhardt, 1995; Verganti, 1997), where firms look both inside and outside in search of new ideas to renew themselves. In fact, the creation of knowledge is a core premise for the innovation process and its management is a critical matter for firms. In particular, firms need to both exploit their core knowledge

and explore new possibilities extremely well (March, 1991), by finding a proper balance between the depth and the breadth of their knowledge base learning (Leonard-Barton, 1995). Such balance represents a strategic dilemma.

There is an increasing interest in academic research to investigate how companies can achieve this balance between exploration and exploitation. Creating ambidextrous organizations has been suggested as one possible solution, which involves the synchronous pursuit of both exploration and exploitation (Benner & Tushman, 2003). What is not fully understood is *how* organizations become ambidextrous (O'Reilly & Tushman, 2008) and how operational and managerial levels within an organization interact in order to resolve the exploration/exploitation dilemma (Smith & Tushman, 2005). It is exactly this that needs further investigation.

The aim of this article is therefore to explore how exploration and exploitation can be simultaneously achieved, through a multi-level analysis that integrates the operational as well as the managerial level. The unit of the analysis is the early phase of the innovation process (i.e., the search) with the aim of investigating how to succeed in carrying out both exploration and exploitation activities. According to the definition of Atuahene-Gima (1995) and Mom, van den Bosch and Volberda (2009), exploration and exploitation are described in terms of the proximity of the sought-for knowledge: *exploitation* activities correspond to the search for familiar, mature, current or proximate knowledge – *local search*, while *exploration* activities correspond to the search for unfamiliar, distant and remote knowledge – *distant search*.

In order to achieve the above aim, we conducted an explorative case study, involving a highly technology-based company. Organizational ambidexterity (OA) has been defined as the capability to deploy both exploration and exploitation strategies at the same time (Gupta, Smith & Shalley, 2006). Accordingly, using the definition of ambidexterity as capability that is 'constituted in the everyday practices' (Antonacopoulou, 2007), we decided to focus on the practices through which firms search simultaneously for both local and distant knowledge. In other words, within the context of the search phase, our perspective is focused on the 'search' organizational practices, including activities and roles, which enable the simultaneous achievement of exploitation and exploration. The case study reported in this article offers a good example of how a balanced exploration and exploitation performance can be achieved and maintained in practice, through a multi-level approach where the practices implemented at the operational and the managerial levels are analysed. Our findings thus contribute to the OA literature by proposing a first interpretative model for dealing with ambidexterity in the search phase of the innovation process.

The article is organized as follows: firstly we define organizational ambidexterity and briefly review the literature. Secondly, the research framework, methodology and case settings are reported. Thirdly, findings illustrate how the firm has been able to combine exploitation of the existing markets and technologies, and exploration of the new ones, in the early phase of the innovation process. The results are then discussed and the interpretative model is finally presented.

Theoretical Background

Managing the contradictions between different activities, opposite strengths and developing skills in order to succeed in realizing different, contrasting and conflicting goals as well as reconciling them, is necessary for organizational survival and success, thus representing a strategic dilemma for firms (Eisenhardt & Martin, 2000; Magnusson & Martini, 2008; Raisch & Birkinshaw, 2008). Existing research suggests ambidexterity as a possible solution (Tushman & O'Reilly, 1996), namely organizations' capability of balancing dynamically contradictory strengths, reminiscent of the human ability to 'use both hands with equal skills' (Carmeli & Halevi, 2009, p. 207).

In this section a literature review on OA is provided to support the development of the research framework.

Literature Review

Organizational ambidexterity is more than just the simple presence of both exploitation and exploration: only if firms succeed in realizing a strategic integration between exploitation and exploration and maintaining such balance does the ambidexterity capability arise (O'Reilly & Tushman, 2004). Such capability is embedded in processes and actions that enable firms to integrate and recombine resources to permit simultaneous exploitation and exploration (Raisch & Birkinshaw, 2008).

Ambidexterity is a relatively young theme that is becoming a central concept in management research, receiving contributions from various research streams such as organizational learning, technological innovation, organizational adaptation, strategic management, and organizational design. Most of these contributions conceptualize ambidexterity as an organizational capability. If we look at Table 1, what emerges is a clear agreement and temporal continuity, apart from a few isolated cases, on the conceptual definition of ambidexterity as a capability.

Over recent decades the literature on this subject has registered increasing interest, and researchers have started investigating the antecedents and the performance outcomes of OA. The literature has, then, examined on the one hand the enablers of ambidexterity, and on the other, the impact of ambidexterity on firms' performance. This article contributes mainly to the first theme, considering the enablers that make it possible for firms to be ambidextrous in the search phase.

Three different broad approaches to organizational ambidexterity have been proposed:

Table 1. An Overview of the Articles which clearly Define Ambidexterity

Article	Theoretical lens	Definition
Tushman and O'Reilly (1996)	Organizational design	The *ability* to simultaneously pursue both incremental and discontinuous innovation and change that result from hosting multiple contradictory structures, processes, and cultures within the same firm
Adler, Goldoftas and Levine (1999)	Organizational design	Exceptional *capability* for both first-order and second-order learning
Birkinshaw and Gibson (2004)	Organizational design	The behavioural *capacity* to simultaneously demonstrate alignment and adaptability across an entire business unit. Contextual ambidexterity can be viewed as a meta-level capacity that permeates all functions and levels in a unit, rather than as a 'dual structure' in which the two demands are kept separate
Gibson and Birkinshaw (2004)	Organizational design	The behavioural *capacity* to simultaneously demonstrate alignment and adaptability across an entire business unit. Contextual ambidexterity can be viewed as a meta-level capacity that permeates all functions and levels in a unit, rather than as a 'dual structure' in which the two demands are kept separate
Im and Rai (2008)	Organizational learning	An organization's *capability* to conduct two paradoxical things at the same time by requiring organizations and their people to have two heterogeneous but related skills simultaneously
Nemanich and Vera (2009)	Organizational learning	The *ability* to explore new capabilities while exploiting existing ones
Rothaermel and Alexandre (2009)	Organizational learning	A firm's *ability* to simultaneously balance different activities in a trade-off situation
Gupta, Smith and Shalley (2006)	Organizational learning	Firms that are *able* to deploy both exploration and exploitation strategies at the same time
He and Wong (2004)	Innovation management	The *capability* to operate in both mature markets and develop new products and services for emerging markets
Jansen et al. (2008)	Innovation management	Organizations *capable* of pursuing exploration and exploitation simultaneously
Andriopoulos and Lewis (2009)	Innovation management	The *ability* to excel at conflicting modes of innovation: at exploiting existing products to enable incremental innovation and at exploring new opportunities to foster more radical innovation
Li, Lin and Chu (2008)	Innovation management	Those organizations, like a juggler who can handle numerous balls at the same time, could rely on given resources to ensure radical innovations as well as incremental innovations simultaneously
Jansen et al. (2009)	Innovation management	A dynamic *capability* that refers to the routines and processes by which organizations mobilize, co-ordinate, and integrate dispersed contradictory efforts, and allocate, reallocate, combine, and recombine resources and assets across differentiated exploratory and exploitative units
De Visser et al. (2009)	Innovation management	An effective organizational strategy to address the tension between exploitation and exploration
Andriopoulos and Lewis (2010)	Innovation management	The *ability* to excel at conflicting modes of innovation
Lubatkin et al. (2006)	Strategic management	Ambidextrous firms are *capable* of exploiting existing competences as well as exploring new opportunities with equal dexterity

