

FROM NEW VENTURE IDEA TO VIABLE BUSINESS: BREAKTHROUGH INNOVATION
CAPABILITY IN ESTABLISHED FIRMS

Gina Colarelli O'Connor
Fischer Chair and Professor of Innovation Management
Entrepreneurship Department
Babson University
Gina Colarelli O'Connor
231 Forest St.
Babson Park, MA 02457
goconnor@babson.edu

Erwin Danneels
Associate Professor of Strategic Innovation and Muma Fellow
Muma College of Business
University of South Florida
4202 E Fowler Ave, Tampa, FL 33620
edanneels@usf.edu

07-10-2021

Running head: From new venture idea to viable business

Key words: competences/capability, microfoundations, breakthrough innovation,
exploitation/exploration, uncertainty

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ABSTRACT

This article presents the culmination of an extensive research program examining breakthrough innovation (BI) in large established firms. As an exploratory activity, breakthrough innovation is characterized by technological, market, resource, and organizational uncertainties. These uncertainties are mitigated by three types of activity: conceptualization, experimentation, and scaling (CES), which together constitute a BI capability. Conceptualization is the generation, elaboration, and articulation of business concepts, experimentation is exploring and validating these concepts, and scaling is growing a viable business. Based on 613 interviews with managers involved in BI efforts in 42 companies over 21 years, we present fine-grained insights into distinct goals, metrics, and practices that support these competences.

INTRODUCTION

Leaders of established firms acknowledge that breakthrough innovation is critical to their long-term growth and renewal (Innovation Leader & KPMG 2020). Going beyond incremental extensions of the current businesses, breakthrough innovation provides new platforms for growth. However, established firms have great difficulty with such innovation, as they are “preoccupied with incremental innovations, improvements, operational efficiency, cost cuts and ‘narrow’ market share competition” (Vanhaverbeke and Peeters, 2005: 249). However, this focus on incremental improvement, operational discipline, closeness to current customers, and

continuous refinement of known processes, so beneficial to the current viability of established firms, does not lead to renewal.

Breakthrough innovations (BIs) offer new-to-the-world performance features or an order of magnitude improved performance in known features (or lower cost), enabled by substantial technological advances (cf. Ahuja and Lampert, 2001; Chandy and Tellis, 1998; Govindarajan, Kopalle, and Danneels, 2011; Lynn, Morone, and Paulson, 1996; O'Connor and Rice, 2013). Because of their superior and unique value proposition BIs have the potential to create new products, product families, and entirely new lines of business; they can transform old industries and create new ones. However, we don't yet have a comprehensive picture of what is required for a firm to achieve breakthrough innovation on a repeated basis, as a source of organizational growth and renewal. That is: what constitutes a *breakthrough innovation capability*? We will propose that a BI capability is comprised of three competencies as building blocks. A competence is a firm's capacity to accomplish a key task in an intentional, reliable, and repeatable manner (Helfat and Winter, 2011). The ability to invoke the three competencies as needed constitutes the BI capability (cf. Amit and Schoemaker, 1993; Makadok, 2001).

This article presents the culmination of an extensive research program examining large established companies' initiatives to develop and commercialize BI and to evolve a capability to do so repeatedly. The research program took place over 20 years, and comprised three research phases of roughly 5 years each, which detailed "what managers actually do, and with what techniques" (Johnson, Melin, and Whittington, 2003: 12). Based on this research program, we have developed an integrative framework of the organizational goals, metrics (performance criteria), and practices which constitute a capability in BI, which we break down into three different sets each forming a competence: conceptualization, experimentation, and scaling. We

will propose that a BI capability is constituted by these three distinct competencies (CES).

Conceptualization is the generation, elaboration, and articulation of business concepts that may form the basis for breakthrough businesses. Experimentation is exploring and validating business concepts by testing their many assumptions, and scaling is growing a fledgling business to a point where it can compete with ongoing businesses in operating units for resources and attention.

THEORETICAL BACKGROUND

We mainly draw on two streams of literature: the tension between exploration and exploitation and uncertainty in BI.

