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Chapter 12

SUSTAINABILITY-ORIENTED TECHNOLOGY EXPLORATION: MANAGERIAL VALUES, AMBIDEXTROUS DESIGN, AND SEPARATION DRIFT[§]

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Sustainability is a key societal challenge and has become an opportunity for innovation. While start-ups are prone to enter such new territories, *established* companies are more hesitant to leave current trajectories and embrace uncertainty linked to sustainability-oriented exploration. We present a case of a conventional high-tech firm of an owner-manager whose strong values of universalism led him to initialise a sustainability-oriented diversification by exploring renewable energy technologies. Our longitudinal study uncovers how changes in ambidextrous organisational design and represented managerial values ultimately resulted in failed exploration. Our contribution is threefold: First, we link individual-level managerial values of universalism with organisational-level phenomena of sustainability-oriented exploration and diversification. Second, we contribute to bridging hitherto mostly separate bodies of literature on sustainability-oriented innovation and ambidexterity to better understand how conventional firms can deploy their technological capabilities for sustainability. Third, we conceptualise the "separation drift" as fading organisational separation resulting in exploration failure.

Keywords: Sustainability-oriented innovation (SOI); radical innovation; managerial values; ambidextrous organisational design; modes of balance; exploration and exploitation; diversification strategy; renewable energy technologies; green technologies; small and medium-sized enterprises (SME).

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Introduction

In light of pressing ecological and social problems worldwide, the drive towards sustainable development leads to changing regulatory frameworks, business environments, market conditions, and customer preferences—although to varying degrees in different sectors. This creates both pressures on existing technological regimes and opportunities for entirely new technological solutions, together providing the opportunity for *sustainability-oriented* (e.g., Hansen *et al*., 2009), *green* (e.g., Schiederig *et al*., 2012), *responsible* (Owen *et al*., 2013) and further *values-based* (Breuer and Lüdeke-Freund, 2017a, 2017b) innovation approaches. Driven by universalism values of top managers, some conventional technology firms reconsider their role in society and ask how their technological capabilities could be leveraged to solve sustainability-related problems. In contrast to approaches aimed at the minimisation of own negative footprints of *existing* products and technologies (e.g., ecodesign), this usually requires exploring *new* sustainability-oriented products for *new* markets—this is a "full" diversification representing "a distinct break with past business experience" (Ansoff, 1957, p. 114).

In the struggle for renewal and long-term survival, firms that are able to simultaneously explore *new* and exploit *existing* opportunities are generally called "ambidextrous organisations" (Cesaroni *et al*., 2005; Gassmann *et al*., 2012; O'Reilly and Tushman, 2008). A central issue in managing the tensions between exploration and exploitation is the application of different modes of balance to pursue both types of innovation while preventing the undesirable spillover of harmful routines and cognitive representations (Lavie *et al*., 2010). For instance, "contamination" or "leaks" can strongly compromise the emergence of path-breaking innovations (Tripsas and Gavetti, 2000). As sustainability-oriented innovations often break with existing experience from current products and markets, such an innovation journey also benefits from ambidexterity (Seebode *et al*., 2012). Established companies can thus adopt ambidextrous organisational designs to balance exploration of sustainability-oriented technologies with exploitation of existing ones (Noci and Verganti, 1999). But many companies fail in this endeavour (Hansen and Wicki, 2019).

Against this background, we follow the call by Seebode *et al*. (2012) and Hansen *et al*. (2019b) to address ambidextrous organisational design in the context of sustainability-oriented innovation with the following overarching research question: *How can top managers of established firms use ambidextrous organisational designs to manage a sustainability-oriented diversification?* Linked to our longitudinal case research design, we focus on three subquestions which represent different stages in the company's diversification process: (a) *What's the role of top management values in embarking towards sustainability-oriented diversification?*

(b) *How can ambidextrous organisational design provide a protected space for values dedicated to sustainability-oriented exploration?*, and (c) *How can a dissolution of organisational separation lead to failure?*

We conduct a longitudinal process study (Huber and Van de Ven, 1995) of an established entrepreneurial firm which embarked towards exploring renewable energy technologies (RET). Our analysis follows an embedded case design with multiple levels of analysis (individuals, teams/functions, organisation, network partners), in line with studies from more conventional technological contexts (Walrave *et al*., 2011; Tripsas, 2009; Khanagha *et al*., 2014). The firm's diversification began with the owner-manager's universalism values and with a deliberate organisational separation to enable sustainability-oriented exploration of RET. A separation drift—this is, the erosion of the boundaries between exploitation and exploration—occurred due to the cumulative effects of top management decisions and related values priorities, middle management behaviours, and market circumstances. To learn from this unsuccessful exploration process and better understand how the values orientation in exploration can change, we examine the dynamics at the interface between old and new businesses. Overall, we add to the emerging interdisciplinary literature at the intersection of sustainability-oriented innovation and ambidexterity. Our contribution lies in clarifying the role of ambidexterity and related modes of balance for sustainability-oriented diversification and related "separation drift" for its failure.

The remainder of this paper is structured as follows. First, we review the literature on sustainability-oriented innovation and ambidexterity. Second, we present our research design. Third, we show in our analysis how the organisational separation blurred over time. Finally, we discuss the interlinkages between top management values, sustainability-oriented diversification, ambidextrous organisational design, and separation failure. Limitations and managerial implications are also presented.