Table 1. continued

Article	Theoretical lens	Definition
Han and Celly (2008)	Strategic management	'Strategic ambidexterity' is the *capability* that enables a firm to carry out inherently paradoxical strategies that embody and manifest two main strategic objectives
Bodwell and Chermack (2010)	Strategic management	The *ability* of an organization to embrace and balance deliberate and emergent approaches to strategy at the same time
Smith and Tushman (2005)	Strategic management	The organization's *ability* to adapt and change through innovation while simultaneously continuing to perform in the short term
Cao, Gedajlovic and Zhang (2009b)	Strategic management	Firm *capable* of both exploiting existing competencies as well as exploring new opportunities. There exist two distinct but related dimensions of ambidexterity, one pertaining to the balance between exploration and exploitation, 'balance dimension of ambidexterity' (BD), and the other pertaining to their combined magnitude, 'combined dimension of ambidexterity' (CD)
Menguc and Auh (2008)	Strategic management	A firm's higher-order *capability* of simultaneously pursuing competing, contradictory, discrete capabilities
O'Reilly and Tushman (2008)	Strategic management	A specific *capability* embodied in senior leadership's learning and expressed through their ability to reconfigure existing organizational assets and competencies in a repeatable way to adapt to changing circumstances
Carmeli and Halevi (2009)	Strategic management	The synchronous pursuit of both exploration and exploitation via loosely coupled and differentiated subunits or individuals, each of which specializes in either exploration or exploitation
Mom, van den Bosch and Volberda (2009)	Strategic management	A manager's behavioural orientation toward combining exploration and exploitation related activities within a certain period of time
Cao, Simsek and Zhang (2009a)	Strategic management	An ambidextrous firm is one that is *capable* of both exploiting existing competencies as well as exploring new opportunities
Lin, Yang and Demirkan (2007)	Strategic alliances	An organization's *ability* to perform two different activities at the same time (Gibson & Birkinshaw, 2004; He & Wong, 2004). The authors apply the concept to alliance formation
Tiwana (2008)	Strategic alliances	Alliance ambidexterity is the *capacity* to simultaneously exhibit alignment with alliance objectives and adaptiveness to changes in the environment
Luo and Rui (2009)	International venturing	Ambidextrous organizations are *able* to pursue simultaneous fulfilment of two disparate, and sometimes seemingly conflicting, objectives
Kristal, Huang and Roth (2010)	Operations management	The authors define an ambidextrous supply chain strategy from a manufacturer's perspective, as a manufacturing firm's strategic choice to simultaneously pursue both supply chain exploitation and exploration practices

structural solutions (O'Reilly & Tushman, 2004), contextual solutions (Gibson & Birkinshaw, 2004) and leadership-based solutions (Smith & Tushman, 2005).

Duncan (1976), perhaps the first researcher to coin the term 'ambidextrous organization', characterized ambidextrous organizations as composing of dual structures. It means that

organizations cope with different tasks that may differ in terms of their complexity and certainty, by establishing multiple structures. This type of ambidexterity enabler is called 'structural', as it is achieved by separating exploitative and explorative activities in the business organization, while establishing at the same time a planned level of integration. Gibson and Birkinshaw (2004) develop an alternative OA enabler view (i.e., the contextual ambidexterity), where ambidexterity arises from features of the organizational context in terms of cultural values and norms. Contextual ambidexterity is achieved 'by building a set of processes or systems that enable and encourage individuals to make their own judgments about how to divide their time between conflicting demands for alignment and adaptability' (Gibson & Birkinshaw, 2004, p. 210).

More recent works shift attention from the operational to the managerial level by emphasizing the role played by senior managers in deciding on exploration and exploitation opportunities and resolving the strategic contradiction between these two activities. The role of top management team characteristics (TMT) in reconciling the tensions between the two activities (Smith & Tushman, 2005) and in pursuing their integration (Andriopoulos & Lewis, 2009; Raisch et al., 2009) have only just begun to be analysed. The few studies that adopt this perspective suggest that ambidexterity takes place at multiple levels within an organization, more precisely at managerial and operational levels. Previous research (Burgelman, 1991; Vera & Crossan, 2004), in fact, clearly indicates a tight connection between the operational and strategic levels in order to build up ambidexterity, but traditionally less research (Siggelkow & Levinthal, 2003) has been devoted to showing how organizations achieve this capability by bridging the managerial and operational levels. Therefore what is still lacking is the overall perspective that integrates the practices carried out at managerial and operational levels, thus showing the merging of this capability. Effectively, even if most of the studies (Table 1) theoretically define OA as a capability, from an empirical point of view they do not analyse the process through which OA could be developed.

Furthermore, most of the studies on antecedents, as we can see from Table 2, adopt a macro-level perspective, carrying out the analysis at firm or business level. What seem to still be lacking are qualitative studies at the micro level, that would allow the complexity of the phenomena to be highlighted and the organizational mechanisms, practices and actors behind this capability to be revealed.

Research Framework

The research framework is built on the gaps emerging from the literature review, which can be summarized in the following points:

(a) micro-level unit of analysis
(b) multi-level perspectives
(c) OA development process

As the unit of analysis in the great majority of the literature contributions is the firm or the BU (business unit), the complexity of the theme can benefit from using a more restricted unit of analysis. Therefore, we chose a micro-level perspective: the search phase of the innovation process. According to Bessant et al. (2005), search is one of the three phases of the innovation process: *search* for new ideas, *selection* to decide which particular ideas should be investigated, and *implementation* of evaluated concepts. The search phase resides at the fuzzy front end, and specifically at the 'early' front-end, where activities are related to generating ideas, managing them and locating opportunities (Crawford & Di Benedetto, 2000), whereas selection and implementation relate to the 'later' front-end, i.e. the selection phase (Backman, Börjesson & Setterberg, 2007).

The literature on ambidexterity identifies three different solutions to deal with tensions: structural, contextual and leadership based. Most of the papers focus only on one of these perspectives, while only a few studies take into consideration the coexistence of all of the three solutions, then providing an overall view. Because the contextual and structural views pertain to the operational level, while the leadership-based view refers to a higher level (the managerial one), the article adopts an overall perspective, where the different levels are nested and integrated.

With regard to the last gap – the OA development process – while many contributions conceptually define OA as a capability, it is not yet fully understood, from an empirical point view, how this capability really emerges (Simsek, 2009). By looking at the practices and the actors behind the operational and managerial levels, as well as at their interplay, it is possible to better reveal the process that leads to OA development.

To sum up: in the search phase of the innovation process (micro-level unit of analysis), we want to shed light on the OA development process through the analysis of its antecedents at both operational and managerial levels (multi-level perspective). The combination of the above aspects is new: while there are contributions that take into account one or more gaps, to our knowledge no contributions address all three aspects at the micro level.

Table 2. The Enablers (or Antecedents) of OA

Contributions	Enablers	Unit of analysis	Methodology	Ambidexterity perspective
Andriopoulos and Lewis (2009)	Formal and informal mechanisms	Multi-level	Case study Cross sectional	NA
Andriopoulos and Lewis (2010)	Formal and informal mechanisms	Multi-level	Case study Cross sectional	NA
Bodwell and Chermack (2010)	Scenario planning	Firm	NA	NA
Cao, Simsek and Zhang (2009a)	Formal and informal mechanisms Managers' ability and attributes	Firm	Quantitative Cross sectional	NA
Im and Rai (2008)	Context and culture	Partnership/ alliance	Quantitative Cross sectional	Contextual
Jansen et al. (2008)	Managers' ability and attributes	Firm	Quantitative Cross sectional	Structural
Jansen et al. (2009)	Organizational structure Formal and informal mechanisms Managers' ability and attributes	Firm	Quantitative Cross sectional	Structural
Li, Lin and Chu (2008)	Organizational structure	Firm	Quantitative Cross sectional	Structural
Mom, van den Bosch and Volberda (2009)	Organizational structure Formal and informal mechanisms Managers' ability and attributes	Individual	Quantitative Cross sectional	Contextual
Nemanich and Vera (2009)	Context and culture Managers' ability and attributes	Team	Quantitative Cross sectional	NA

NA = not applicable.

