Exploration of green technologies in SMEs: the role of ambidexterity, domain separation and commercialization

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Abstract: In ambidexterity, a central issue is the undesirable spillover of harmful routines and cognitive representations from core business to the exploratory innovation space. This paper examines a conventional manufacturing SME in a business-to-business market that developed renewable energy technologies in the scope of a new business unit, but has ultimately failed to innovate. The aim is to examine how the interface between the old and new business was managed over time. Using an in-depth longitudinal case study, we investigated innovation processes over time and identified three major sources for failure. First, several modes of separation can simultaneously coevolve within the firm, which increases management complexity. Second, an organizational separation drift from a textbook-like to a looser form of separation allows for undesirable spillover of routines cannibalizing the new business. A third cause for failure is the mismatch between the intended product-market strategy and the actual product-market exploration.

Keywords: new product development (NPD); product exploration; market exploration; renewable energy; sustainability; small and medium sized enterprise; case study

1 Introduction

In uncertain, volatile and rapidly evolving industries threatened by disruptive technology development, the balance between exploration and exploitation for long-term survival is particularly challenging and firms are increasingly required to simultaneously exploit and explore (O'Reilly and Tushman, 2008, Cesaroni *et al.*, 2005). Firms with this capability

are called ambidextrous organizations. A context which becomes more and more relevant for the research in ambidexterity is the increasingly changing societies and markets against the background of sustainable development. Though to varying degrees in various sectors, this leads to changing regulatory frameworks, business environments, market conditions and customer preferences, therefore gives reason to both pressures towards existing technology regimes and opportunities for entirely new technological spaces often referred to as green or sustainability-oriented innovation (e.g. Schiederig *et al.*, 2012).

In ambidexterity, a central issue is the undesirable spillover of harmful routines and cognitive representations from the core business to the explorative innovation space. For instance, contamination or leaks strongly compromise the emergence of path-breaking product or market innovations from the protected exploratory innovation space (Tripsas and Gavetti, 2000). There is important ambidexterity literature about large firms (Gupta *et al.*, 2006; Lavie *et al.*, 2010; O'Reilly and Tushman, 2013), which discusses four modes of balance between the old and new business (Lavie *et al.*, 2010). However, small and medium-sized enterprises (SME), who are just as threatened in the face of volatile markets as larger firms (Welsh and White, 1981), received comparatively little attention. What's more is that the management of the exploration and exploitation interface is still poorly understood and more in-depth research in this direction is needed (Lavie *et al.*, 2010; O'Reilly and Tushman, 2013).

Learning from a case of failed exploration, the paper aims to examine how the interface between the exploratory and exploitative business was mismanaged over time. The research strategy is to examine exploratory innovation processes and obstacles across value chain functions (research & development, production and sales & marketing), across various organizational levels (top-management, departments, individuals) as well as internal and external exploration (through alliances) in an in-depth longitudinal case study (Yin, 2014). Other ambidexterity scholars have used this method, including Adler *et al.* (1999), Tripsas and Gavetti (2000), Walrave *et al.* (2011).

The case examines an owner-managed manufacturing SME of about 200 employees operating as an international technology leader in a business-to-business market. As top-management realized that its main market was threatened, it decided to grow organically and, because the founders believed in sustainable development, searched for new applications for its core technology in the area of renewable energies. It initiated a successful explorative learning process that did, until now, not lead to a successful outcome.

The contributions to theory are threefold. First, the paper demonstrates that several modes of separation can simultaneously coexist and coevolve within the firm. The consequence is that the interface between the old and the new business can be relatively fluid, thus requiring important managerial efforts to separate old and new. Not only must top-management integrate the two with a strong competitive vision (Tushman *et al.*, 1997), it must also select and coach middle-level managers who adopt boundary-spanning roles (Tushman, 1977; Cohen and Levinthal, 1990). Hence, we hypothesize that the advantage of decentralized management of ambidexterity, even though it appears resource efficient at first sight (Lavie *et al.*, 2010), is off-set by the increase in managerial effort. Second, a drift from a "textbook-like" to a looser form of separation is observed over time allowing for gradual or sudden spillover of undesirable routines and cognitive representations to contaminate the exploratory innovation space (Tripsas and Gavetti, 2000). Finally, the paper reveals that the misfit between intended product-market strategy and the actual product-market exploration can be a major cause for failure. Management myopia (Levinthal and March, 1993) might induce that the form of ambidexterity chosen does not fit the intended product-market strategy.

The rest of this paper is structured as following: first the literature on exploration and exploitation is reviewed (section 2). Then, the methodology is introduced (section 3). The results are described in section 4 and analyzed along three core lines in section 5. The last section discusses the findings and concludes the paper.

2 Literature review

2.1 Exploration and exploitation

March (1991) set the stage for the ambidexterity discussion in his seminal work on exploration and exploitation. He posited that the ability to pursue innovation to secure immediate and long-term competitive advantage is a fundamental challenge for the survival of organizations.

Considering the important variety of interpretations, we concur with others (Lavie *et al.*, 2010; O'Reilly and Tushman, 2013) that March's original definition ought to be used. March (1991) defined *exploration* as learning and knowledge creation that involves search, variation, risk taking, experimentation, play, flexibility, discovery and innovation. From a technological perspective, exploration involves a shift to a different technological trajectory (Benner and Tushman, 2002). *Exploitation* on the other hand, relates refinement, production, efficiency, selection, implementation and execution (March, 1991). It involves improvement in the existing components and, most importantly, builds on existing technological trajectories (Benner and Tushman, 2002) and therefore exploitative innovation is aimed at improving the existing product-market domain (He and Wong 2004).

Table 1 Types and mechanisms of separation

Type of separation	*Level of analysis*	*Mechanism of separation*
Organizational	Organizational level	Activities occur simultaneously but are situated within distinct organizational units.
Temporal	Organizational level	Exploration and exploitation coexist in the same organization units but at different points in time; organizations switch between expiration and exportation.
Contextual	Individual and team level	Exploration and exploitation occur simultaneously in a given organizational unit
Domain	Organizational level	Exploration and exploitation occur in particular domains, while balancing these activities across domains.

Source: based on Lavie *et al.*, (2010)

Scholars argued that reducing the inherent tensions that appear within an organization that simultaneously explores and exploits falls on top-management (Tushman *et al.*, 1997).

The extant literature describes mechanisms to reduce this tension, which are captured in several typologies (Gupta *et al.*, 2006; Simsek *et al.*, 2009; Lavie *et al.*, 2010). We base ourselves on the typology proposed by Lavie *et al.* (2010) that includes organizational, temporal, contextual and domain separation (Table 1), which are approaches to create an infrastructure for the harmonious coexistence of conflicting organizational architectures. They serve as mechanisms to protect the exploratory innovation space from managerial myopia and inertia (Levinthal and March, 1993) and shield it from harmful routines, cognitive representations (Tripsas and Gavetti, 2000) that can prevent the heathy development of the new innovation trajectory (Tripsas, 2013). Being the key mode of separation - and maybe also the least understood - domain separation will be introduced more in depth.