Literature Review

Sustainability-oriented innovation as expression of universalism values

Whether it is seeking legitimacy in the face of externally changing political, regulatory, and stakeholder environments or intrinsic motivation based on internal managerial values, practitioners are increasingly interested in how to address the ecological, societal, and broader sustainability challenges in innovation processes. This has led to an increasing attention of innovation management scholars in concepts referred to as *sustainability-oriented* (Hansen *et al*., 2009; Klewitz and Hansen, 2014), *green* (Dangelico and Pujari, 2010; Noci and Verganti, 1999;

Schiederig *et al*., 2012), *responsible* (Owen *et al*., 2013), *stakeholder-oriented* (Hall and Martin, 2005), and *values-based* innovation (Breuer and Lüdeke-Freund, 2017a, 2017b). These normative concepts are all characterised by the value of "universalism" with its concern "*for the welfare of those in the larger society and world and for nature*" (Schwartz, 2012, p. 7). The expression of such values in top management and, in the context of small and medium-sized enterprises, owner managers is the defining antecedent for a firm's sustainability innovation strategy (Hansen and Klewitz, 2012). As values are "ordered systems of priorities", universalism values are then usually prioritised over other values such as conservational values of tradition, conformity, and security (Schwartz, 2012). In the following we use the term sustainability-oriented innovation to cover product, product-service, or business model innovations aiming at commercial success while either reducing negative or increasing positive impacts on the natural environment and societies embedded in it (Hansen and Dunker, 2013; Schiederig *et al*., 2012).

Sustainability-oriented innovation and the need for ambidexterity

While *incremental* or exploitative attempts to sustainability innovation have been widely adopted in practice (e.g., more efficient processes), there are often calls for more *radical* innovation (Kennedy *et al*., 2017)—and thus exploration—for solutions with more significant contributions to sustainability. This goes beyond process and a product's life-cycle improvements and addresses innovative new technologies, products, and services (Noci and Verganti, 1999). While some streams of literature deal exclusively with new entrepreneurial ventures being "sustainable" as part of their founders' mission (e.g., Hockerts and Wüstenhagen, 2010; Kuckertz and Wagner, 2010; Schaltegger and Wagner, 2011), here we are more interested in sustainability-oriented exploration by conventional technology firms. Particularly, we look into "diversification" understood as developing new products for new markets (Ansoff, 1957). An established company's diversification into sustainability contexts is similar to what Hart (1997) called a "sustainability vision": it directs a company towards the solution of social and environmental problems through new technologies, markets, products, and processes.

While any innovation task needs to somewhat pass phases of search, selection, implementation, and value capture (Tidd and Bessant, 2013, p. 47), the search for radically new and sustainability-oriented technological opportunities is characterised by complex, iterative, and trial-and-error learning journeys across multiple technological pathways (Wicki and Hansen, 2019). Diversification therefore requires new skills, techniques, and facilities and "inevitably leads to […] organisational changes in the structures of the business which represents a distinct break with past business experience" (Ansoff, 1957, p. 114). Existing companies then

need to deal with both maintaining the old conventional business and developing the new values-based business—which sometimes contradict or cannibalise each other. They face exploitation-exploration challenges as addressed in the ambidexterity literature (Raisch *et al*., 2009). Take the example of the automobile firm Daimler AG, which had hitherto focused on premium car *sales*, but then created the independent organisation Car2Go for introducing an innovative and environmentally-friendly car *sharing* service (Firnkorn and Müller, 2011)—hence, successfully developing two different logics in the same firm. Against this background, and in line with the observations of Seebode *et al*. (2012) and Hansen *et al*. (2019b), the context of sustainability-oriented innovation provides a relevant new context to study ambidexterity, but has so far been largely neglected.

Ambidexterity and the management of exploration and exploitation

Ambidexterity involves the joint pursuit of two different forms of innovation: exploration and exploitation. In his seminal work, March (1991) defined *exploration* as learning and knowledge creation that involves search, variation, risk taking, experimentation, play, flexibility, discovery, and innovation. To succeed, leadership teams are recommended to develop—based on their values—a compelling vision and strategic intent providing direction for the exploration (Smith and Tushman, 2005). *Exploitation,* on the other hand, relates to refinement, production, efficiency, selection, implementation, and execution (March, 1991, p. 71). Exploitation is therefore aimed at incrementally improving the existing product-market domain (He and Wong, 2004). While these seminal publications on ambidexterity have been contributed by scholars of organisational theory, researchers in technology and innovation management have swiftly adopted these perspectives to contribute to explaining radical vs. incremental innovation (e.g., Gassmann *et al*., 2012).

Implementing ambidexterity is a key managerial task (O'Reilly and Tushman, 2008, 2013). Top management needs to orchestrate the two different innovation spaces, related organisational goals, and underlying values (Tushman *et al*., 1997). They need to balance the two opposing modes of innovation with their inherent tensions (Raisch and Birkinshaw, 2008). Lavie *et al*. (2010) consider four modes of balance. The first three are based on separation of the two innovation types. This protects the exploratory innovation space from managerial myopia and inertia (Levinthal and March, 1993) and shields it from harmful routines, and cognitive representations (Tripsas and Gavetti, 2000) that can prevent the healthy development of new innovation trajectories (Tripsas, 2013). First, *temporal separation* of exploitation–exploration is important when looking at longer time intervals where companies switch from exploitation to exploration and vice versa. This is less relevant in this paper, as we are focused on how ambidexterity is managed within