We analyse the antecedents in terms of organizational practices and actors and the OA in terms of innovation tensions, adopting both a static and a combined approach. These two approaches are not concurrent but complementary, with the static analysis seen as preliminary to the combined one. The two boxes in Figures 1(a) and 1(b) are the same in terms of constructs: the only difference is in the 'relational aspect' between the various elements of the frame. The static view makes a picture of these elements, while the combined one 'plays a film' starring the elements and looking at how the different components integrate with one another. The static view (Figure 1a) explores the practices carried out by different actors at the operational and managerial levels (antecedents), while the combined view
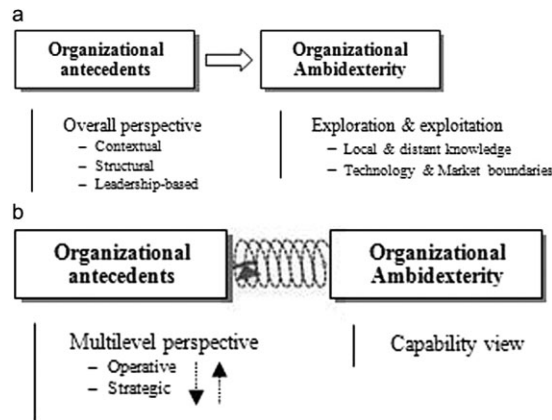
Figure 1. Static (a) and Combined (b) Views of the Framework

Figure 2.   Exploration   and   Exploitation Characterization

(Figure 1b) examines the interplay between the practices (the OA process).

In Figure 1(a), the OA box refers to the achievement of ambidexterity, in terms of solving the different tensions in the search phase of the innovation process. These tensions refer both to the nature of knowledge (market vs. technology) and proximity of knowledge (local vs. distant). In other words, efforts of firms are directed towards both searching for knowledge that makes it possible to improve and deepen existing technological knowledge and competences, and searching for knowledge that makes it possible to broaden the existing technological capability through the generation of unfamiliar, distant and remote technological knowledge. The same considerations could be done regarding market search activities, that are targeted towards the generation of market intelligence pertaining to current needs ('local market search') and search activities aimed at producing knowledge about new opportunities outside of immediate markets ('distant market search').

By distinguishing between the market and the technological knowledge dimensions, it is possible to de-construct and identify tensions that arise in the search phase. According to the Abernathy and Clark framework (1985), market and technological domains are here used as dimensions to characterize and differentiate exploration from exploitation (Figure 2).

To analyse the static dimension, we adopted the lens of organizational practices, as it allows us to underline processes and activities that facilitate the OA capability. While in the static dimension the focus is on practices and roles, in the dynamic dimension the focus is on the process to develop OA capability, i.e., on the
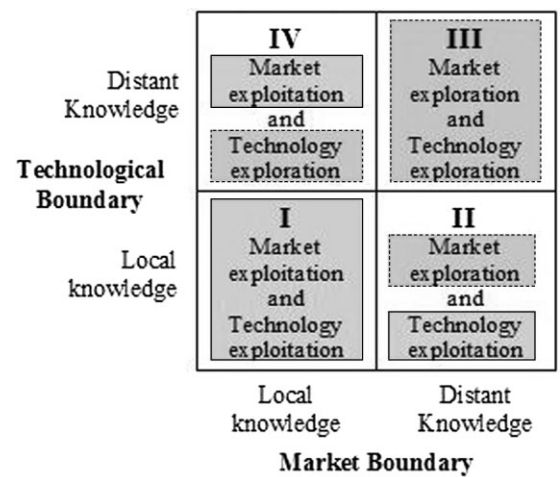
interplay of the antecedents that makes it possible to achieve ambidexterity. As illustrated in Figure 1(b) the antecedent box is now analysed according to the multi-level perspective, which involves both the operational and managerial levels through a top-down and bottom-up process. The multi-level interplay enables OA capability to be developed and consolidated. The combined dimension underlines this cyclical interplay of the enablers, which contribute to the capability development. It can also be analysed using the time dimension, although this has not been done in this article.

Methodology

Given the complexity of the topic, as well as the little prior knowledge on the specific theme investigated (how to develop OA capability), the exploratory case study approach is considered to be the most appropriate methodology. According to the definition of an exploratory case study, the aim of this article is to 'clarify and define the nature of a problem (concept)' (Yin, 2009) without providing conclusive evidence. Therefore, useful learning points within the field, which future research can leverage upon, are given.

As suggested by Yin (2009), the case study we selected is representative of the reality we wanted to investigate and therefore it could act as a pilot case for other forms of studies. There are several reasons that guided us in the case selection. Firstly, the company belongs to a knowledge-intensive industry, where rapid technological changes, coupled with intense competition, compress product life cycles,

Table 3. Sources of Evidence for the Case Study Research

Primary data sources	• Semi-structured interviews (December 2008–November 2009)

Informant	# interview	Σ Hour
• *Corporate R&D Manager*	3	8
• *Knowledge Manager*	2	6

	• Personal research notes
	• Ongoing discussions
	• Internal documents
	• Balance sheets
	• The company's website
Secondary data sources	• Sector description
	• Press releases
	• Previous case studies conducted on the firm

pushing the firm to search for new knowledge. Secondly, for this company not only technological knowledge but also customer knowledge is important, thus creating building blocks of competitive advantage. The case firm is renowned for its excellence in both exploitation and exploration, within an intensely competitive industry: it is highly and consistently profitable, while simultaneously receiving numerous awards and top rankings for cutting-edge innovation. It thus represents a good model of ambidexterity in the innovation process. Finally, it is a good example of a firm that has developed and managed ambidexterity capability in the search phase of the innovation process.

Data Collection and Analysis

The aim of the qualitative research is to portray the reality of the area under investigation, to enhance understanding of the situation and to develop the clearest possible picture of the phenomenon (Yin, 2009). We therefore carried out face-to-face semi-structured interviews with key actors, conducted in a narrative way: this offered us the possibility to modify the line of enquiry, to follow up interesting responses and to investigate the underlying motivations for particular choices. A pre-interview with questions covering general topics (such as company history and structure, innovation projects and their classification, clients and competitors) was also performed.

An interview protocol was designed with exploitation and exploration tensions in mind: questions about the R&D organization, about practices and people involved in the different phases of the innovation process, about locations, roles and about types of knowledge associated with the search phase have been examined. We conducted five interviews, between December 2008 and November 2009, with the R&D chief and the knowledge manager: each session lasted approximately 180 to 300 minutes. After we transcribed the recorded interviews, we returned them to the interviewees for verification. Subsequently, we adapted our case study reports to any additional information obtained. Responses from the interviews were used to develop a case study database that included tables to record data. These tables were helpful in guaranteeing that the data collected were based on the research questions. Annual reports and internal documents were also examined. Table 3 shows the sources we used to collect data.