Exploration-Exploitation tensions. BI involves *exploration* in both technological and market dimensions as it is based on new technologies, and applies these to markets that do not exist yet. Exploration is the search for new alternatives in emerging domains (Bhardwaj, Camillus, and Hounshell, 2006; March, 1991; Danneels, 2002; Danneels and Sethi 2011). The explorativeness of BI projects creates uncertainty, such that the project outcomes and pathways for achieving them are unknown, and unknowable (Townsend et al., 2018), at the outset. In contrast, the ongoing, mainstream organization has objectives of operational excellence: customer satisfaction, cost containment, and consistent quality. Operational excellence requires strict adherence to plans, budgets, and schedules, achieving reliable outcomes, and driving out variance and errors (Benner and Tushman, 2003; Kanter, 1989). In other words, established businesses are geared towards exploitation, have an established track record (Block and MacMillan, 1993), and generate reliable, short-term results.

The uncertainty of BI makes prediction of sales, repeat purchases, costs, yields, and any other classic operational excellence metric nearly impossible, and hence makes BI development incompatible with the work of the mainstream organization. Therefore, firms pursuing BI need the ability to maintain exploration in the face of ongoing exploitation (March, 1991). It is commonly accepted that organizations tend towards exploitation (Benner and Tushman, 2003; March, 1991; March and Levinthal, 1993). We explain that BI, as a form of exploration, is hindered by the mainstream organization in its efforts to reduce uncertainties, what we refer to as the “pull from the mainstream.”

The Nature of Uncertainty in BI. As an exploratory activity, breakthrough innovation is highly uncertain. This uncertainty is broader than just the lack of clear prospects of immediate return (cf. March, 1991). Prior research has found this *uncertainty* to be of four types: technological, market, resources, and organizational (TMRO - O'Connor and Rice, 2013).

BI projects face high market uncertainty. Market structures and value chains may not yet exist, rendering many market related issues unknowable ex ante (Townsend et al., 2018). Market uncertainties involve lack of knowledge regarding customer needs and wants, the nature and attractiveness of potential target markets, value propositions, what should be the initial market to enter and what should be follow-on applications, and the competitive offerings.

Breakthroughs often draw on unproven technologies. Technical uncertainties relate to the completeness and correctness of the underlying scientific knowledge, the lack of knowledge regarding whether the specifications of the product can be achieved, the reliability of the manufacturing processes, and so forth.

Resource uncertainty regards the availability of financial and organizational resources for the project. Because the breakthrough innovation development cycle typically lasts a decade or

longer, the resource and funding needs and their sources change multiple times. Interest in projects waxes and wanes as decision makers and sponsors come and go, and resource provision lacks continuity. The company may not have easy access to the types of resources necessary to progress the project, given the newness of the technological field and the newness of the market domain that BIs address. It is often unclear which resources will be needed and how and where to obtain them, such as through internal development, partnering, or acquisition.

Organizational uncertainty regards the ongoing commitment to the BI effort, and the eventual fit of the new business to the organization. The business that results from the BI project could be aligned (with an existing BU), multi-aligned (with several BUs), or unaligned (i.e., not fit with any current BU). Accordingly, it is uncertain where the new business will be housed eventually: as part of an existing business, as an entirely new business, or even spun off. In the extreme, fit may be so high that the business concept should be pursued inside the mainstream as product development vs. as a venture in the BI effort. Ongoing commitment to the venture, and venturing in general, is another aspect of organizational uncertainty. Top leadership commitment to BI can change rapidly, especially in the face of TMT turnover or organizational stress.

We build on this prior work to understand uncertainties in the three competences we propose constitute a breakthrough innovation capability. We specify how they take on different forms as the new venture evolves from idea to business, and how they can be mitigated using different metrics and practices (cf. Townsend et al., 2018), and by taking a portfolio rather than project approach.

The above literature streams are used in this article to develop insight into the nature of the organizational capability to pursue breakthrough innovation. In the method section, we will review the three phases of the study and the iterative data analysis that helped understand the

workings of a BI capability. In the findings section, we examine the goals, metrics, and practices associated with conceptualization, experimentation, and scaling (CES), and how each competence generates and mitigates uncertainty. We identify how the mainstream tends to turn exploration into exploitation in each set of activities, by examining “pull from the mainstream” in each of the three key BI activities.

DATA COLLECTION

We draw upon three real-time longitudinal studies of breakthrough (or radical) innovation in large, established firms conducted from 1995 to 2015 (see Exhibit 1 for an overview of phases and participating companies). In all, 42 firms participated in the research program, and 613 interviews were conducted. All firms were well-known multinational industrial companies over 50 years old and with greater than \$1 billion in annual revenue.