dedicated episodes of exploration. Second, *organisational separation* is about maintaining structurally independent units reintegrated only by the next hierarchical level (usually top management). Third, *domain separation* considers exploration in one domain with exploitation in another one. In this paper, we consider the value chain function domain (Lavie *et al*., 2010) covering research and development (R&D) and sales and marketing (S&M). While Lavie *et al*. (2006) applies a narrow understanding that considers R&D as exploratory and S&M as exploitative, Voss and Voss' (2013), based on Ansoff's (1957) matrix of product-market strategies, takes this a step further. They distinguish two cross-functional combinations of exploration and exploitation: product development (i.e., product exploration and market exploitation) and market development (product exploitation and market exploration). The latter modes of separation can be supported through alliances, for instance, when exploration is separated from exploitative core business through R&D alliances (Lavie *et al*., 2010; Raisch and Birkinshaw, 2008). Last but not least, in contrast to separation, *contextual ambidexterity* shifts the burden of balancing exploitation–exploration to the individual. This requires creating a task environment that is conducive to both exploration-exploitation (Adler *et al*., 1999). Contextual ambidexterity scholars (e.g., Adler *et al*., 1999) see job enrichment, role switching, task partitioning, and meta-routines as exploration–exploitation management approaches.

Overall, the literature review highlights the challenge of businesses in many industries to explore sustainability-oriented innovations while exploiting their existing, more conventional business. Balancing these innovation spaces, which are characterised by different sets of values, require an adequate organisational design. The management challenges for top and middle management are great. As shown in more depth in our case study, if ambidexterity is not managed properly, sustainability-oriented exploration may ultimately fail.

Method

Research design

We undertook a longitudinal process study (Huber and Van de Ven, 1995) in a medium-sized entrepreneurial technology firm (here referred to as "TechLtd"). Such process studies of individual organisations are important to unravel the underlying dynamics of a phenomenon (Siggelkow, 2007), particularly in the case of *un*successful innovation projects (van Oorschot *et al*., 2013). We looked at the unfolding innovation processes at TechLtd and the dynamics involved in managing ambidexterity at the interface between the existing (conventional) and new (sustainability-oriented) businesses and thereby followed the methodological

approach of other ambidexterity scholars (e.g., Khanagha *et al*., 2014; Tripsas, 2013; Walrave *et al*., 2011). We also follow Jelinek and Schoonhoven (1993) who emphasise the need to go "inside" the firm. This, as Heller (1999) mentions, allows to better understand the multitude of daily decisions which create more or less strongly coupled exploration-exploitation spaces within the firm.

Case selection

We followed theoretical sampling (Eisenhardt, 1989) with the aim of elaborating ambidexterity theory in the context of values-based sustainability contexts. The chosen case is *critical* for extending well-established theory (Yin, 2018, p. 49) for the following reasons: (i) In relation to the increasing interest in sustainability-oriented and related innovation concepts (Noci and Verganti, 1999; Fichter, 2009; Schiederig *et al*., 2012), our study is a first attempt to *empirically* integrate sustainability-oriented innovation with ambidexterity theory, including the consideration of management values. (ii) While most innovation and diffusion studies are subject to a pro-innovation bias in which mostly successful innovations are studied using ex-post analysis, our case presents an example of failed ambidexterity management and therefore unsuccessful exploration which was studied at several points of time (Rogers, 2003, p. 112).

The case is also *revelatory* (Yin, 2018) as it is relatively difficult to get (longitudinal) access to the unfolding exploration process, particularly when unsuccessful. This was achieved through an engaged scholarship approach (Van de Ven, 2007).

Introducing TechLtd

The study examines TechLtd, an entrepreneurial medium-sized firm employing about 220 employees in Germany. The family business, founded in 1962, is owner-managed in the second generation. Despite global market leadership in selected niches, the company operates largely 'below the radar' in the national context, therefore representing typical characteristics of a 'hidden champion' (Simon, 2009) and the German 'Mittelstand'. The company, driven by a strong engineering culture, develops and produces electronic components (computerised numerical control system; high-speed motor and generator control devices) which they sell to customers (i.e., system integrators) in business-to-business niche markets. Its products are highly customised to the specific needs of its customers. Product development takes several months and is characterised by intensive R&D collaboration with customers and trust-based, long-term relationships. Production is done in small batches and is, contrary to industry trends, located in Germany. Sales offices exist in Europe, the USA, and Asia.

Universalism values of the TechLtd family business can be traced back to the founders' early establishment of a charitable foundation. With the founders close to the protestant church, the charity aims at addressing social causes in the region from a diaconal perspective (e.g., social housing, child care, group activities). The second-generation owner-manager has also assumed leadership in the foundation. Driven by their universalism values, TechLtd started exploring RET (for a detailed account of the set of technologies explored, see Wicki and Hansen 2019). Key to exploration was partnering through strategic alliances from RET and related domains. Nevertheless, after significant resources spent (about 3 million euros) success did not materialise and exploration efforts were minimised.

Organisational structure representing exploitation and exploration

TechLtd has a rather flat hierarchical organisation. Top management, represented by the owner-manager (i.e., CEO) and the chief technology officer (CTO), is responsible for balancing exploitation and exploration across all organisational units. The company is organised in individual units structured along value chain functions (R&D and S&M) and three business lines, reporting directly to the top management; a general production department serves all three business lines. The first business line deals with computerised numerical control (CNC) systems, which represents the core of the company with regard to its historical roots, size, and sales. The second business line, drive electronics, was created 30 years earlier as a spin-off and contributes about twenty percent of total sales. Instead of controllers for CNC systems, this unit commercialises systems for high-speed motors, which contributes to the firm's core competency in the analysis and control of high-speed rotation. These two business lines are characterised by an *exploitation* rationale focusing on continuously producing incremental innovations to create competitive advantages. The focus of this paper is the most recent, third business line "feed-in technology". It is characterised by the *exploration* rationale and was established to explore how the company could use its engineering competencies for developing new applications for the market of RET.