2.2 Domain separation

Domain separation is a mode of balance in which firms carry out exploration and exploitation in distinct domains. A distinctive feature is that the balance is managed independently at each function but in congruence with the needs of the other functions. Its management, being decentralized, demands less proactive management attention and coordination efforts are reduced (Lavie *et al.*, 2009; Lavie *et al.*, 2010). Thus domain separation seems quite adapted to SMEs, who are typical concerned by resource constraints and limited management capacity.

Several domains are identified in the extent literature. At the intra-organizational level, the *value chain function domain* is discussed (Lavie and Rosenkopf, 2006; Li *et al.*, 2008). In this case, exploration and exploitation is balanced along the value chain. A typology of domain separation representing a continuum from less to more complex exploration was identified (Voss and Voss, 2013): a) product exploration and market exploitation (product ambidexterity), b) product exploitation and market exploration (market ambidexterity), and c) product and market exploration (pure exploration). This typology corresponds to Ansoff's (1957) matrix of product-market strategies based on a) product development, (b) market development, and (c) diversification, the latter being the most challenging.

At the inter-organizational level, a balance can be found in the *network structure* and the *partner attribute domain* (Lavie & Rosenkopf 2006). This means that alliances can be formed with existing (exploitation) or a new partners (exploration). Then, alliances can be formed with partners having different attributes (such as size or industry focus) than previous partners. The formation of alliances can be attributed to each value chain function or across functions. R&D alliances are typically used to reduce technology development costs, sales and marketing alliances to leverage market access, cross-functional alliance for both (Lavie and Rosenkopf, 2006).

2.3 Ambidexterity in SMEs

The literature features a rich discussion on the differences between small and large firms. In many ways small business are particular and are not just little big businesses (Welsh & White 1981). The most frequently discussed difference include: a) the amount of resources available, b) SMEs, unlike large enterprises, often compete in clusters where competitors are prone to price cutting, c) fewer resources are available to hire manager and qualified personnel, as the owner-manager salary represents a much large fraction of the revenues and d) external forces tend to have a more determining impact on SMEs (Welsh & White 1981). However, compared to their larger counterparts, SMEs have the advantage of

greater flexibility and can therefore react much faster to a changing technological, market and regulatory situation (Welsh and White, 1981).

In the innovation management literature, no innovatory advantage is unequivocally associated with neither large nor small firms (Schumpeter, 1934). In fact, the advantage of SMEs is mainly behavioral and the one of large firms material (Rothwell, 1989; Nooteboom, 1994).

In the ambidexterity literature, recent research indicates that resource availability (Sidhu *et al.*, 2004; Cao *et al.*, 2009) and firm size (Zhiang *et al.*, 2007) positively influence the performance of ambidextrous firms. These findings indicate that SMEs, who typically lack resources, are disadvantaged. However, in a survey of 139 SMEs, Lubatkin (2006) finds out that ambidexterity is also positively related to relative firm performance in the SME context. In a recent study, Voss and Voss (2013) analyzed the impact on revenue of product and market exploration strategies, showing that some forms ambidexterity are positively related to SME performance. Thus, the ambidexterity literature also considers that SMEs can possibly successfully pursue ambidexterity strategies.

2.4 Ambidexterity in the context of green innovations

Even though the number of management publications on eco or green innovations are strongly increasing (Schiederig *et al.*, 2012), to our knowledge, green innovations were not discussed in the ambidexterity literature yet. Green innovations include new products, services or business models and can be various, such as renewable energies. They share many similarities with conventional technical innovations, but differ in purpose, direction of search and complexity (Noci and Verganti, 1999; Paech, 2007; Bos-Brouwers, 2009). Indeed, on top of commercial success, green innovations embrace the explicit double-aim to improve the firm's sustainability performance and to contribute solving societal issues (Hansen *et al.*, 2009). To fulfil this purpose, firms need to search in a specific direction to make sure that the innovation outcome will eventually have a positive impact, which increases complexity and decrease the number of options (Fichter *et al.*, 2005).

Notwithstanding the significant managerial complexity, empirical investigation demonstrated that some SMEs are highly committed to the development of green innovations (Noci and Verganti, 1999). Depending how radical the innovation is, it might involve product exploration, market exploration or both. While incremental attempts to green innovation have been widely adopted in businesses (e.g. energy-efficient products), it is often called for more radical innovation – and thus exploration – for more significant contributions to environmental protection and sustainable development (Noci and Verganti, 1999). Therefore, the case of green innovation provides a rich empirical ground for the ambidexterity literature. Conversely, the ambidexterity literature might also fertilize the literature on green innovations.

2.5 Innovation process research

To examine how the interface between exploration and exportation was managed, we analyzed the innovation processes. To account for its complexity (Cooper, 1983), we relied on the fireworks innovation process model (Van de Ven, A. and Poole, 1990) that allowed us to study why and how innovations did or did not developed over time. More specifically, this model allowed to study setbacks, changes in the direction, fluid participation of personnel, involvement and role of top-management, evolution in the cognitive representations and routines over time.

3 Research method

3.1 Research design

The aim of the research is to examine how several forms of separation were operationalized and how the interface between the exploratory and exploitative business was managed over time. The paper thus adopts an explorative longitudinal single-case study approach considering a time period of 10 years (2003-2013). According to (Yin, 2014), single case-studies are adopted for research that require an in-depth examination of a contemporary topic. Other authors including Adler *et al.* (1999), Tripsas and Gavetti, (2000), Walrave *et al.* (2011) used this method. While the larger part of the time frame was subject to ex-post analysis, we were able to observe the last two years of the innovation process during its unfolding allowing us to collect first hand insights about the process.

3.2 Case selection

As indicated before, the case examines an owner-managed manufacturing SME in its second generation employing approximately 220 employees in Germany. The company is driven by a strong engineering culture, developing and producing technological components (Computerized Numerical Control system, high-speed motor and generator control devices) which they sell to customers (system integrators) in the context of business-to-business markets (in the remainder of the paper we will refer to it as "TechLtd"). Within their narrow niche, TechLtd has pursued market leadership on international scope while operating largely below the radar in the regional and national contexts, therefore representing typical characteristics of a "hidden champion" (Simon, 2009). TechLtd use its technological and engineering competencies to develop a component for the renewable energy technology (RET) market: an electricity inverter for small-wind turbines. The innovation received full top-management commitment and significant resources (about 3 million euros) but had eventually to be terminated because sales figures did not develop as expected.