Insert Exhibit 1 about here

The Industrial Research Institute (now named the Innovation Research Interchange), a professional organization of R&D Directors and Chief Technology Officers of large (Fortune 1000) industrial companies, was a partner throughout this research program. Since the project was sponsored by the IRI, the studies benefitted from deep and broad access to member companies.

Secondly, and independently of the sample companies, the IRI formed a subcommittee of their members, including two co-chairs, who met with the researchers three times/year, listened to the updates on the research, including interim results, and provided feedback to help validate

interpretations of the data. At times they pointed out unusual or interesting findings, which focused attention on specific phenomena and caused additional analyses. For example, at one meeting during Phase 2 of the research program, a description of approaches to BI was noted as remarkable by the subcommittee members. Comparing those approaches across firms and within firms over time led to the insight that three distinct organizational competencies were common to all prospering BIs.

Data were collected prospectively. While initially the histories of the BI initiatives were collected, the rest of the data were collected in real time, which helps alleviate retrospective bias. The research program consisted of three phases, each with a distinct focus: BI projects, BI firm capability development, and mechanisms for sustaining a BI capability. We now briefly review each of these.

Phase 1. Phase 1 followed the progress and setbacks of twelve BI *projects* in ten large established firms for five years. In order to qualify research sites for Phase 1, in collaboration with members of the IRI, a breakthrough innovation project was defined as follows: an R&D project with an identified team and budget judged by senior technical leaders as having the potential for at least one of the three following outcomes: new to the world performance features; significant improvement in known features; or significant decrease in costs. The expectation was that achievement of these outcomes could be the foundation for an entirely new business.

Phase 1 started with the premise that US based companies had become quite capable at incremental innovation through the use of disciplined processes (e.g., Stage-Gate), but struggled with breakthrough innovation. Therefore it set out to examine projects believed to be potential breakthroughs, to find patterns in practices and experiences through cross-case comparisons.

Twelve projects were qualified into the study, one each in eight companies and two in two companies (several companies offered projects that did not qualify). Site visits were conducted at the beginning of the study period, and follow-up interviews were held each six months to one year to track project progress and setbacks. The project leader was interviewed in each follow-up, along with any additional team members she/he invited. In some cases there were additional site visits. In all, 186 interviews were conducted.

Phase 1 provided evidence regarding attempts to transition the projects to the mainstream resulting in failure, incrementalization to align with the business unit, lack of funding or managerial attention, and inadequate adaptation of project management processes and metrics to project uncertainties. When a haphazard one-off project approach was used and no distinction was made with incremental new product development, firms used inappropriate project management approaches (e.g., stage-gate approach) and project metrics (e.g., NPV), and hence terminated emergent BI projects.

Phase 2: Phase 2 followed a set of twelve *firms*, each of which had the intention to develop a BI capability, for five years. Data were collected in real time as the firms attempted to enhance their BI capability. Thus the unit of observation was not the project as in Phase 1, but rather the organizational initiative to build or improve a capability for BI. To qualify into the Phase 2 study, companies had to have a declared intent to develop or improve a BI capability, and an identified group of people and set of resources for implementing that initiative. Following a round of qualifying interviews, twelve companies participated in Phase 2, agreeing to have informants interviewed every six months for a four year period of time following the initial qualifying interview. An additional nine companies served as a validation sample, meeting in

workshops four times to discuss their BI challenges, and help refine and extend initial findings (cf. ‘member check,’ Lincoln and Guba, 1985).

Like in Phase 1, the initial round of data collection for the twelve primary participating companies involved site visits to each company, during which the person in charge of the BI capability initiative was interviewed, along with his/her direct reports and those to whom s/he reported. In addition, leaders of several BI projects in each company were interviewed. Following the site visit, there were five rounds of follow-up interviews, at six month intervals. The follow ups involved interviewing the lead person, as well as other individuals s/he identified as having emerged as key players in the evolution of the BI capability. In all, 246 interviews were conducted in Phase 2.

The evidence from this phase suggested the need to break down the components of BI into the three organizational competencies, as we recognized that activities grouped into these areas, and that each involved distinct goals, metrics, and practices. The evidence also helped us gain a better understanding of the interrelations among projects as part of a portfolio. Most companies started with a set of projects that originated from different sources and were independent of one another. The failure rates were high and the projects were fairly small. Over time they began to group the projects into domain areas and cross learn within a domain, which led them to see the pursuit of breakthroughs at a portfolio level, building momentum through the development of numerous applications for markets small and large. This finding ran counter to much of the conventional wisdom about breakthrough innovation finding success through ‘killer applications.’