Data collection

We utilised a combination of retrospective and real-time data collection approaches (Pettigrew, 1990) covering the exploration process over a period of 12 years (2002–2013). Our main data collection occurred from 2013 to 2014 which enabled us to observe the last year of the on-going innovation process and the immediate follow-up activities in real time. In 2021, we conducted a follow-up data collection

(web site; interview with CTO) in order to assess any potential long-term changes in the exploration outcomes.

To assure construct validity and overcome bias involved in partially retrospective accounts, we triangulated various data sources (Babbie, 2013) including semi-structured interviews, participatory observation, focus groups, and desk research (Table 1). We also used triangulation and reflexive interpretation for integrating diverse and partly contradicting perspectives from various internal and external informants (Alvesson, 2003; Shanton, 2004). On the company level, informants were members of top and middle management involved in the exploration, including *current* employees of the company and *former* (R&D) managers. Semi-structured interviews served to retrace events characterising the innovation process and the underlying values expressed in the interviews. Focus group sessions were used to understand the motivation of strategic and operational choices as well as to develop a deep understanding of the top management's values and cognitive representations as they evolved over time. Internal documents (e.g., market research reports, technical design descriptions, and customer lists) were used to obtain facts about the market, product development, and commercialisation. Business partners, value chain-related actors (including former customers and competitors), and further representatives of the small wind industry were interviewed to gain an in-depth understanding of the industry dynamics. Furthermore, considerable research effort was made to understand the small wind industry, to clearly identify the role of external factors in the unsuccessful innovation process, and to isolate them from internal factors. The interview material was fully transcribed and data from site visits and participant-observation was protocolled (Babbie, 2013).

Table 1. Data collection methods.

Data types and sources	Quantity
Semi-structured interviews	**19**
— *Internal*[1]	*(9)*
— *External*	*(10)*
Participant observation	**15**
— *Internal*	*(13 meetings)*
— *External*	*(2 industry events)*
Focus group sessions	**7**
Document analysis	**96**
— *Internal*	*(25,* e.g., *market studies, sales statistics, customer lists)*
— *External*	*(71 publicly available documents, e.g. industry reports, market analysis, newspaper and magazine articles and websites of industry actors)*

[1]Includes interviews with former managers not employed in the company anymore.

Data analysis

Our embedded case study focusses on the exploration process of RET. In order to gain an optimal understanding of dynamics at multiple levels, our units of analysis cover the top management team, middle managers from different organisational units (e.g., R&D, production, S&M), and strategic alliance partners.

In line with the recommendations for longitudinal case studies (Van de Ven and Poole, 1990; Huber and Van de Ven, 1995; Yin, 2018), we started the analysis by inductively reconstructing the descriptive timeline of the exploration process. For the detailed analysis across the phases, we derived a coding structure using an abductive and iterative process: We identified important themes from the data (e.g., staff decisions, strategic partnerships, critical incidents) and reflected them from the perspective of established literature from diverse fields presented in the literature review (e.g., ambidexterity, structural separation, contextual ambidexterity). Vice versa, we also used clues from literature to further explore and analyze our case. Based on Gioia *et al*. (2013), we linked primary data with first order concepts, second-order themes, and aggregate dimensions (see Fig. 1). Going beyond the traditional Gioia technique, we then applied this coding structure across longitudinal phases in order to analyze each code's specific instantiation across phases.

We assured 'trustworthiness' (Guba, 1981) by adopting several of Shenton (2004)'s strategies such as triangulation of data and informants, transparency and

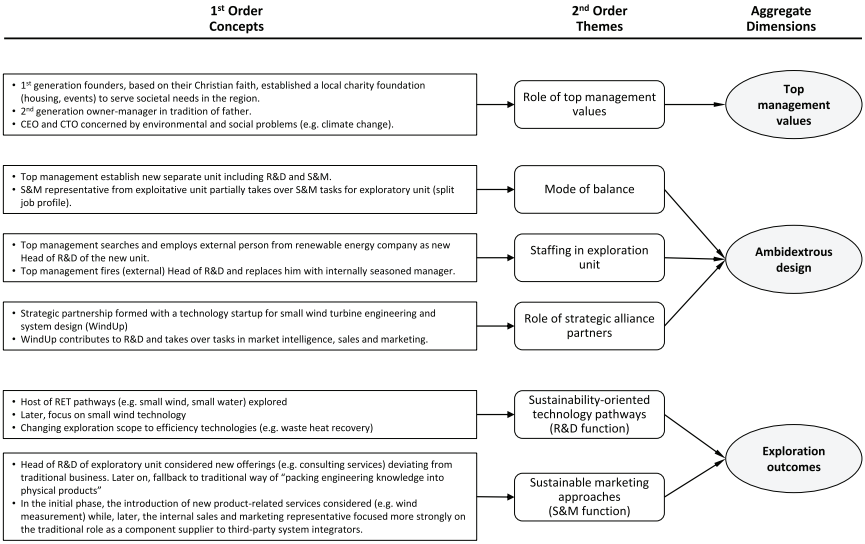

Fig. 1. Coding structure as basis for cross-phase analysis.

documentation of the methodological approach, rich description of the phenomena and context, and consideration of alternative explanations (see also Steinke, 2004). To create credibility and objectivity, *multiple investigators*—including two senior researchers—were involved in the analysis, each taking specific roles allowing for *peer scrutiny* (Shenton, 2004). One of the researchers (the second author) was most strongly immersed in the empirical field and prepared the field notes, transcripts, and descriptive case report (Eisenhardt, 1989). A second researcher (the first author), focused on the iterative process of data analysis and theory-building. At major milestones, in-depth discussions between the first two researchers continued until consent over the interpretations was achieved. The third researcher served as a 'critical friend', pointed to theoretical inconsistencies and provide fresh perspectives. Such peer scrutiny was additionally provided by various reviewers and discussants at major research conferences. Last but not least, *member checks* regarding partial and overall analysis were conducted with all management levels.