The case study was chosen for being critical, revelatory and representative (Yin 2003, p.41): First, we followed theoretical sampling (Eisenhardt, 1989, p. 537) as the case can be considered *critical* regarding three criteria: (i) While most innovation studies are success stories and are therefore linked to the success bias, our case presents an example of a unsatisfactory and terminated innovation. (ii) As the case rules out two of the often conjured reasons of innovation failures (lacking top-management commitment and financial resources (Welsh and White, 1981) allows us to concentrate on the role of ambidexterity in general and domain separation in particular for explaining failure. (iii) Contrary to green technology or RET start-ups, the case of conventional firms who endeavor to develop such technologies by balancing exploration and exploitation are rarely discussed in the innovation management literature. Second, the case is also *revelatory* as it provided the research team full access to the innovation process both ex-post and during its unfolding. Last but not least, the case organization is also *representative* for other hidden champions amongst European SMEs in general and the German 'Mittelstand' in particular.

3.3 Data collection and analysis

The research relies on the triangulation of various qualitative data sources including semi-structured interviews, in-depth qualitative data through participatory observation and desk research (Babbie, 2013). Table 2 provides an overview of the case data. The participant-observation data was protocolled and the interview material fully transcribed according to

the methods described in (Babbie, 2013). The data was then coded and analyzed using software for qualitative analysis.

Table 2 Description of case data

	Internal: Top and middle management	*External: Business partners and value chain actors*	*Total*
Semi-structured interview	7 interviews	10 interviews	17
Participant observation	11 meetings, 5 workshops	2 industry conferences	18
Desk-research	25 internal documents (e.g. market studies, sales statistics, customer lists)	70 publicly available documents (e.g. industry reports, market analysis, newspaper and magazine articles and industry actors' website)	95

4 Descriptive results: phases of the innovation process

This section first introduces TechLtd and its context before taking a longitudinal perspective on the innovation process.

4.1 Case introduction and context

The manufacturing firm, TechLtd has grown in the past 50 years into a world leader in its niche market of control systems for high-speed engines. Its primary market is machine tools, within which it focuses on drilling applications, in particular for circuit-boards used in electronic devices. Production is located in Germany with sales offices in the USA, Europe and Asia. Its products are highly customized to the clients' needs. Product customization takes several months and is characterized by intensive collaboration between the internal R&D team and the client. As the clients typically equipped an inventory of 100-200 machine-tools at once, products were manufactured in small series. Given the product-market situation, the sales strategy was to target international niche players and to develop personal, long-standing relationships. Customization and trust were the keys to successful sales, which always happened at a technical level, product developers negotiated with engineers of the client.

TechLtd adopted a matrix organization (Figure 1) that structured the firm into three functional departments – Research & Development (R&D), Production and Sales & Marketing (S&M) – and three business units. The first business unit, which the company's foundation was actually built on, deals with Computerized Numerical Control (CNC) and has been largest one. The second, Drive Electronics was created 40 years ago as a spin-off of the first one and today represents about 20% of total sales. Instead of engine control systems, it sold control systems for high-speed generators and turbines. A third unit was created with the decision ten-fifteen years ago to explore new technological solutions for the RET market. The particularity of the matrix structure is the presence of a single production department that received orders from all business units.

Table 3 Activities, events, knowledge developed and lessons learnt along the innovation process

Domain	*Phase 1: Technological exploration* (2003-2005)	*Phase 2: Product development* (2006-2008)	*Phase 3: Market introduction* (2009-2012)	*Phase 4: Reconsideration and termination* (2013
Top-management	• Strategic planning • Hire new R&D head and engineers for R&D exploration	• Support small-wind project • End of broader R&D exploration: refocus on specific small wind project only	• Pull alarm signal • Order new market research and increase S&M resources	• Reallocate R&D resources • Started final attempt and maintained S&M resources because main competitor stepped out of market, • Project Termination
R&D	• R&D networking, new projects with university and industry partners, e.g.: - Air flow system - Fuel cell inverter - Induction system - Feed-in technology • Decision: develop small wind inverter. • New partnership with start-up WindUp (with whom the product will be developed): including preliminary product design.	• Product development/design: - Intense collaboration with WindUp - Build prototypes - Test product - Improve product with three lead-users	• Product improvement: - New versions and updates, - cooperation with lead users, - Trouble-shooting of poor quality turbines.	–
S&M	–	• WindUp: market analysis for product design. • Cold client acquisition: - Strategy: high-quality, customized inverter to increase turbine efficiency - Outcome: many purchase intentions.	• With WindUp: client acquisition Europe and USA • New market research, focus: Spain, Portugal, Scotland, etc. • Response to bad signal: more internal sales efforts at TechLtd	• Last intensive sales efforts targeting former market leader's clients

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Domain	*Phase 1: Technological exploration*	*Phase 2: Product development*	*Phase 3: Market introduction*	*Phase 4: Reconsideration and termination*
	(2003-2005)	(2006-2008)	(2009-2012)	(2013
Lessons learned and knowledge developed	• R&D networking (to leverage others' assets) • Developed know-how for feed-in (and built and inverter) • Pure engineering consultancy turns production facility into cost center (no option for future) • To avoid idle production facility, need to target niche markets that fits existing organizational structure. Consequence: decide on small-wind because: 1) leverage WindUp's market access 2) project fits S&M organizational structure.	—	• Negative market signals: product did not fitting the market. • Many manufacturers are unprofessional and provided wrong sales figures. • Market is segmented: small and big manufacturers need different inverters. • Inverter market evolved more rapidly than expected: competitors' product improved and prices fall. • Partner WindUp had good market access but little sales experience. Consequence: Explored new international markets	

The longitudinal innovation process from its inception in January 2003 to its termination in September 2013 will be presented next by structuring it into four major phases (an overview is given both in Table 3 and

Figure **2**).

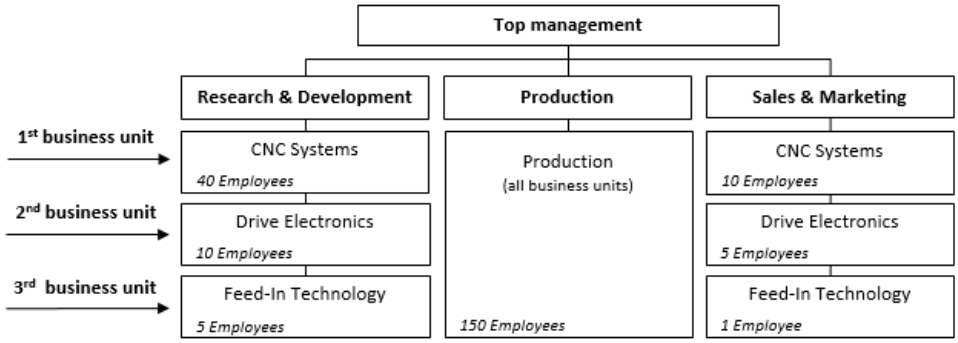

Figure 1 Organizational chart of TechLtd after market introduction, (phase 3, 2009)

4.2 Phase 1: Technological exploration

In 2003, the top-management of TechLtd hired an external engineer as head of R&D of the newly created business unit in order to lead the exploration of new (RET) applications. Under his lead, several options related to the feed-in of green electricity into the grid were explored. Among those projects, there was a collaboration with technical university that served to develop the technological basis of the new business unit: the electricity inverter.