Phase 2 findings showed the challenge of the roles and careers of individuals in sustaining a BI capability. In contrast with the R&D scientists, who acted within their normal

role descriptions, the employees involved in setting up the new businesses based on these inventions experienced career risks and contradictory metrics and expectations. This observation motivated the third phase of the research program: examining the people who made BI projects happen.

Phase 3: Finally, Phase 3 focused on roles and responsibilities required to sustain breakthrough innovation over time, beyond R&D. Eleven companies participated. Phase 3 used snowball sampling to identify who was involved in BI from invention to commercialization. First, the person in charge of the BI capability initiative in the firm was interviewed as the primary point of contact. Next, this informant provided names of R&D scientists who had discovered breakthroughs, who were interviewed along with their managers. The scientists introduced others they'd relied on to help them move their inventions forward. Those people were next interviewed, and asked who else was involved in commercialization. This approach was continued until all relevant people were reached, wherever they were located throughout the organization. In all, 181 interviews were conducted for Phase 3.

Each interviewee provided information about their current role and responsibilities, their daily tasks, and how their performance was measured. They were also asked about their educational and career backgrounds, professional experience, personal characteristics, career path to date, motivations, frustrations, and rewards. At the end of the observation period each was interviewed again, and asked about career changes during the intervening time, as well as their job and career satisfaction. These interviews gave us much deeper insight into the three organizational competencies we identified in Phase 2 and how they are enacted. We observed how distinctive the three competencies are in terms of skills, metrics, and processes. Most companies had not distinguished the organizational competencies enough to institute distinct job

descriptions, selection and development processes, and performance metrics. We noted how often personnel evaluations were mismatched to what the person was trying to accomplish, which exacerbated the frustration among individuals pursuing BI.

ANALYSIS

As mentioned, the current study presents the culmination of an extensive research program examining breakthrough innovation (BI) in large established firms. We conducted iterative and integrative analysis of all data across all research phases and firms, prior research reports, memos, and articles, and other literature, which led to new questions and conceptual frames (cf. Eisenhardt, 1989; Burawoy, 1991). During this process of iterating between the data, existing theories, and our own emergent understandings, we developed fine-grained insights into the firms' efforts to achieve BI unfolding over time (cf. Yin, 2018), which we ultimately assembled in an overarching theoretical framework.

Our initial goal was to identify the tasks that need to be accomplished in the journey from BI business idea to viable venture. We started with a rudimentary distinction between three sets of BI activities (reference disguised), which we elaborated and connected to the pre-existing work regarding uncertainties in BI. We then realized these uncertainties result from the explorativeness of BI. Next, we conceptualized BI as capabilities, as the companies were seeking repeated, reliable, and intentional BI outcomes. In addition, the comparison between Phase 1 and the later phases made us aware of the importance of examining BI at the portfolio level as well as at the level of the individual project. Some of the prior literature had focused on one-off BIs (such as through champions or skunk works), while the intent of the firms in Phase 2 was to form a capability. We used the variances across projects and companies, and the variances over time

in approaches to achieving BI capability and their outcomes. Both cross case comparisons and cross time evolution showed the development of the BI competences, and enabled us to compare approaches that seemed effective with those that were not. This was the foundation of the findings which identify patterns of goals, metrics, and practices within and across cases.

We followed the extended case method (Burawoy, 1991; Danneels, 2011) in drawing on existing literature to inform our data analysis and guide our theory development. This approach goes through many cycles of confrontation between data and theory, with each iteration directing the analyst to additional data, concepts, and theories. We first built on existing literature on product innovation and breakthrough innovation (BI), and the nature of uncertainty therein (O'Connor and Rice, 2013). This prior work informed our understanding of how three competences reduce these uncertainties.

We had distinct roles in the development of the current paper. One of the authors was the lead researcher on the BI research program detailed above, and was deeply immersed in data collection and analysis over twenty years. The other author invited her to revisit the entire program to develop an understanding of the nature of an organizational capability for BI. He deconstructed prior insights and findings, examined relevant data, and validated, extended, or challenged the first author's interpretations. Together we continuously revisited the consistency between the data and the emergent theoretical interpretations (cf. Yin 2018), in which the first author functioned as the data expert because of her immersion in the research program. The second author provided fresh eyes, as he was "naïve" from a data perspective, and offered new perspective by bringing new literature and concepts.