Analysis

Our analysis deals with how TechLtd's management changed the ambidexterity course leading to separation drift, which caused obstacles for the values-based diversification and exploration processes. The organisational boundary between exploitative units and the new exploratory unit driven by universalism values became porous and a drift from a textbook-like organisational separation to a much looser and partly dysfunctional separation was observed (Table 2). This separation drift that followed in the subsequent phases is expressed in changing

Table 2. Analysis of exploration process and separation drift.

	Phase 1: *Complete separation (2003–2008)*	Phase 2: *Partial separation (2008–2011)*	Phase 3: *Dissolved separation (2011–2013)*
Top management values:			
— Values priorities:	Universalism values lead to start of sustainability-oriented exploration	Universalism values start competing with security values (e.g. potential sunk costs of investments), when explicit sales goals for exploration unit where enforced by top management	Commercial realities (i.e., "security" values) outbid universalism values

Table 2. (*Continued*)

	Phase 1: *Complete separation (2003–2008)*	Phase 2: *Partial separation (2008–2011)*	Phase 3: *Dissolved separation (2011–2013)*
Ambidextrous design:			
— Mode of balance:	Full organisational separation (including both R&D and S&M)	Organisational separation partially maintained, particularly in the R&D domain, with S&M increasingly characterised by contextual ambidexterity (complementary asset linking)	Hollowed-out organisational separation of R&D, with increasing emphasis on contextual ambidexterity (full complementary asset linking to existing S&M)
— Staffing/values in exploration unit:			
— *Research and Development (Head of R&D)*:	Externally hired from renewable energy company	Internally seasoned engineer replaces the externally hired Head	Unchanged
— *Sales and Marketing (S&M)*:	n.a. (S&M exploration pursued in integrated fashion together with R&D)	Part-time role of marketing officer from core business with sense for sustainability onboarded to exploration unit (complementary asset reuse)	Marketing officer from core business now takes over a 100% position focused on internal commercialisation (taking over tasks from strategic ally).
— Role of strategic alliances from sustainability area:	*Strong*: Search for and exchange with diverse RET start-ups; strategic alliance with WindUp and related intensive collaboration	*Medium*: Gradual shifting of responsibilities from RET alliance partner to internal staff	*Weak*: Insourcing of most responsibilities from alliance partner to internal staff
Exploration outcomes:			
— R&D: Sustainability-oriented technology pathways and knowledge:	*High*: Several RETs explored	*Medium*: Main focus on single RET technology	*Low*: Single RET technology further pursued, but ultimately withdrawn from market; other RET explorations abandoned; new

Table 2. (*Continued*)

	Phase 1: *Complete separation (2003–2008)*	Phase 2: *Partial separation (2008–2011)*	Phase 3: *Dissolved separation (2011–2013)*
			explorations: substitution of ambitious RET focus with broader energy efficiency.
— S&M: Sustainable marketing approaches:	*High*: more radical S&M exploration in new unit, also in collaboration with alliance partner; new product-service-system business models explored going beyond established technology selling	*Medium*: core business routines increasingly adopted; decreasing role of alliance partner in S&M; focus on transactional sales of RET products.	*Low*: conventional sales approaches known from core business applied by core business staff; only supportive role by alliance partner.

Notes: R&D = Research and development; S&M = Sales and marketing; RET = Renewable energy technologies.

top management value priorities, the ambidextrous organisational design, and the exploration outcomes.

Phase 1: Complete structural separation

Top management values

The second-generation owner-manager felt the need to bring universalism values, previously only expressed through his personal leadership style and charity, more directly into core business. With their strong technological expertise, he wanted to find a way to deploy them for sustainability. Together with the CTO, he decided to develop an entirely new range of products for emerging sustainability-related markets in the domain of RET to support the ongoing energy transition in Germany.

Ambidextrous design

To begin technological exploration in the RET field, in 2003, the top management pursued a structural separation by establishing a new exploratory unit with focus

on feed-in technologies for RET. The top management hired an external engineer from a solar energy technology company as Head of R&D for the newly created unit. With this industry background, this manager had a good fit with the universalism values of top management. His task was to lead the exploration of new RET applications. By searching for overlaps with the company's core competencies, particularly in controlling high-speed rotational devices, this led to the focus on "rotation-based" RET (i.e., turbines for harvesting energy from wind or water) and, later, also further rotation-based sustainable energy technologies (e.g., flywheel storage). Under his lead, several technological options were explored with regard to the feed-in of electricity into the power grid.

The new head of R&D brought not only values fitting to the aims of the exploration unit, but also new knowledge, new open innovation practices, and an integrated approach to project management. His view of product development covered the whole range from idea generation to commercialisation, crossing the functional boundaries between R&D and S&M. Hence, initially, no formal S&M responsibilities existed for the new exploratory unit as marketing planning was de facto covered in an integrated way by the R&D manager.