This process of interaction provided an opportunity to validate our findings (Yin, 2009). While internal validity (i.e., establishing a causal relationship whereby certain conditions are shown to lead to others) and external validity (i.e., establishing the domain where a study's findings can be generalized) are important for explanatory (causal) case studies, they are not important for exploratory ones (Yin, 2009). Consequently, construct validity, defined as the correct establishment of operational measures for the concepts being studied, is by far the most important validity issue for this study.

The threats to construct validity are either the failure to incorporate all the dimensions of the concept into operation or the risk of incorporating the wrong concepts, namely those that are irrelevant to the construct under investigation. In our case, it means how well we have translated ambidexterity, local and distant search, practices, managerial and operational levels into concrete language that people can understand (Aiman-Smith et al., 2005). This is important to us because we are trying to translate rather complex concepts into as simple a language as possible.
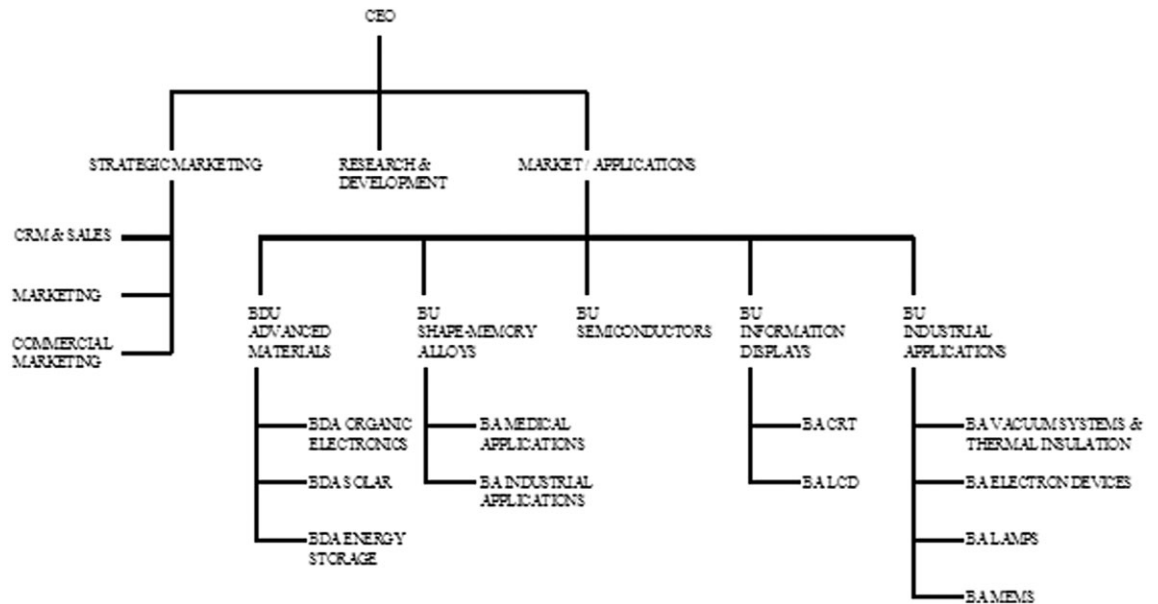
Figure 3. PHYSICA'S Innovation Organization

Three tactics were used to increase construct validity in this research. Firstly, triangulation of the data is achieved by the use of multiple sources of evidence. These sources included case study research protocols, documents collected during the interviews, multiple interviewees during each session and the use of workshops involving multiple participants. Secondly, a chain of evidence is established that involves all the collected data being systematically documented and stored with appropriate references. Finally, all collected data are presented back to the respondents for confirmation and all case study reports are reviewed by key informants. This allows any inconsistencies or ambiguities to be detected thus increasing the construct validity of the research.

Case Setting

PHYSICA is a high-tech Italian company, located in Lainate (Mailand district), which was selected through purposive sampling. The firm was established 62 years ago and has now grown to serve a global market with average revenues of €154.2 million annually (2004–2008 period). PHYSICA specializes in the development of getter technology and operates in sectors including information displays and lighting, complex high-vacuum systems and vacuum thermal insulation, drawing on technologies ranging from large vacuum power tubes to miniaturized devices such as microelectronic and micro-mechanical systems. The Group also leads the market in

the ultra-pure gas purification systems for the semiconductor industry and other high-technology industries. More recently, PHYSICA entered the medical business through a variety of products based on shape-memory alloys and particularly on NiTiNOL.

Overall Organization

The Group Headquarters are located in Lainate, and it is here that the management, the corporate R&D laboratories, the corporate functions and the technical support functions are located. The group's organizational structure consists of four business units (BU) and one business development unit (BDU). Each of these BUs contains several business areas (BA) and business development areas (BDA) (Figure 3). The BAs and the BDAs, underlying the unit structure, focus on specific market segments and applications.

R&D Organization

For PHYSICA's scientists, innovation is a mind-set. They are challenged by customers' requests (real market innovators), and are supported by a management policy that every year allocates approximately 10 per cent of the sales revenues to research and development activities. PHYSICA R&D is located mainly in Lainate. Corporate laboratories cover an area of 3,300 m², where over 60 people are daily committed to investigating problems, developing proposals and testing solutions using highly advanced instrumentation and math-
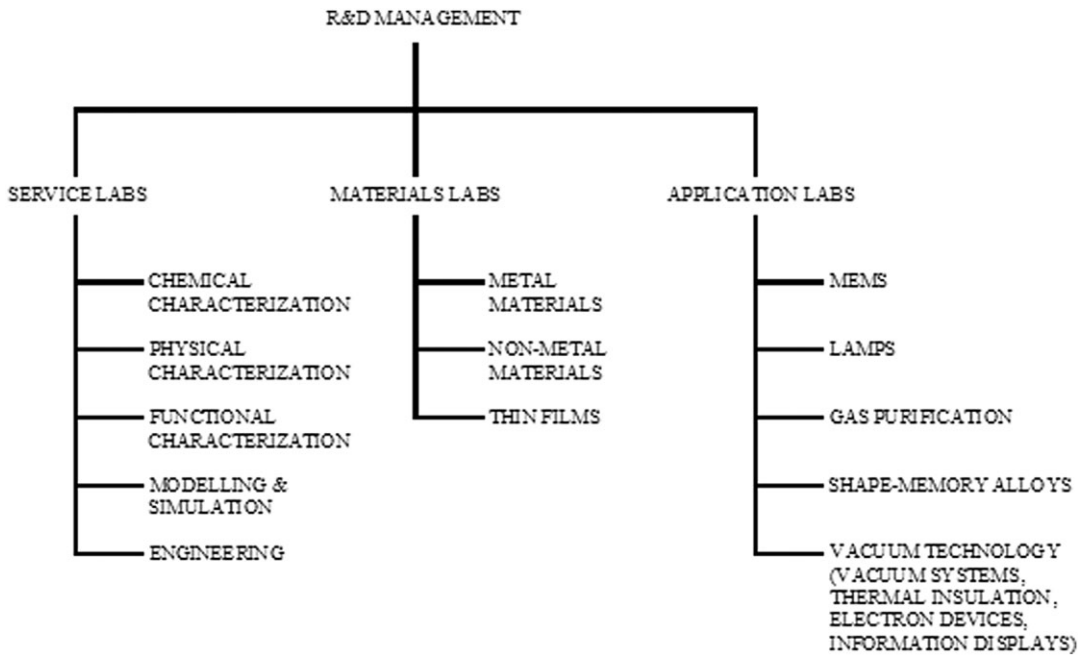
Figure 4. PHYSICA'S Corporate R&D Organization

emathical modelling. At present, R&D in Lainate is made up of three different areas: the 'Application Labs', the 'Service Labs' and the 'Material Labs' (Figure 4).