During almost two years we engaged in dialogue, wherein the second author "interrogated" the first to check his interpretations and request elaboration and corroboration by

evidence, and they both tried to understand each other's ideas and reasoning. One example of debate happened when the second authored suggested to map the stages of CES unto types of uncertainty, such that Conceptualization and Experimentation address Technology and Market uncertainties, and Scaling addresses Organizational and Resource uncertainties. In our dialogue we realized that CES indeed resolve uncertainties but not in a particular sequence. Returning to the data we confirmed for instance that Scaling also is often plagued with Technical uncertainties, in particular related to manufacturing, and that Organizational uncertainties plague new business creation throughout the exploration process.

FINDINGS

We found that the performance of three types of activity (CES), which take place sequentially as the venture increases in maturity from an idea for a fledgling BI to a viable business, is necessary to address the BI uncertainties we discussed earlier. In addition, each of the activities is subject to the tendency towards exploitation, which we label “pull from the mainstream.” Each nurtures a portfolio of opportunities at a time, culling and enriching the set of projects. We examine these three organizational competencies next. We explicate each in terms of the same aspects: definition, role of uncertainty, portfolio view, distinct goals, measures of performance, effective practices, and how the mainstream organization pulls the exploration back to exploitation. For an overview, see Table 1.

Insert Table 1 about here

CONCEPTUALIZATION

Definition. Conceptualization is the generation, elaboration, and articulation of ideas for breakthrough business opportunities. Conceptualization identifies possibilities, many of them not imagined at the outset.

Uncertainty. The business concepts generated in conceptualization have varying uncertainty profiles. Conceptualization is about the world of the possible, not the world of the probable, so uncertainty is very high (cf. Knight, 1921). Uncertainty is brought about by the explorative nature of the business concepts. In some firms, and more in later observations, it is circumscribed by the domains of innovation intent (the firm's vision of its future business domains). Even so, exciting use cases challenge these boundaries.

Goal. Its objective is to develop *business concepts* that could create new business platforms within the domains of innovation intent. A business concept consists of a market value proposition (benefits to customers), the attractiveness of the opportunity (magnitude, richness, and strategic alignment), and business model options, accompanied by a preliminary understanding of technical and IP feasibility and assessment of funding and resource requirements.

Portfolio. Through the course of the study, companies increasingly sought a set of interrelated ideas for business opportunities, rather than one-off independent ideas. This enabled cross-learning between projects within a given domain. Often, no single market seemed 'big enough' or 'ready' yet, so they built their business case by showing the many possible product lines that could be developed, or possible problems that could be solved. Their purpose was to develop a suite of offerings rich and robust enough to be a new business area for the company. For example, Otis Elevator invented a solution to the problem of the mile high building, in which numerous banks of elevators drastically limit rentable space. The innovation involved decoupling

the elevator car from its shaft and moving it horizontally onto another shaft, such that space devoted to elevator shafts and passenger transfer could be reduced. However, mile high buildings are rare. Otis found additional uses for the technology of horizontal movement of elevator cars, including transport of prisoners and rides at theme parks.

Most companies, in developing their capability for BI, defined several problem/opportunity areas they believed could become new business platforms for the company's future. Hence, they pursued a match between the portfolio of opportunities under consideration in Conceptualization and the firm's domains of innovation intent. For example, Grundfos, a manufacturer of industrial water pumps, focused their conceptualization efforts on three domains of innovation intent: "zero impact commercial buildings," "decentralized water treatment", and "future homes and living in China." Each of the three domains had the backing of senior leadership and was staffed with a small team who were expected to conceptualize many opportunities within each domain, such that there would be a portfolio of them to vet, to merge together, to dismiss, to pivot, or to build on in experimentation.

Metrics. Our firms found that precise financial calculation regarding the value of these ideas is not feasible. Instead heuristics (Bingham, Howell, and Ott, 2019) are used, which paradoxically also requires discipline and great effort. Using cross-case comparisons and abstraction, we found that the metrics used by our study companies could be grouped into these four categories.

The first conceptualization metric involves the *magnitude* of the opportunity. Only a ballpark estimate of market size can be made here, but such is sufficient (see also Christensen, Kaufman, and Shih, 2008). One interviewee explained: "A range of sales is the primary thing we're looking at. Could this thing be \$2 billion? Or is it more likely to be somewhere in the range

of quarter to a half billion dollars? Does it have the potential to be a blockbuster?” In appreciating magnitude, companies considered the importance of the problem and appropriability of their solution through securing intellectual property rights.