Part of the new innovation approach by the Head of R&D in the exploration unit was also intensive networking and collaboration in *R&D alliances* in the RET field. They led to the development of new, cognitively distant knowledge, but fitting to the new values-based approach. Most indicative is a collaboration with a technical university that allowed TechLtd to develop a central technological component: the electricity inverter that allows to feed the generated electricity into the power grid. In this context, the R&D manager began to work with a young and engineering-minded spin-off from the university. Besides broad knowledge in decentralised energy production and use, the start-up had particularly mastered small wind technologies. They had access to the related global market, but lacked production and broader commercial capabilities (in the following we will refer to this start-up as 'WindUp'). Compared to the more established market for large wind turbines, small wind was at a very early development stage facing large uncertainties (e.g. Gsänger, 2013), not only lacking a dominant design but also policy support such as feed-in tariffs. Given their complementary expertise and assets, TechLtd saw an opportunity for collaboration and started to negotiate its scope. The start-up was indecisive between the development of several RET products. As TechLtd hoped to develop a product close to its own core competencies, it eventually persuaded the spin-off to jointly develop a small wind control system which seemed to be technically overlapping with the control of high-speed motors dealt with in the second business line of TechLtd. Later they added an electricity inverter customised to the specifics of small wind turbines. The R&D tasks and costs were shared between the two firms.

To leverage each other's assets, it was decided that TechLtd would be responsible for manufacturing and WindUp for bringing the product to the market. In this way, the strategic ally took over considerable responsibility and became also part of S&M exploration. For example, product-related services for the small wind technologies (e.g., wind measurements) were explored together with the ally, who was already active in this domain and had experience in the global small wind market.

Exploration outcomes

This first phase was characterised by an exploration with a broad scope in the RET domain. It included many technological pathways (for an overview of technological pathways explored in the firm see Wicki and Hansen, 2019), the engagement in different associated technological innovation systems (see, for instance, Wicki and Hansen, 2017), and, relatedly, the initiation of many R&D partnerships. It also cumulated in a strong strategic alliance with WindUp to explore small wind technologies, which is studied more in detail in the remainder of this paper as exemplar for the broader technological exploration.

Regarding S&M, the new R&D manager covered it in an integrated way and aimed at going beyond just finding new customers. Next to conventional S&M for the new technologies as such, he also explored new product-related services and service business models, for instance, consultancy services. In contrast, in the core business the way to do was to 'pack' engineering knowledge into a physical product through in-house design and manufacturing and to sell these technological components to system integrators. Further exploration ideas in the area of services (e.g., wind measurement) were spurred by the strategic ally. These differences to core business show that the protection of the innovation space was effective and exploration in both domains (R&D and S&M) possible.

Phase 2: Partial separation

Top management values priorities

After several years of exploration, the initial enthusiasm for sustainability-oriented exploration started to diminish. A global financial crisis led top management to re-prioritise from an ambitious and broad sustainability mission to financial stability with reduced resources for exploration, demonstrating that security values kicked in. Along this phase, the leadership approach turned from laissez-faire to a more performance-driven approach based on explicit sales targets for explored technologies.

Ambidextrous design

Not meeting sufficient sales, the head of R&D for the business line "feed-in technology" was replaced by top management. This represented the loss of a RET pro who considerably coined the previous exploration process—a decision which was several years later at least partially regretted. After several temporary replacement, the position was ultimately staffed with an internal engineer, who had extensive product development and design experience in the two core business lines. This change led to a difficult transition time where teams had to get used to the new management setup. It also raised uncertainty about the desired values for the new business (i.e., to generate new sustainability-oriented trajectories or plannable results comparable to the established business) and therefore further weakened the exploratory orientation.

While the R&D-related collaboration in exploration activities remained constant, a part-time position was created at TechLtd to manage the S&M activities at the interface with the alliance partner WindUp. One salesperson from core business with intrinsic motivation for sustainability, who had also welcomed the values-based diversification of the company from its beginning, seemed fitting. But he took over this responsibility in addition to his existing S&M responsibilities for the old core business. With these dual responsibilities for both exploitation and exploration, this represented a form of core-complementary asset linking with existing S&M function (Taylor and Helfat, 2009) and related behavioural demand on the existing sales officer to adopt contextual ambidexterity. The exploratory orientation was more and more constrained because, despite sustainability values, the S&M strategies from core business were simply transferred to the exploratory unit. Overall, this weakened the exploratory orientation of the new feed-in unit and allowed for the separation drift to begin.

Exploration outcomes

Values relevant to kicking-off the exploration became at least partly superseded by business realities and related security values. Routines and cognitive representations of the old business started migrating into the exploratory space, therefore reducing its exploratory orientation. Main R&D-related exploration results constituted the further development of the small wind inverter technology with the alliance partner, with minor activities in other technological pathways.

S&M activities were split between TechLtd and the WindUp start-up. TechLtd requested market intelligence (e.g., international market study on regulations and electricity feed-in tariffs in key countries such as Spain, Portugal, and Scotland) from WindUp to contribute to specifying the final product design. Regarding customer contacts and sales transactions, WindUp maintained their leading role, but

increasingly TechLtd's S&M officer also engaged in sales activities. As in this phase S&M was driven in a context of contextual ambidexterity, where the S&M officer was actually also responsible for core business, he followed the belief that engineering knowledge needs to be packed into physical products and sold to system integrators in order to keep the existing manufacturing unit busy. He therefore did not follow-up on ideas of service business model innovation surfaced in the previous phase (e.g., consultancy services).

Phase 3: Dissolved separation

Top management values priorities

This phase starts with the top-management decision to end all but one exploratory project in the feed-in-technology business line as they found that costs invested so far had not led to sufficient tangible results. This demonstrates that security values came to the forefront. They now exclusively focused on the small wind project with emphasis on accelerated product commercialisation.