The *Application Labs* are laboratories that develop prospective products and prototypes, according to specific application needs, working in close co-operation with customers, PHYSICA business managers and manufacturing sites. The Application Lab Manager should therefore be able to understand both the commercial and the technological dimensions of the products. He is in charge of developing and finely tuning products' required functional properties.

The *Service Labs* are transverse laboratories that support other R&D laboratories, manufacturing sites, BAs and BDAs, while interacting directly with customers. They gather the knowledge required for the different application needs, and deal with the chemical, physical and functional characterization of materials and products, with modelling and simulation and with technological and engineering problems.

The *Materials Labs* are responsible for the development of knowledge-intensive materials. There are three main laboratories within this group. The oldest laboratory deals with the development of metallic materials. A second laboratory gathers multiple complementary knowledge on non-metallic materials. Finally, a third laboratory is dedicated to the

development of metal thin-films of different nature.

Findings

It is clear from the PHYSICA management that in such a competitive world, the organization should succeed both in supporting customers' cutting-edge applications and in developing highly innovative solutions, by competing in mature and emerging businesses as well as technologies. All this means realizing a continuous interplay between exploratory and exploitative activities in order to guarantee the firm competitive strength both in the short and in the long term. PHYSICA's business strategy does require uniformly tiling the time axis with NPD projects, through long-term research efforts as well as through short- to mid-term exploitation of core and growing technologies.

The findings are reported below following the research framework: firstly, the static dimension is analysed in terms of key organizational roles, search practices and managerial level; secondly the combined view is explored.

The Static View: Key Organizational Roles and Practices for Search

In PHYSICA, the search phase of the innovation process involves several professional roles

with different but interrelated tasks. In fact, searching is a widespread activity that involves actors, with specific tasks to accomplish, in the manufacturing sites as well as in Lainate. These organizational roles implement different searching practices in order to find ideas to improve the existing products, or to create new ones as well as improve and/or create new markets.

As specified above, the static view (Figure 1a) analyses the structures, organizational context and TMT as elements that might facilitate OA, in terms of exploitation and exploration both in the market and on the technological side. Findings are reported below according to this framework, starting from the exploitation process (the solid outline boxes in Figure 2) and then moving to the exploration one (the dashed outline boxes).

Market Exploitation

The exploitation of knowledge related to existing markets is realized through a constant monitoring of the customers and the evolution of their application requirements. It is primarily carried out within the different BUs, involving professional figures strongly connected to each other.

The different units are managed by the business unit managers (BUMs) who are responsible for the definition of strategies and commercial policies, with the aim of ensuring that the sale forecasts are met within defined budgets. Directly under the BUMs, in different geographical competence areas, are the sales managers, who co-ordinate teams of salespeople responsible for ensuring the firm's constant contact with the client. The main task of the sales staff is to propose to customers' existing products that respond to known application needs. Direct contact with the customers through the sales staff allows a continuous monitoring of the market and of the customers' expectations, thus generating knowledge about their eventual changes. Furthermore, the sales staff, through the interaction with the sales managers, ensure a continuous information flow to the BUMs on possible customer problems and needs.

When information about new customer application requirements reaches the BUM, other BUM collaborators come into play, the so-called business managers (BMs), who in PHYSICA typically have a technical background. BMs visit the client to examine the issues regarding application requirements more deeply. The BMs' technical competencies allow them to understand customer needs and to suitably transfer them to the R&D function, typically to the specific Application Lab

Manager. Should it prove necessary to intervene with significant scientific/technological developments, the BM when visiting the client is accompanied, by an R&D researcher, selected each time in accordance with the necessary skills.

Further tasks of the BMs consist in the identification of new clients inside the markets covered by the firm (prospective customers) and in the interface and in the active dialogue with those clients considered of strategic importance by the firm. To do this, they participate actively in sector trade shows which are useful to build connections with competitors, suppliers, customers and individuals who have an interest in specific types of products and technologies. They also search through the internet and maintain and establish contacts with existing and potential customers, both through direct meetings or through the company's website. BMs are therefore transversal figures, able to converse both with the commercial areas and the technological ones. BUMs, in addition to the BMs, also interface with commercial marketing actors who are entrusted with carrying out marketing studies in order to anticipate future market trends.

Technology Exploitation

From the point of view of the operational processes, all the information picked up by the BM and the researcher during their meetings with the client is collected in a document, called a Visit Report, which is distributed to a group of interested people – typically the R&D managers, the heads of the specific Application Labs, the BUMs, the people in charge of the manufacturing sites, the CEO and possible other professional figures, if required.

Exploitation is also realized in the technological side, mainly involving the manufacturing sites and R&D. Over the years, PHYSICA has developed a wide spectrum of distinctive competencies that allow the realization of continuous technological innovation. To keep alive the core technology potentialities, it is necessary to constantly update, improve and maintain them, in order to prevent technology obsolescence. To guarantee the continuity of such activity, professional figures in charge of 'technological development' have, therefore, been defined. Technological development is carried out both within the manufacturing sites and within the R&D unit in Lainate. In the first case, technological exploitation is realized thanks to the work of technicians and specialized engineers who deal with the continuous improvement of existing manufacturing technologies by talking to technology suppliers, by

Table 4. Market and Technology Exploitation

Tension	Roles	Practices	Managerial level
Market exploitation	• BU managers • Sales managers (hierarchically dependent on BU managers) • Sales staff • BMs (with technical background) with transversal role	• Continuous market monitoring through direct relationships with customers by sales function • Bottom-up information flow to BU managers • Involvement of the other BU managers when a new requirement emerged from customers • Transversal information flow from BMs to R&D • Knowledge codification, and sharing to the operational and managerial level • Tight collaboration between BMs and R&D researchers • Connection building and improvement with prospective customers, suppliers, competitors by BMs	• BU managers report directly to CEO • BU managers–marketing interface • CEO, R&D manager, BU managers are all involved in the visit report
Technology exploitation	Technological development into two separated structures: • manufacturing sites (technicians and engineers) • R&D (researchers)	• Continuous knowledge updating by technicians from many sources • Great knowledge sharing within R&D lab researchers	• R&D manager reports directly to CEO

participating in sector trade shows and by continuously updating their knowledge via articles and scientific documentation.

In the Lainate laboratories, on the other hand, there are 60 researchers located in the materials, service and application labs ready to deal with technological exploitation. Continuous contacts with technology suppliers, participation in sector trade shows, fairs and congresses together with consultation of scientific documentation are practices largely used by these researchers too. Thanks to the opportunities of knowledge exchange and confrontation among researchers with different competencies, in Lainate the activity of technological development is more effective than that realized in the manufacturing sites.

Table 4 summarizes the main findings for exploitation.