In the context of this collaboration, TechLtd met a start-up named WindUp (pseudonym) who had promising engineering projects in the area of renewable energies. WindUp mastered technologies related to wind power and had access to the small-wind market, but lacked the production and commercial capabilities. Given this complementary expertise, TechLtd saw the opportunity to work with a young, dynamic engineering-minded start-up and began to explore ways to leverage their assets. As the start-up hesitated between the development of a battery and a small-wind turbine control system, TechLtd pushed for the latter as it hoped to develop an application closer to its core competencies of controlling high speed rotation (in this sense, the control of a small wind turbines is similar to that of high-speed generators). What's more is that the size of the small-wind niche market fitted TechLtd's production facility.

At that time, the small-wind market was at a very early stage, particularly in Germany. However, even though developments had been slow, industry associations and related actors predicted encouraging double-digit growth figures and many experts foresaw the same growth patterns as in the solar and "big-wind" industry, twenty years ago. This assessment is not surprising given the overall positive outlook for renewable energies with very strong policy support in Germany during 2004 and 2008 making Germany one of the world's most important renewable energy market (particularly the electricity feed in law "EEG"; see e.g. (Luethi, 2010). Small turbines were typically sized between 0.5 and 15 kW output power, which is small compared with the 1-8 MW of big-wind turbines. To WindUp's knowledge, no satisfying inverter existed for small wind turbines. The ones used in the market were originally developed for photovoltaic applications, and therefore undermined wind turbine performance and refrained market development.

Considering the good fit with its production capacity, TechLtd signed a collaboration agreement with WindUp to develop and commercialize an electricity inverter for small-wind turbines. The R&D was to be shared between the two firms, however to leverage each other's assets: TechLtd would produce and WindUp market the product.

4.3 Phase 2: Product development

WindUp first carried out preliminary market research that showed positive market signals and a favorable competitive situation. An intensive R&D collaboration followed between the two firms, product development reached full speed and seven engineers were occupied. Following the principles of the lead-user method, the new product was adjusted to the needs of three turbine manufacturers that appeared to be typical for the industry. Later, TechLtd mandated WindUp to carry out a second market analysis that focused on the different national electricity feed in norms and regulations, which outcomes marked an important milestone in product development as they determined the final product design.

By 2008, top-management, motivated by resource parsimony, decided to end all but one exploratory projects in the feed-in business unit and focused their efforts on the small-wind project. The business unit's head of R&D left the firm and top-management subsequently searched for an engineer who would dedicate his work on product development and design. The position was staffed internally. Several months later, a second internal engineer was allocated to the unit and from there on, the management was split between the two engineers, one for the R&D, a senior product developer, the other for S&M. From there on it was more strenuously integrated into the matrix organization, with two dedicated and independently managed department (R&D and S&M) as shown in Figure 1, unlike before, when one manager was in charge of the entire business unit.

Now that a proper S&M department existed, the sales strategy was defined. Even though WindUp actually did the largest part of the sales (60% of client acquisition), TechLtd dictated the strategy based on its sales approaches in the other two (core) business units: the largest clients were contacted in each national market. The called acquisitions were mostly done through direct contact and meetings at trade fairs. The main sales argument was high customization and engineering excellence; the excellent inverter which increase the efficiency of the turbine, thus making it more attractive to the final user.

4.4 Phase 3: Market introduction

TechLtd entered pre-production. After market introduction, sales gently took off but remained rather low. Some (wind turbine) end-users began to complain about the low yields of their installation and incriminated both inverter and turbine manufacturers. TechLtd's engineers analyzed the problem, discovered important weaknesses in the turbines and increased collaboration with manufacturers (their direct customers) to solve the problems discovered by the end-users. It turned out that they were better equipped to do so in comparison to the turbine manufacturers, as of their extensive technical knowledge. To compensate for the poor quality, extra features were developed, thus shifting parts of turbine management to the inverter. In increasing efforts to tackle turbine manufacturer's engineering problems, TechLtd hoped to increase sales figures, improve client relationship and secure competitive advantage.

Table 4 Comparison old and new markets

Market criteria	*Old market (CNC Systems)*	*New market (Feed-In Technology for small-wind turbines)*
Maturity	High	Low
Volatility	Low	High
Customization	High (made-to-order)	Low
Size	20-30 international buyers	300 very diverse international buyers
State intervention	None	High (multiple regulatory environments increase complexity)

However, sales figures were not increasing as expected. WindUp, who had the overall overview of the market, was the first to realize that the market was more complex than initially estimated (see Table 3). First, given the early and immature state of the turbine market, it was more segmented than originally expected: large professional and small artisanal firms (some of them lead users) coexisted in the market and expressed very different needs. By increasing customer-specific development efforts, TechLtd inadvertently reoriented its product towards the need of the artisanal segment. Second, the inverter market evolved more rapidly than expected. The competitors largely improved their design, launched ad-hoc small wind inverters that partially copied TechLtd's design features and, driven by the competitors' success in and economies of scale from the solar branch, drastically reduced prices. The product design choices made earlier, being largely based on national norms and regulations, did not sufficiently consider market aspects. The decision to increase customization further drastically narrowed down (to approximately only 40%) the (already small) market segment that could be served.

In reaction, top-management ordered further mark market research to explore other international markets and further strengthened its own sales team to increase client acquisition capacity.

4.5 Phase 4: Reconsideration and termination

The additional sales efforts did not translated into increased sales figures and therefore top-management decided to stop production and reallocate R&D resources to other projects. Several dozen inverters still waiting on the shelves for sales, only the salesperson continued his work.

About half a year after the production end, the largest competitor abandoned the small-wind inverter market. TechLtd interpreted this as a positive market signal and decided to redouble sales efforts to test market reaction. The clients of the former competitor were systematically contacted. The most promising one rejected their offer, because TechLtd's product was similar to one of their competitors but offered less functions for the double of the price.