Ambidextrous design

During this phase, the inner function of the exploration unit only partly changed. The unit was still staffed with a seasoned R&D manager of the core business. Moreover, the marketing officer previously only in part-time responsibility for S&M (and originally coming from core business), was now fully deployed with the goal to take over more responsibility from the strategic ally. Basically, R&D and S&M in the exploratory unit was now driven by two engineers seasoned through over ten years of core business experience and related routines.

Exploration outcomes

Regarding R&D, the technological exploration, while a single technology successfully transitioned from development to commercialisation, the firm radically abandoned other RET. Some new technological pathways were initiated, but pursued rather superficially and addressed much more incremental innovations focusing on energy efficiency (e.g., waste heat recovery), much in contrast to the initial renewable energy agenda.

Regarding S&M, exploratory orientation vanished. The selected impetuses for more radical S&M exploration, as enforced by the initial R&D manager in phase 1, remained absent. The exploratory potential of the ally was not leveraged anymore as the S&M strategy was in this later phase more strongly defined by TechLtd

based on own core business routines. The strategy can be described as follows: the largest clients were contacted in each international market with the objective of developing long-standing supplier relationships. The main sales arguments to system integrators were the inverter's customisation to the small wind turbine technology and, more generally, engineering excellence. This would provide strong sales arguments to the turbine manufacturer in charge of selling the system (turbine plus inverter) to end-users. The joint S&M activities were in fact reduced to finding new customers. This made S&M even more core business oriented.

Discussion and Conclusion

Our fine-grained process study on a failed values-based exploration involving an initially carefully planned separation and then separation drift, sheds light on both the opportunities and risks involved when embarking towards sustainability-oriented diversification through ambidextrous organisational design (Fig. 2). In the following, we first discuss the overall diversification process and, second, the specifics of the separation drift.

Universalism values, sustainability-oriented diversification, and ambidexterity

Mounting evidence on the unsustainability of existing industrial practices and the economy as a whole, increasingly provokes top managers in established firms to

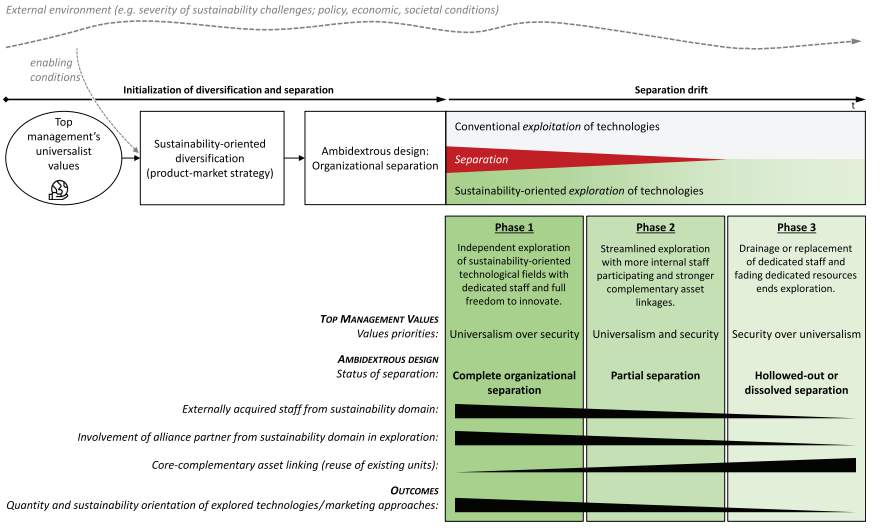

Fig. 2. Sustainability-oriented diversification, ambidexterity, and separation drift.

reflect their company's role in society. But while the ambition of managers with universalism values may be to contribute to solving societal challenges, their existing business (with its underlying values) usually follows more conventional business rationales and is focused more narrowly on exploitation of current products and markets through incremental innovation. Representing a "top-down integration approach" (Breuer and Lüdeke-Freund 2017b, 60f), we showed how top management's universalism values led them to develop a sustainability vision (Hart, 1997) and initiate a diversification strategy (Ansoff, 1957) to leverage and further develop a company's technological skillset for solving sustainability problems.

But as such a diversification at least partly breaks with a company's existing capabilities and middle management values, companies face the challenge of how to organise such values-driven, sustainability-oriented exploration (which consumes a lot of resources) while maintaining the exploitation of existing business (which generates current cash flows). Against this background, sustainability provides a new context in which ambidextrous organisational design becomes important (Seebode *et al*., 2012; Hansen *et al*., 2019b). An ambidextrous design generally reduces the risk of incremental innovation crowding out radical innovation. Firms engaging in sustainability-oriented exploration additionally need to shield the *universalism-based* sustainability values (often driven by intrinsically motivated individuals) from the more *conventional* security values and related business rationale. This is crucial—and needs to be assured over relatively longer periods of time—because additional complexity, uncertainties, and related risks come into play in radical sustainability innovation (Kennedy *et al*., 2017); for instance, the difficulty in finding partners with similar values (Breuer and Lüdeke-Freund, 2017a), the directional risk linked to the ultimate sustainability impact of the developed technology (Hansen *et al*., 2009), and the problem that sustainable technologies are usually in disadvantage over their conventional counterparts (Rennings, 2000).

However, contrary to these demands of a strong and prolonged separation, various circumstances may lead to a blurring of the separation, spillover of exploitative practices, and thus weakening or even hollowing-out of the exploratory unit with its values dedicated to sustainability. In the following we discuss in more detail the concept of a separation drift and, interrelated, the mismatch of modes of balance used for the diversification.