Market Exploration

While the BMs and the sales managers are mainly involved with the monitoring of existing markets, another figure, the business development manager (BDM) is in charge of business development and the identification of potential new markets by gathering knowledge about them. This role is assisted by different collaborators, the business developers (BDs), who participate in trade shows and read market studies and 'road maps' for technology development, made available for instance by the European Commission (EC), by the US Department of Energy (DOE), and the Japanese New Energy and Industrial Technology Development Organization (NEDO). Even if the business development function is institutionally entrusted with exploring new markets, and, in particular, with collecting application demands that can already be satisfied by the functional properties of existing products, this function has often involved interest in themes of technology development, and it has often included close collaboration with the R&D unit or even direct direction from the R&D unit. This ambivalence has brought about some difficulties in jointly conducting technology and market exploration typically resulting in an excessive focus on the former. The risk is to have a vast set of technologies with elevated but rather heterogeneous potentialities, barely integrable and barely sustainable. PHYSICA's top management is therefore currently redefining the BD tasks, focusing their activity on the identification of new business opportunities that can substantially be acheieved through the exploitation of existing technologies. This complements the activity developed by the BUMs, who operate inside consolidated markets. The BD function will keep on garrisoning specific areas of interest, with particular reference to those indicated in Figure 2, by employing push/pull approaches. Specific initiatives of discontinuous innovation for long-term development, undertaken through technology-push approaches in their starting phase, will be carried out under the direct responsibility of the R&D function.

Technology Exploration

The contact with clients is undoubtedly a source of innovative ideas, not only at the market level but also at the technology level, because new application demands can require completely new technological knowledge, therefore representing an input to the technology exploration.

In the R&D function, due to their own personal qualities, researchers represent a community devoted to generating completely new technological knowledge (in addition to constantly improving what already exists). Each researcher is called upon to contribute to technology development and innovation in order to produce systems that can be translated into products. The R&D manager, together with each researcher, constantly seeks new technologies able to respond to the merging application demands. They also evaluate how such technologies can be integrated with existing and well-known ones. Their roles are crucial in ensuring a medium- and long-term view, suggesting, for example, alternative future scenarios, particularly those which do not necessarily follow the current technological trajectory. They act as brokers by continuously capturing knowledge on technologies identified outside the firm, by participating at events and conferences even outside their current realms of experience. They thus foster the creation of an open and innovative climate, by promoting an open and collaborative research environment with, for example, universities, research centres and specialized agencies.

Table 5 summarizes the main findings for exploration.

The Dynamic View: Managerial and Operational Level Interplay

The previous analysis highlights two dimensions that cause tensions in the search phase:

– the local–distant tension, which concerns the proximity of the knowledge generated within the search phase;
– the tension between the two different natures of the sought-after knowledge (market and technology oriented).

It also identifies the practices and the different business figures whose roles are institutionally oriented to generate distant/local knowledge from technology or from the market (due to their personal qualities or to the actual role that they hold). At the same time, for that knowledge to be useful it is necessary to integrate it.

The knowledge generated in each of the quadrants in Figure 2 is converged to organizational figures at managerial level, like the BDMs, BUMs and R&D manager. They periodically meet together, and with the CEO, in order to share the knowledge they received from the bottom (i.e., from the operational level) and verify that the expected results are reached. During these meetings some reports are compiled and successively made accessible to the whole organization.

In this intra-company dissemination process, an important role is played by the

Table 5. Market and Technology Exploration

Tension	Roles	Practices	Managerial level
Market exploration	• BD manager • BDs	• Monitoring by BDs (trade shows, tech road map, market studies)	• BD manager reports directly to CEO
Technology exploration	• R&D manager • Lab managers • Researchers • BD manager • BDs	• Brokering activity • Open innovation context • Intrapreneurship • Tech and market dev. by BDs (this practice causes problems on tech focus)	• R&D manager foster an open and collaborative climate • R&D manager reports directly to CEO • Business dev. role redefinition

knowledge management function, whose main task consists in keeping the firm knowledge asset updated and easily accessible by all the functions involved in development, research and innovation projects. The knowledge manager must ensure a continuous flow of knowledge inside the organization, storing what has been newly acquired, disseminating it and making it available according to the needs of each firm function. For this reason, the knowledge manager is a member of staff, who is in a suitable position to collaborate with all the firm's functions, using a variety of technological tools and organizational mechanisms. He is expected to facilitate co-ordination, to increase the speed of communication between the various functions and to widen the scope of the firm information network, thus fostering knowledge sharing.

The different tensions are solved at the operational level, choosing a structural organizational configuration, where different employees are devoted to searching for a specific type of knowledge. Integration activities are then needed in order to convey and find synergies between all the search results. Top managers play this role, as they have established some organizational mechanisms devoted to integrate the different pieces of knowledge. Managers are then configured as contextual roles because, on the one hand, they intertwine in the specific searching activities and, on the other, they integrate all the generated knowledge. Consequently, knowledge differentiation and integration is the third tension, which is solved in PHYSICA by adopting a multi-level interplay between operational and managerial roles (Figure 5).

With all this evidence from the case analysis, we can develop an interpretative model to explain the OA capability development process in PHYSICA. Our aim is to shed light on the process that leads to the OA capability emergence, analysing how the different antecedents (at the operational and managerial level) interact with each other.

We identified a top-down and bottom-up development process, which is composed of three main cyclical phases: plan, do and check (see Figure 6). Initially, top management senses the tensions that characterize search, such as the one to improve existing knowledge, or the one to concurrently try to generate completely new ones both in technological and market domains. In this phase, top management realizes that the creation and management of knowledge is a core premise for being competitive. This implies facing and resolving tensions between contrasting strengths. On the one hand, the firm should perform extremely well in the exploitation of its core knowledge as well as in the exploration of new possibilities, by finding a proper balance between the depth and breadth of its knowledge base. On the other hand, it has to pay great and balanced attention to both technological aspects and market issues. Such tensions appear as paradoxes because our respondents described their opposing poles as complementary.

Resolving tensions requires a clear configuration of resources, identification of specific capabilities within the firm and a well-developed knowledge strategy. This is why we called this preliminary phase a '*plan phase*'.