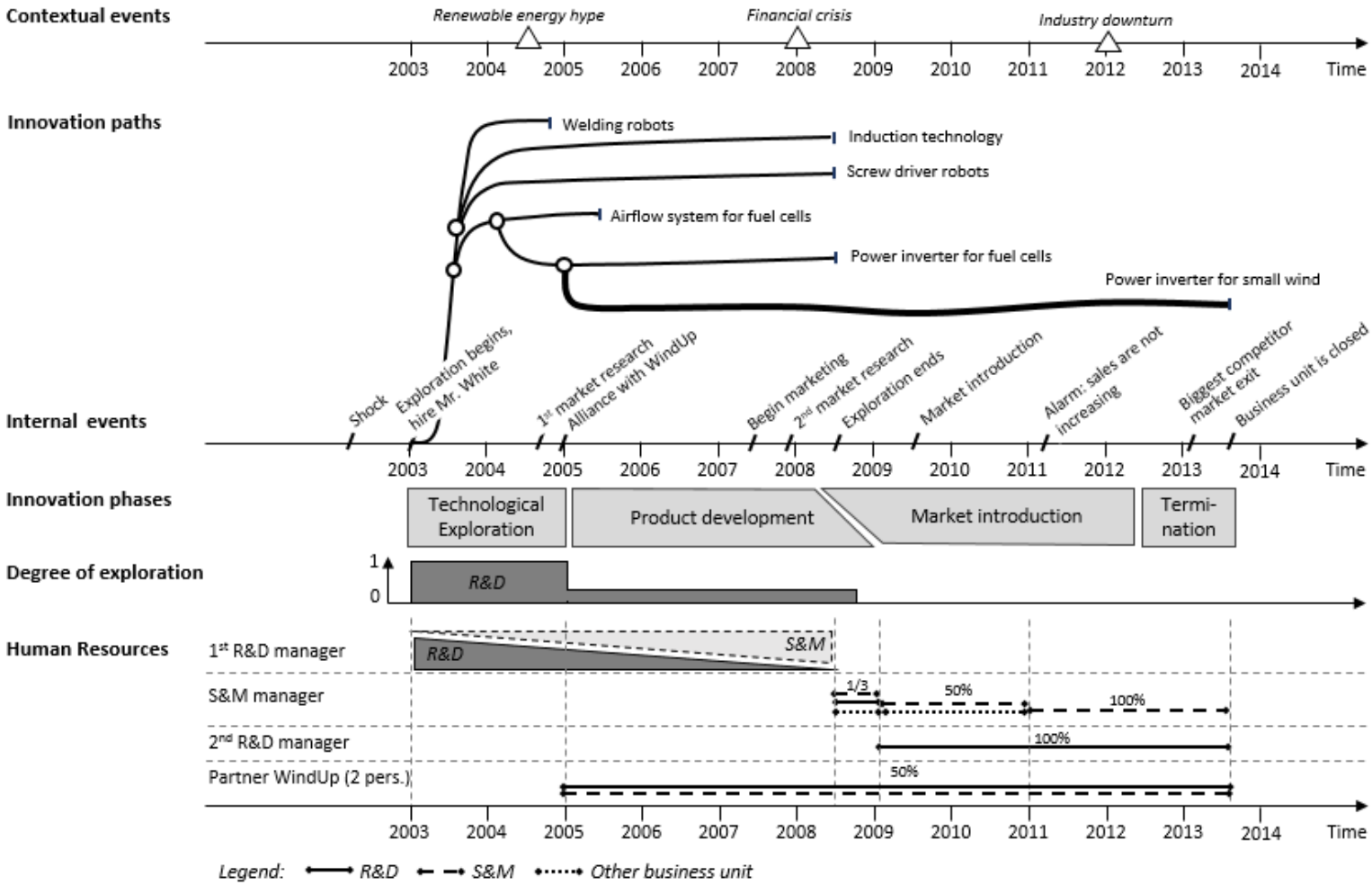

Figure 2 Visualization of the innovation process over time based on contextual events, innovation paths, internal events, innovation phases, degree of exploration and human resource involvement.

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While the small wind journey came to an end, new small scale exploratory investigations were initialized by the top-management as an attempt to utilize the generic parts of their product design as well as their gained knowledge in energy-related markets. They sought related energy-efficiency markets in need for competencies of controlling high speed rotation, such as fluid flow machines (e.g. used in combined heat and power plants) and flywheel energy storage (kinetic energy storage based on a rotating mass). Hence, though the focal innovation failed, at the same time, knowledge and competencies gained during the failed project is just another input to subsequent exploration – which, however, is not further considered in this paper.

5 Analysis

5.1 Organizational separation drift

Organizational separation in the R&D function

In the phase of technological exploration (phase 1), TechLtd established the new inverter R&D unit which effectively followed an exploratory pathway with a clear organizational boundary towards the more established R&D units, at least in the first phase:

First, in terms of staffing, an externally acquired engineer was appointed head of the exploratory R&D unit who then acted as a gatekeeper between the old and the new business. He brought knowledge about renewable energies and related industry contacts into the innovation project. He also adopted a new management style that was based on the integrated profile of product management (for instance, he thought of product development from idea generation to commercialization) rather than functional specialization, which represented a new routine in the firm. Further, he strongly relied on open innovation and networking for the R&D exploration: he gathered available competences in-house, initiated knowledge generating and asset leveraging alliances, and coordinated the work of his staff.

Second, this staffing policy also led to several exploratory R&D alliances (also see Table 3 in previous chapter) that were new to the firm. In the alliance with WindUp, the firm developed for the first time an entire product in a strategic alliance; earlier collaborations were intended to customize existing products to clients' needs. However, this high degree of exploration in the inter-organizational domain dropped after top-management intervention and the departure of the R&D manager.

Third, in terms of cognitive representation, the way of doing business in the established business was to "pack" engineering knowledge into a product via design and manufacture it in-house in order to avoid that that knowledge could be copied or stolen. In contrast, the new R&D manager explored new ways of selling knowledge, in particularly through

consultancy services (Table 3). This shows the protection of the innovation space was effective and that exploration was possible. The team later returned to the old way of selling knowledge, but only because they realized that consultancy services did not match the business model, as it would leave the production facility idle and turn into a cost center.

Overtime throughout phases 2 to 4, the organizational boundary between old and new business became porous and a drift from a textbook-like organizational separation to a looser form was observed. Indeed, the SME's R&D exploration process was very polarized: after a time period of openness and relatively large resource spending for exploring new technological and market opportunities in a separate organizational unit with new (external) managers and R&D partners, due to resource constraints they suddenly and radically narrowed down and restructured this to become much more exploitation focused. In other words, after a phase of exploring various quite different technological opportunities, they (too) quickly narrowed down the technological pathways to a single one and (too) quickly specified product design – which later turned out to fit only to selected segments of an overall small market. Several factors support this drift.

The quality of the organizational boundary eroded when the R&D unit manager was replaced several times by internal managers, who managed the unit like the core business. Indeed, original R&D manager had adopted a holistic project management approach and, even though he was formally only in charge of product development, also worked on the S&M (

Figure **2**). This drift is also captured in the organizational structure. When S&M unit management was split into two functions (one for product design and the other for S&M), the exploratory business unit became more strenuously integrated into the matrix organization. What's more is that, as already explained, the new managers also had long-standing core business experience and shared responsibilities between the old and new business. The fact that he was not briefed on the dual (ambidexterity) demands of his new job further contributed to weaken the boundary.