Separation drift

Characteristics and conceptual boundaries

Separation drift—an analogy to "mission drift" discussed in the literature on sustainable entrepreneurship (Hockerts and Wüstenhagen, 2010)—is the gradual

erosion of the exploration-exploitation boundary. In a first phase (see Fig. 2 again), businesses may start an exploration of new sustainability-oriented technologies and markets in good faith with textbook-like modes of separation and adequate resource allocation for the protected exploration unit. External staff with values priory forged in sustainability-driven firms are taken on board to drive exploration (Raisch and Birkinshaw, 2008). In a second phase, shifting value priorities of top management, replacement of staff and related middle management values, resource fading, and unexpected events may make organisations gradually shift from exploration purely based on universalism values to also embracing exploitative practices representing more conventional values. People, cognitive frames, and practices from established units gradually take over even separated units. Phase 3 represents further hollowing-out, where separate organisational structures created based on universalism values may still exist, but their inner functioning no longer differs to those units represented by more conventional values.

The separation drift conceptually differs from adequately managed transition modes for the integration into core business (Gassmann *et al*., 2012), because the drift occurs before an exploration leads to mature results. For instance, while the new technology may have achieved maturity, the lack of incubation (i.e., absence of adequate business model) before transition can jeopardise exploration success (Hansen *et al*., 2019b; O'Connor and DeMartino, 2006). For the same reason, the drift also differs conceptually from a planned approach of temporal separation (Lavie *et al*., 2010), where a firm toggles (successful) phases of exploration with phases of exploitation.

Misfit of product-market strategy and modes of balance

With our focus on "full" diversification (Ansoff, 1957) as a strategy of established firms to embark towards solving sustainability problems, the product-market strategy is characterised by new products for new markets. Ideally, this is addressed by a "pure" exploration in both R&D and S&M functions, and by adopting a full organisational separation as mode of balance (Voss and Voss, 2013). Our case analysis reveals that the separation drift is directly linked to the way these modes of balance changed over time: while exploration started with a clear-cut organisational separation, later phases were characterised by strong complementary asset linking with existing S&M units from core business (Taylor and Helfat, 2009), which demanded S&M representatives to excel in both exploitation and exploration in a form of contextual ambidexterity. This situation puts the burden of balancing exploration-exploitation spaces on individual middle managers who are not necessarily equipped with the adequate management skills and overarching vision. Additionally, the required supportive organisational context (Gibson and

Birkinshaw, 2004) may be missing. Modes of balance then become dysfunctional and exploitative practices take over in later phases of the exploration. Indeed, the mode of balance effectively used in our case looks more like cross-functional ambidexterity focused on product development: R&D followed the desired exploratory style, while S&M practices—despite focusing on new customers—remained rather exploitative. Whereas cross-functional ambidexterity is often a deliberate strategy in resource-scarce contexts (Voss and Voss, 2013), in our case it seemed to be a more unconscious drift occurring over time.

A weak market exploration can be a major cause of exploration failure in sustainability contexts. Market exploration is not only needed to incubate the business models necessary to commercialise a new technology (O'Connor and DeMartino, 2006), but also to overcome additional complexities and uncertainties stemming from a variety of reasons: First, competition in the market with conventional (unsustainable) products/technologies is often distorted due to the double externality problem (Rennings, 2000). Second, relatedly, markets for sustainability-oriented technologies are often strongly influenced by dynamic and sometimes uncertain policy frameworks (e.g., changing feed-in-tariffs for renewable electricity; see Hansen *et al*., 2019a) making exploration even more challenging (Bessant *et al*., 2014; Hill and Rothaermel, 2003). Third, in contrast to the RET explored in our case study, in other product categories, the sustainability features may be a hidden attribute that lead to communication challenges with customers (De Marchi, 2012).

Limitations

Our study faces two limitations. First, while our analysis presents longitudinal evidence on failed ambidexterity management, we do not have final proof about whether this was the only cause for failure. The difficult characteristics of the immature small wind market may have limited innovation success, even for a firm with superior ambidexterity management. Second, the research design addresses a single organisation and is therefore not *generalisable*. Still, it is *transferable* (Shenton, 2004) as the pitfalls described are likely to occur with other firms embarking towards sustainability-oriented exploration.

Management implications

Management implications are fivefold: First, top managers from established firms aiming at deploying and further developing the firm's technological skillset to solve sustainability challenges, can embark towards a diversification strategy. Second, in contrast to the existing, more conventional business units, the exploration in

the new sustainability context is more driven by universalism values (and related individuals) and therefore needs some shielding from core business and the established company actors representing conventional values. Top managers therefore need to establish separate organisational structures or other forms of ambidextrous organisational design, which can stand the test of time. Third, an important threat for exploration is that resource fading or unexpected events—and linked to that, the change to managers with different values—may gradually shift priorities away from exploratory to exploitative practices before the innovations reach maturity and the diversification can be considered complete. This gradual shift, here coined separation drift, may not be recognised if it occurs slowly over time. Fourth, top managers should make sure that diversification comes along with a pure exploration involving both R&D and S&M. Particularly in sustainability contexts, markets are linked to considerable uncertainties which need proper time and resources for exploring new business models for commercialising the new technologies (Hansen *et al*., 2009; Schaltegger *et al*., 2016). Fifth, a top-down integration approach (Breuer and Lüdeke-Freund 2017b, 60f), as represented by our case of a top management-initiated diversification, could be complemented by elements of a bottom-up approach in order to better engage employees in the new innovation paradigm.

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