Organizational and managerial solutions are designed to manage these paradoxes: in our case, a structural ambidextrous design is chosen, defining the specific organizational
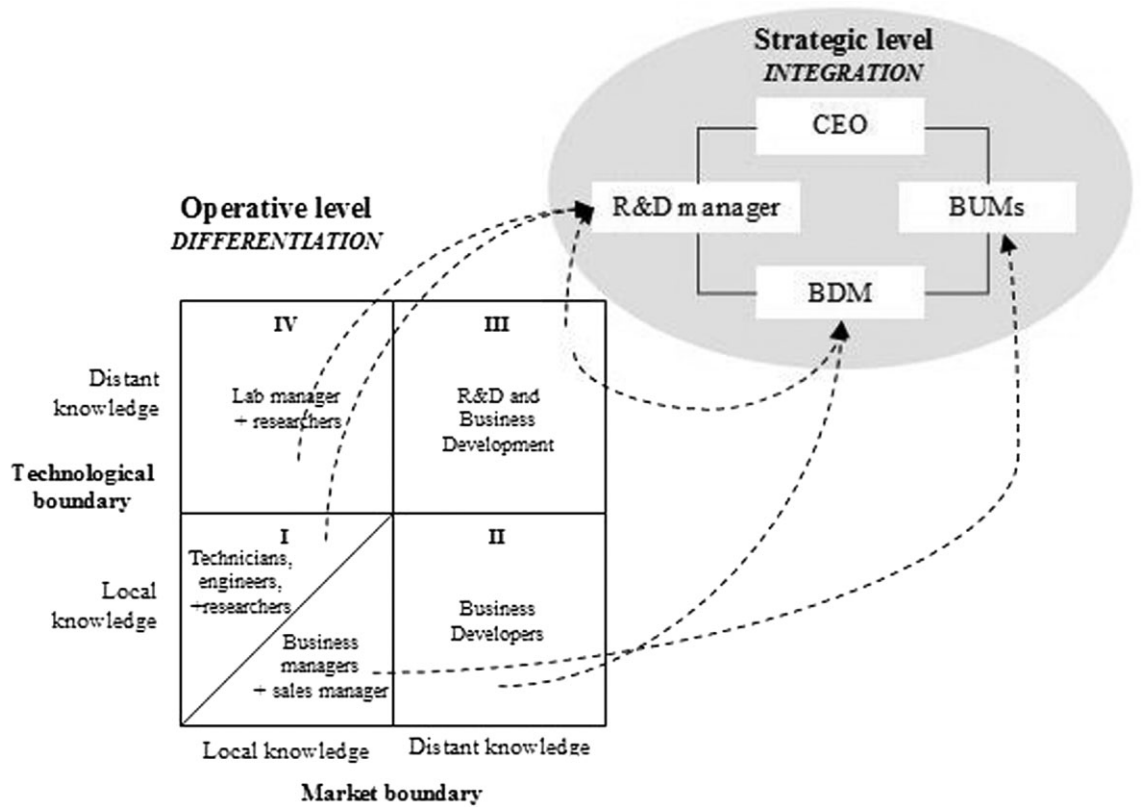
Figure 5. The Multi-level Interplay for Knowledge Differentiation and Integration
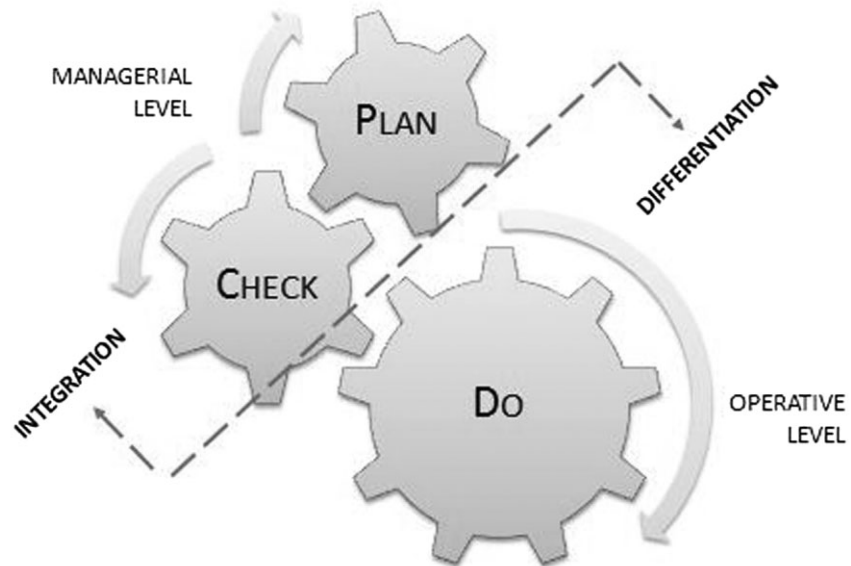

Figure 6. The Interpretative Multi-level Model for OA Development

roles and practices for generating knowledge in the search phase. Top management identifies a solution for managing paradoxes in the physical separation of both explora-tive/exploitative activities and market/technological topics, by creating organizational roles with specifically designed tasks.

According to the top management directives, at the operational level, different people, specialized in the exploration or exploitation of market or technology, are in charge of carrying out such practices (*do phase*). The exploitation of existing knowledge is in fact located mainly in the different manufacturing sites, while explorative search, aimed at identifying completely new and unfamiliar knowledge, is carried out mainly at Lainate. The same occurs for technology or market issues which are assigned to well-defined organizational roles.

Therefore, *differentiation* is perceived to be crucial. Clearly, focusing actions helps to maximize the different benefits of contrasting poles maintaining multiple competencies within the organization (Gilbert, 2005). This allows complex activities to be split up into small, more elementary tasks. In fact, people clearly know what their jobs are, who they must report to and how they should do their work. This is in accordance with the organizational literature that analyses in depth the differentiation process, highlighting benefits for organizations (Lawrence & Lorsch, 1967). Isolation allows subgroups to maintain genetic diversity and to explore a wider range of solutions amongst all the possible ones. At the same time, new genes can propagate throughout the whole system.

Within the 'do phase', employees carry out search practices to ensure high levels of both poles of the previously identified tensions. This phase is very important because without it firms may only become aware of tensions but will not be able to really overcome them and, therefore, benefit from them.

Even if differentiation focuses actions on each pole separately and ensures in-depth attention to both technological and marketing aspects, there is a problem attached to the combination and the integration of the different generated knowledge. Moreover, such structural differentiation poses a series of challenges in the knowledge transfer between exploratory and exploitative domains.

The 'do phase' generates a company's widespread and granular knowledge that must be combined and integrated in such a way that the whole system is co-ordinated and the organization's objectives are achieved. According to Lawrence and Lorsch (1967), in a subsequent stage, the firm adopts an integrated approach for the knowledge generated for the organization and management.

Integration is a necessary step. It refers to 'the process of achieving unity of effort among various subsystems in the accomplishment of the organization's tasks' (Lawrence & Lorsch, 1967, p. 4). This is done in what is called the 'check phase', where the knowledge generated is centralized, transferred and evaluated by an ambidextrous team. It is called the '*check phase*' because the acquired market and technological knowledge is first confronted with the expected results and subsequently merged at managerial level. The generated knowledge is therefore conveyed in organizational figures at managerial level, who periodically meet together, and with the CEO, in order to share the knowledge they hold. In other words, the structural separation between market and technology search activities (that are carried out respectively in the business areas and in the R&D function) requires the creation of a set of mechanisms to integrate the knowledge generated within these units. These meetings are an important occasion for integrating the whole knowledge generated across the organization. Integration is thus realized through a vertically imposed bureaucratic process that co-ordinates the efforts of many specialists within the organization, by reconciling the distinct objectives of organizational members, by 'matching differences' (Lorsch & Lawrence, 1969, p. 26) and by identifying synergies. This ensures the optimal and continuous control over the required balance between marketing and technological explorative and exploitative knowledge, pursuing its constant achievement.

If the balancing of exploration and exploitation both in market and technological issues is not met, the need may arise for a revision of organizational design, roles and searching practices. The cycle thus ends with the identification of possible corrections to be made in the organizational structure and in the tasks assigned, or with modifications to be carried out in the original business plan and their execution (*re-plan*).

Therefore ambidexterity capability in the search phase is the result of a process made up of three interconnected steps: a phase where managers with a double and paradoxical mindset recognize tensions and define the suitable practices to face these tensions, a phase where these practices are performed by employees, and a phase where these different pieces of knowledge are integrated and checked by the top management. These three steps cannot be characterized by a perfect sequential path, as they are continuously interacting with one another. In this process, managers have a paradoxical mindset, as they are able to recognize tensions, to choose right solutions, and to integrate the different generated knowledge. While searching at the operational level is carried out mainly through a structural separation of activities, at the managerial level the contextual solution seems to

prevail, due to the fact that managers not only must dispose of their time switching over between contrasting activities, but also they must find a way to synergize the results of the firm's many searching tasks. This suggests a different practical prescription for managers: to seek synergies in order to get integration may not be successful; instead they have to be prepared to switch between strategies.