This drift is also observed in the evolution of knowledge development over time (Table 3). In the first phase, new R&D knowledge (such as how to make an inverter) and S&M knowledge (for instance, on their revenue model) was developed. The latter phases did not show any significant R&D knowledge development. Finally, the drift is also visible in the R&D networking activities (Table 3). While the initial phase was characterized by intensive networking, besides product development with customers, no new alliances were established in the latter phases. In fact, close collaboration with customers is a sign for exploitation, as it is a core business routine.

These factors support that an organizational separation drift occurred that prevented the innovation to reach maturity and compromised its commercial success. This is different from temporal separation as the integration of the new innovation in the existing business happened too early and in an uncontrolled manner.

Inter-organizational separation and contextual ambidexterity in the S&M functions

With regard to the *S&M* department, the case is more complex. While the organizational chart of TechLtd pretends some form of organizational separation (individual S&M units for old and new business units), this was not the case. To some extent, an inter-organizational separation existed during technology exploration in phase 1. At TechLtd's S&M department, initially no formal responsibilities existed for the new exploratory unit and marketing planning was *de facto* under the responsibility of the R&D manager who also interpreted his position as including S&M exploration and marketing planning.

Important parts of the sales responsibilities – particularly customer acquisition – were taken over by the alliance partner WindUp. However, though the alliance partner suggested an individual S&M approach diverting from existing experiences of TechLtd, the sales strategy was ultimately specified by TechLtd using their experiences from established business units – therefore, seriously limiting the potentials of (inter-)organizational separation and ultimately exploration. At the end of phase 1, one sales person at TechLtd was appointed part-time for the collaborative sales approach with the alliance partner, though while maintaining sales responsibilities for the old business – representing a form of contextual ambidexterity.

Overall, the interface between old and new was not managed effectively in this function domain, which translates into a low level of (S&M) exploration. Following phase 1, when the R&D manager left, the position was re-staffed several times with in-house engineers who gained their experience in the core business (during more than 10 years) and worked only part-time in the new business unit (as illustrated in

Figure **2**). This structural situation allowed for the spillover of at least two cognitive representations and routines, which illustrate the unsuccessful separation.

The first cognitive frame that permeated is understanding of how business-to-business markets function. As discussed, the old and new markets were significantly different (Table 4) and the old strategy – based on long-term, personal, trustful relationships – matched the need of the mature core business market. Thus the old sales department was structured accordingly: a handful of senior engineers took care of the sales and maintained the trust with clients. Assuming that the small-wind market would function in a similar way, the same sales approach was replicated, even though the new market – young, volatile and rapidly evolving – was significantly different from the old.

The second cognitive representation that permeated is the belief that business-to-business is synonym with made-to-order and high customer-specific development and design. When the first end-users complained about the low yields of the wind turbines and TechLtd realized that the turbine manufacturers lacked technical know-how, the R&D team began to enhancing the inverter with an additional functions to compensate for the poor turbine quality, thus increasing product design specificity. Doing so, the product became less attractive to other customer segments, which did not experience these issues and were thus not interested in the additional functions. Because customer-specific development was seen as a central for success, the routine of customization products was also applied to the new business, even though this eventually drastically narrowed down the already small market segment.

These spillovers are even more curious, as the market was virtually unknown to TechLtd, that the partner WindUp had access to and knowledge about the market, and that the joint-venture agreement set that WindUp would be responsible for the sales. Nevertheless, in this function, the management of the exploration and exploitation interface did not protect the new unit from the old cognitive representation and routines, thus preventing market exploration to unfold. Knowledge about the market was developed, but only towards the end of phase 3 (market introduction), too late to turn it into action and adjust the sales strategy.

5.2 Misfit of product-market strategy and domain separation

The new small-wind inverter *product* was to be sold in a new *market*. For the success of this intended product-market strategy, an exploration in both the *product* and the *market* domain would have been necessary – which, however, did not take place. Therefore, a

mismatch between the intended product-market strategy and the actual product-market exploration can be observed.

First and most evidently, given the function domain separation with organizational separation only for the R&D function, allowed only for exploration in the product domain, not the S&M domain. The rather porous boundary due to predominantly contextual separation in the S&M domain allowed for the spillover of routines and cognitive frame that translated into the adoption of the core business sales approach. This adoption clearly signals the lack of market exploration and is consequently responsible for the inability to successfully market the product. As previously shown in Table 4, there exist important differences between the old and new markets. The old sales strategy, as already explained, was well adapted to the core business market. Assuming that the small-wind market would function in a similar way, the sales strategy was replicated in the new unit. However, the strategy was misaligned with needs of the new market (Table 4). Further, considering the structure of the new market, the department was drastically understaff. Indeed, with less than half of the personal of the old S&M department, the new department had to penetrate a market ten times bigger. Therefore, the adoption of the old sales strategy also lead to an underestimation of the required S&M efforts for successful commercialization.

The lack of knowledge development in the S&M domain is another signal for the absence of market exploration. As explained above, even though knowledge about the market was developed (Table 3), it was gained too late in the product development process and was not translated into a new sales approach. The close cognitive proximity to the old business simply did not allow for experimentation. This lack is also visible in

Figure **2**: the exploration in the R&D domain translated into the emergence of various new product innovation trajectories (left side of the fireworks graph), however, in phase 3, no similar emergence in the sales approaches could be observed (right side).

5.3 Combination of modes of separation

Although the formal organizational of TechLtd. (see again Figure 1 in the previous chapter) may indicate a clear-cut organizational separation between the old and new business, the analysis revealed that a combination of modes of separation coexisted within the firm. The dominant mode of separation at TechLtd was *function domain* separation with exploration being strongly focused on the R&D domain, while the S&M (as well as production) domain ultimately remained as usual. Within the individual functions, TechLtd. tried different forms of managing ambidexterity: in the R&D domain, they used *organizational* separation; in the production domain *contextual* ambidexterity; and in the S&M domain a mixture with *inter-organizational separation* with a strategic start-up partner in the early phases and mainly (unsuccessful) *contextual* ambidexterity in the later phases. As analyzed previously separation both in R&D and S&M domains eroded over time leading to separation drift (ch. 5.1). In the end, the R&D exploration was to some extent successful (small series production), but the S&M approach turned out to be mostly exploitative, leading to misfit between the pure (product-market) exploration the firm embarked on and the actual activities (ch. 5.2).