The Multi-Level Approach and Management Literature

For a long time, innovation management theory has highlighted the differences between exploration and exploitation activities to the point where it has almost become an established truth that these two fundamental parts of business activities are opposed to each other and need to be handled separately. The main arguments supporting this position refer to resource shortage, to the effect of self-feeding, and to diversities of routines (Gupta, Smith & Shalley, 2006). With few exceptions, the literature has suggested that these activities require different strategies and organizational solutions, so they cannot be successfully combined within a single organization. This literature stream conceives management as the rational way of dealing with trade-offs between incommensurable alternatives. Following this particular view, managers have the possibility of choosing between different levels of alternatives that apparently cannot be simultaneously realized. As such, management consists of choosing among various possibilities to arrive at the optimal solution. However, a number of leading firms seem to be able to handle the tensions quite well, revealing good performance over time and therefore the trade-offs perspective has also been criticized.

Another stream of the management literature, which goes beyond the idea that there is a single optimal solution to a given problem, argues that management is about handling different dualities, tensions or paradoxes (Janssens & Steyaert, 1999; Lewis, 2000; Bledow et al., 2009; Smith, 2009). Managing with contradictions calls for 'a processual way of dealing with dualities – a way of managing that reflects a dynamic approach, one that keeps tension alive and is embedded in the complexity of the context and its relational interaction' (Janssens & Steyaert, 1999, p. 136). However, as noted by Magnusson and Martini (2008), most of the studies dealing with paradoxes merely identify them. There are only few examples of paradox operationalization and, in particular, little interest shown in how paradoxes can be dealt with in management practice. Examples of operationalization are

presented by Poole and van de Ven (1989), who suggested four different ways of dealing with paradoxes when building theories, and by Janssens and Steyaert (1999) who proposed six different strategies.

Referring to a framework for engaging innovation process tensions, the current literature presents the works by Bledow et al. (2009) and by Smith (2009), who also refer to works by other scholars such as Smith and Tushman (2005), O'Reilly and Tushman (2008) and Andriopoulos and Lewis (2009). Bledow et al. (2009) identify three managerial strategies to respond to innovation tensions, which are consistent with the four ways identified by Poole and van de Ven (1989): splitting the tensions across time or space (dichotomous strategy), living with tensions (Eastern dialectic strategy) and finding a synergy to integrate tensions (Western dialectic strategy). They proposed a dialectic approach to manage contradictions, based on thesis, antithesis and synthesis: the first two refer to the handling of innovation tensions, while the third one represents the way to resolve them. With respect to the three strategies above reported, the synthesis one in based on the synergies between the tensions (i.e. integration). The dialectic approach is based on the premise that managerial strategies have to resolve tensions. However, this is not the only possible way to act: tensions can be supported by management in order to coexist. Along these lines, Smith (2009) proposed a dynamic approach of managing contradictions that expands the dialectic approach of Bledow et al. (2009). Smith's model adds complexity to the managerial strategy: the dialectic approach is joined with the dichotomous approaches. 'This new process involves engaging both dichotomous approaches through differentiating, and dialectic approaches through integrating (Smith and Tushman, 2005)' (Smith, 2009, p. 339).

This differentiation and integration interplay to manage tensions can apply to different organization levels, where tensions are differentiated at the subunit level – operational – and integrated at management level (Smith & Tushman, 2005; O'Reilly & Tushman, 2008). In this line, Andriopoulos and Lewis (2009), who investigated product development teams, identify the same dialectic and dichotomous approaches at different levels. Gibson and Birkinshaw (2004) introduced an organizational context to foster discipline and trust, stretch and support.

The multi-level model we propose here has the same premise as the works by Smith (2009), Smith and Tushman (2005), Gibson and Birkinshaw (2004) and Andriopoulos and Lewis (2009). However, it also has some par-

ticularities: while the other contributions refer to the innovation tensions, our model is developed from a micro-level unit of analysis. This implies that tensions such as idea generation vs. implementation do not add complexity to the model as they are external to it, while tensions such as structured vs. flexible environments are analysed inside the search phase and not between early stages of the innovation process and the implementation stage. In other words, the choice of the search phase as our analysis micro-level unit purifies the model from those tensions which refer to the other phases of the innovation process.

In the special issue of *Organization Science* on ambidexterity, Raisch et al. (2009) suggested 'four closely interrelated "central tensions" that need to be addressed to enable further progress in research on ambidexterity' (Raisch et al., 2009, p. 685): differentiation vs. integration, individual vs. organizational level, static vs. dynamic, internal vs. external. The case study reported in this article addresses all these tensions as it provides evidence for the complementarities between differentiation and integration, for the manager's personal ambidexterity, for the dynamic component of OA and for the firm's ability to integrate its internal and external knowledge bases.

Conclusions

Despite significant work on the tension between exploration and exploitation activities and the need to resolve this tension for firms' survival, it is still not clearly understood how firms can achieve a lasting balance between the two. Even if most of the literature agrees in defining ambidexterity as a capability, there are still few studies that empirically deepen the construct, analysing how this capability could be achieved. Seeking to learn from an ambidextrous exemplar, we have focused on a firm case study which is a good example of how firms can succeed in resolving tensions and in developing ambidexterity capability within the search phase. In order to try to fill the gaps still present in the current literature, we have analysed how this capability emerges, by looking at OA static and combined views.

The findings demonstrate that ambidexterity is not simply rooted in an individual's ability to divide time between competing activities, as suggested by Gibson and Birkinshaw (2004), nor is it simply a matter of organizational structure (Tushman & O'Reilly, 1996; Gupta, Smith & Shalley, 2006), nor even is it only determined by the role of top managers (Jansen et al., 2008). The analysis of the internal structure of search practices shows

that architectural and contextual issues, as well as managerial responsibility, co-exist and are deeply linked in developing and sustaining ambidexterity. Moreover, the findings suggest that ambidexterity is achieved through a three-phase process, where both managerial and operational levels are involved. From this evidence, we developed an interpretative multi-level model, composed of three phases. The first phase is carried out at the operational level, creating the potential for ambidexterity by providing the ground and the principles to face search tensions. During this phase, issues regarding the organizational structure and the operational systems implemented to face tensions arise. In the second phase, these issues are translated by employees into operational procedures and executed. Finally, there is a check phase where the top management is responsible for keeping and enhancing integration within the firm.

To sum up, in this article we have opened a new perspective for analysing ambidexterity, by using a more fine-grained unit of analysis – the search phase of the innovation process – and by adopting a combination of static and dynamic approaches. By using a qualitative explorative approach we have provided a first contribution to understand the inner process of ambidexterity capability building. In fact, even if from a theoretical point of view studies on OA agree in defining the construct as a capability, from an empirical point of view, only few studies analyse all the features and the processes that make the development of this capability possible. As for the nature of explorative study, the article sheds some light on the issue, but more studies are needed to analyse the topic in more depth.

Firstly, our study is limited to a high technology organization, that is, characterized by a business-to-business model, and to the search phase of the innovation process. As a consequence, our results cannot be extended beyond these contingencies and other studies can examine the topic adopting different perspectives. Secondly, in the previous sections we have stated that, in order to build and maintain the ambidexterity capability, managers adopt a dual mindset and prove capable of paradoxical thinking. This means that they must follow a contextual approach, switching their intervention from one pole of the tension to another and also integrating the different generated knowledge. However, it is not fully understood how they can develop such paradoxical thinking. Further studies are needed to analyse these aspects in more depth. To this end, we suggest studying ambidexterity by adopting an individual level of analysis. Thirdly, future studies should adopt a longitu-

dinal approach to investigate ambidexterity: only longitudinal designs are in fact able to better explain ambidexterity, when described as a dynamic capability.

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