Our conclusion from this picture is that, while domain separation and contextual ambidexterity may be theoretically more resource-efficient means for managing ambidexterity than full organizational separation, they also lead to more complex coordination requirements between the different ambidexterity modes and therefore top management challenges. They also lead to higher risks that the exploration could ultimately fail. Overall, contingent on exploration type (pure vs. partial; see (Voss and Voss, 2013), it should be carefully weighed whether full organizational separation covering all functions

or a combination of domain separation with other modes of ambidexterity should be pursued.

6 Discussion and conclusion

While academic work relating ambidexterity with firm performance is numerous (O'Reilly and Tushman, 2013), our knowledge on the management of the exploration and exploitation interface remained sparse. With this fine-grained case of a manufacturing SME, we shed light on three essential management challenges, which may constrain the successful pursuit of ambidexterity, if unaddressed.

6.1 Organizational separation drift

While businesses may start with good faith their exploration with textbook-like modes of separation (e.g. organizational separation) and adequate resource spending of the resulting protected units, due to unexpected events or simply due to resource fading they may gradually shift priorities away from exploration readopting more exploitative practices and letting the thinking and practices from established units gradually or suddenly take over even of separated units. In the case of organizational separation, for example, separate organizational structures (e.g. departments) may still exist, but their inner functioning no longer differs and may or may not ultimately lead to the dissolution of formal separation – which we then label 'organizational separation drift' or 'exploration drift'.

The paper hypothesizes that SMEs are prone to stop exploratory processes too early and therefore are often not able to reap the potential benefits from exploratory activities leaving not much more than failed opportunities and sunk costs. Hence, we thus content with that exploration and exploitation are associated in time and thus argue that parsimonious resource spending over the project period can increase the odds of success. Too early resource commitment not only compromises success but also limits the options for future exploration.

6.3 Misfit of product-market strategy and domain separation

As result of iterative procedure of idea exploration and selection, the SME ultimately focused on a very exploratory innovation project with the aim of developing a new product for a new market (Ansoff, 1957; Voss and Voss, 2013). This paper finds that the degree of exploration of an innovation task at hand is related to the success of various types of separation or ambidexterity. For example, exploratory innovations simultaneously focusing on new products in new markets (pure exploration according to Voss and Voss, 2013) cannot be adequately addressed with only R&D exploration, which was resulting from a function domain separation. Rather it needs cross-functional exploration in both R&D and marketing (i.e. new product requires new R&D and new markets may require new marketing approaches simultaneously). On the contrary, *new* products for *existing* markets or *existing* products for *new* markets could very well be addressed with function domain separation and exploration limited to one function. This bias towards exploratory product development without market exploration can be a cause of exploration failure in manufacturing SME.

The development of environmental and energy technology often involves the most radical form of innovation, which implies exploration both in the product and the market domains (pure exploration) and is known to be very difficult to achieve. In addition, these innovations are strongly dependent on political and institutional context, which has the

potential both to increase complexity and uncertainty. This shows that exploration in technology fields with strong political influence and high uncertainty can be more challenging than innovation in more conventional areas. Particularly SMEs are usually not capable of monitoring (or even influencing) institutional contexts leading to higher risks in their exploration endeavors.

6.3 Combination, (temporal) interaction and embeddedness of various modes of separation

It seems to be likely for SMEs that, in order to reduce costs and management attention, that different modes of separation and ambidexterity are combined (here temporal separation, function domain separation, organizational separation, and contextual ambidexterity). For example, limiting exploration both to specific time periods (temporal separation) and to selected value chains functions (domain separation) could reduce costs, at least theoretically. Being simultaneously pursued, they of course interact or are even embedded (e.g. organizational separation for selected function domains; contextual ambidexterity for remaining function domains). Their proper combination can enable resource-efficient exploration – and are therefore likely for SMEs – but, at the same time, increases complexity, inconsistencies and risk of exploration failure. In turn, this demands stronger management attention, which is linked to explorations costs. We thus question Lavie *et al.*'s (2010) assumption that domain separation is less resource intensive. We hypothesize that the resource burden is shifted from costs related to set up and maintenance of structure separation towards human resource management.

6.4 Further research and limitations

Further research should explore those three challenges in bigger depth and breadth and focus on the role of top-management teams, management practices and leadership styles in the management the exploration and exploitation interface. At present, the literature features only isolated strides in this direction (Lubatkin, 2006; Burton *et al.*, 2012), which represents promising area for future research.

Our study is limited at least in two ways: first, the research design following a single-case study, which limits the generalization of the results. Still, we think that the challenges and pitfalls described are quite representative for the group of hidden champion-type engineering SMEs and, more generally, entrepreneurial SMEs embarking towards green innovation. A second limitation is that the major part of the innovation process was only analyzed using ex-post analysis which is subject to bias due to the retrospective account by the individuals interviewed. We used triangulation and reflexive interpretation (Alvesson 2003) to cope with this limitation.

6.5 Managerial implications

Three implications can be drawn from our research. First, even though several modes of separation between the old and the new business can coexist within the firm, top-management should carefully consider how they separate old and new. Drawing on too many modes of separation simultaneously (rather than a clearcut organizational separation) can lead to exploding complexity, which a) might simply compromise the success of the innovation endeavor and b) tremendous increase management effort later on.

Second, an important threat for the exploration is that unexpected events or resource fading may gradually shift priorities away from exploration, readopting more exploitative

practices and letting the thinking and practices from established units take over even of separated units.

Third, is a new product intended for an unknown markets, top-management should provide space for exploration both in the R&D as well and S&M domains. This is in fact more likely in the case of environmental or sustainability-oriented innovations such as renewable energy.

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References

Adler, P.S., Goldoftas, B. and Levine, D.I. (1999), "Flexibility versus efficiency? A case study of model changeovers in the Toyota production system", *Organization Science*, Vol. 10 No. 1, pp. 43–68.

Ansoff, H.I. (1957), "Strategies for diversification", *Harvard Business Review*, Vol. 35 No. 5, pp. 113–124.

Babbie, R. (2013), *The Practice of Social Research, 13th ed*, Wadsworth Cengage Learning.

Benner, M.J. and Tushman, M.L. (2002), "Process Management and Technological Innovation: A Longitudinal Study of the Photography and Paint Industry", *Administrative Science Quarterly*, Vol. 47, pp. 676–706.

Bos-Brouwers, H. (2009), "Corporate sustainability and innovation in SMEs: evidence of themes and activities in practice", *Business Strategy and the Environment*.

Burton, M.D., O'Reilly, C.A. and Bidwell, M. (2012), *Management systems for exploration and exploitation: The micro-foundations of organizational ambidexterity.*, Boston.

Cao, Q., Simsek, Z. and Zhang, H. (2009), "Unpacking organizational ambidexterity: Dimensions, contingencies and synergistic effects", *Organization Science*, Vol. 20, pp. 781–796.

Cesaroni, F., Di Minin, A. and Piccaluga, A. (2005), "Exploration and Exploitation Strategies in Industrial R&D", *Creativity and Innovation Management*, Vol. 5 No. 3, pp. 222–232.

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive Capacity: A New Perspective on Learning and Innovation", *Administrative Science Quarterly*, Vol. 35 No. 1, pp. 128–152.

Cooper, R.G. (1983), "The new product process: an empirically-based classification scheme", *R&D Management*, Vol. 13 No. 1, pp. 1–13.

Eisenhardt, K. (1989), "Building Theories from Case Study Research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532–550.

Fichter, K., Paech, N. and Pfriem, R. (Eds.) (2005), *Nachhaltige Zukunftsmärkte: Orientierungen für unternehmerische Innovationsprozesse im 21. Jahrhundert, Theorie der Unternehmung*, Bd. 29, Metropolis-Verl., Marburg.

Gupta, A.K., Smith, K.G. and Shalley, C.E. (2006), "The Interplay Between Exploration and Exploitation", *Academy of Management Journal*, Vol. 49 No. 4, pp. 693–706.

Hansen, E., Große-Dunker, F. and Reichwald, R. (2009), "Sustainable Innovation Cube - A Framework to Evaluate Sustainability-Oriented Innovations", *International Journal of Innovation Management*, Vol. 13 No. 4, pp. 683–713.

He, Z.-L. and Wong, P.-K. (2004), "Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis", *Organization Science*, Vol. 15 No. 4, pp. 481–494.

Lavie, D., Kang, J. and Rosenkopf, L. (2009), *The performance effects of balance exploration and exploitation within and across alliance domains*, Paper presented at the Academy of Management Best Paper Proceedings, Chicago.
Lavie, D. and Rosenkopf, L. (2006), "Balancing exploration and exploitation in alliance formation", *Academy of Management Journal*, Vol. 49 No. 4, pp. 797–818.
Lavie, D., Stettner, U. and Tushman, M.L. (2010), "Exploration and Exploitation Within and Across Organizations", *The Academy of Management Annals*, Vol. 4 No. 1, pp. 109–155.
Levinthal, D.A. and March, J.G. (1993), "The Myopia of learning", *Strategic Management Journal*, Vol. 14 No. Special Issue: Organizations, Decision Making and Strategy, pp. 95–112.
Li, Y., Vanhaverbeke, W. and Schoenmakers, W. (2008), "Exploration and Exploitation in Innovation: Reframing the Interpretation", *Creativity and Innovation Management*, Vol. 17 No. 2, pp. 107–126.
Lubatkin, M.H. (2006), "Ambidexterity and Performance in Small-to Medium-Sized Firms: The Pivotal Role of Top Management Team Behavioral Integration", *Journal of Management*, Vol. 32 No. 5, pp. 646–672.
Luethi, S. (2010), "Effective deployment of photovoltaics in the Mediterranean countries: balancing policy risk and return", *Solar Energy*, Vol. 84 No. 6, pp. 1059–1071.
March, J.G. (1991), "Exploration and Exploitation in Organizational Learning", *Organization Science*, Vol. 2 No. 1, pp. 71–87.
Noci, G. and Verganti, R. (1999), "Managing 'green' product innovation in small firms", *R&D Management*, Vol. 29 No. 1, pp. 3–15.
Nooteboom, B. (1994), "Innovation and Diffusion in Small Firms: Theory and Evidence", *Small Business Economics*, Vol. 6, pp. 327–347.
O'Reilly, C.A. and Tushman, M.L. (2008), "Ambidexterity as a dynamic capability: resolving the innovator's dilemma", *Research in Organizational Behavior*, Vol. 28, pp. 185–206.
O'Reilly, C.A. and Tushman, M.L. (2013), "Organizational Ambidexterity: Past, Present, and Future", *Academy of Management Perspectives*, Vol. 27 No. 4, pp. 324–338.
Paech, N. (2007), *Directional Certainty in Sustainability-Oriented Innovation Management*, Oldenburg.
Rothwell, R. (1989), "Small Firms, Innovation and Industrial Change", *Small Business Economics*, pp. 51–64.
Schiederig, T., Tietze, F. and Herstatt, C. (2012), "Green innovation in technology and innovation management - an exploratory literature review", *R&D Management*, Vol. 42 No. 2, pp. 180–192.
Schumpeter, J.A. (1934), *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*, Vol. 55, Transaction publishers.
Sidhu, J., Volberda, H.W. and Commandeur, H. (2004), "Exploring exploration orientation and its determinants: Some empirical evidences", *Journal of Management Studies*, Vol. 41, pp. 913–932.
Simon, H. (2009), *Hidden champions of the twenty-first century: The success strategies of unknown world market leaders*, Springer Science & Business Media.
Simsek, Z., Heavey, C., Veiga, J.F. and Souder, D. (2009), "A typology for aligning organizational ambidexterity's conceptualizations, antecedents, and outcomes", *Journal of Management Studies*, Vol. 46 No. 5, pp. 864–894.
Tripsas, M. (2013), *Exploring the interaction between organizational identity and organizational design in technological transitions (Working Paper)*, Chesnut Hill, MA.
Tripsas, M. and Gavetti, G. (2000), "Capabilities, cognition, and inertia: Evidence from digital imaging", *Strategic Management Journal*, Vol. 21 No. 10-11, pp. 1147–1161.
Tushman, M.L. (1977), "Special boundary roles in the innovation process", *Administrative Science Quarterly*, Vol. 22, pp. 587–605.
Tushman, M.L., Anderson, P.C. and O'Reilly III, C.A. (1997), "Technology Cycles, Innovation Streams, an Ambidextrous Organizations: Organization Renewal Through Innovation Streams and Strategic Change", *Managing Strategic Innovation and Change*, pp. 3–23.
Van de Ven, A. and Poole, M.S. (1990), "Methods for studying innovation development in the Minnesota Innovation Research Program", *Organization Science*, Vol. 1 No. 3, pp. 313–335.

Voss, G.B. and Voss, Z.G. (2013), "Strategic Ambidexterity in Small and Medium-Sized Enterprises: Implementing Exploration and Exploitation in Product and Market Domains", *Organization Science*, Vol. 24 No. 5, pp. 1459–1477.

Walrave, B., van Oorschot, Kim E. and Romme, A. Georges L. (2011), "Getting Trapped in the Suppression of Exploration: A Simulation Model", *Journal of Management Studies*, Vol. 48 No. 8, pp. 1727–1751.

Welsh, J.A. and White, J.F. (1981), "A Small Business Is Not a Little Big Business", *Harvard Business Review*, No. July-August 1981.

Yin, R.K. (2014), *Case study research: Design and methods*, Fifth edition.

Zhiang, L., Yang, H. and Demirkan, I. (2007), "The performance consequence of ambidexterity in strategic alliance formations: Empirical investigation and computational theorizing", *Management Science*, Vol. 53, pp. 1645–1658.