Another metric involves the *richness* of the opportunity. The concept should potentially form the basis for an entire family of products and services (cf. Sanderson and Uzumeri, 1995). A program manager at Intel put it metaphorically: “I try to look for rich veins that I can mine.” At Analog Devices, the development of an accelerometer chip opened a rich domain of applications, including use in videogames, air bag sensors, and gyroscopes (Coates and McDermott, 2002). Identifying the richness of the opportunity landscape in terms of the multitude of potential applications or use cases is a crucial aspect of conceptualization so that the business concept is robust and many options are opened up.

Additionally, firms use as a metric the *strategic alignment* of the opportunity. In some cases that meant fit with current businesses, such as Corning’s flexible glass which aligned with its Display Division. Others considered alignment in terms of adjacency to multiple business units, such as Air Products’ remote monitoring of air purification systems, or Kodak’s Organic Light Emitting Diode (OLED) which could potentially supply that technology to all of the company’s business units. Other companies, rather than using the current businesses as a reference point, assessed alignment with domains of innovation intent, meaning their envisioned businesses of the future. For example, at one firm concepts related to advanced solar technologies were unaligned with any of the current divisions, but were aligned with intent to become a global sustainable energy player. We note that firms that used this alignment with an envisioned future state were more likely to produce breakthrough innovations than those who tried to align their innovations with existing businesses.

Finally, *feasibility* was a metric: is the business idea within the realm of the possible? The domains of innovation intent, as mentioned earlier, are new emerging areas in which the company may not be fully capable at the outset. Many of the Conceptualization teams worked to find ways to access new technologies through licensing or partnering, or recognized the need for complementary technologies, and thus considered the feasibility of finding and gaining access to new technical competencies or new market networks that could help bring the idea to commercial reality.

Generation Practices. All but one of our study companies were proactive and purposeful in promoting the generation of new business ideas, in contrast to the folklore that claims breakthroughs are discovered serendipitously. Ideas came from internal and external sources. To stimulate internal idea generation, most of the companies facilitated idea workshops and fairs, captured ideas from within the organization through suggestion boxes and internal contests, and gave employees time to pursue promising ideas. Most invested in exploratory scientific research. They also scouted outside the organization, with universities, other companies, and government institutes for trends, and attended conferences. Some also made investments in start-up firms through venture capital funds.

Over the course of the study, many companies changed their idea generation practices. Most companies started their BI initiatives by announcing a call for ideas to all company employees. Many also opened idea portals to receive submissions from customers and other external parties. All companies in this study expressed frustration with their initial idea generation approach. Despite the volume of ideas, most were not usable, either because their potential was too small to significantly influence revenue growth or because the ideas were irrelevant to the company's strategy.

At Nortel Networks, the initial call for ideas resulted in over 2000 submissions in one week. The review team could not keep up, and could not effectively respond to each submission. The result was an alienated employee base, who resented having their ideas rejected. At Shell Chemical, the idea management system inputs were evaluated and a subset invited to present to a board, who would fund their next steps. However, the board liked so many of the opportunities that they spread their pool of funds too thinly across them. The result was that no opportunity could garner enough coaching or financial resources to make an impact. They all eventually withered. At PPG an R&D Director exclaimed: “Every idea looks great! We don’t know where to focus our attention!” Over the course of the observation period, most companies evolved from identifying solo projects to identifying fewer major domain or platform-level initiatives.

In Phase 2 several companies (DuPont, Corning, and Sealed Air) formed dedicated conceptualization teams comprised of market/technical pairs of people with dedicated conceptualization responsibilities. Other companies (Air Products, IBM) dedicated individual personnel to work in these roles. As we investigated this role further in Phase 3, we found these team members really skilled at learning about different areas; they characterized themselves as ‘lovers of learning’. In other words, they were not subject matter experts in a particular market or technology, but had skills to learn about new ones. Their learning abilities were fungible across technology areas and markets, i.e. of a second-order nature (cf. Danneels, 2002).

Elaboration Practices. These practices intend to broaden the BI idea, to ensure that the full scope of the opportunity space is identified and described. Elaborating new business ideas involves examining ways that ideas could be expanded into multiple applications, or capture greater value through a more comprehensive understanding of the diverse benefits within any

single application area. As one interviewee described: "...[My job is] to build the concepts to be bigger and bigger and bigger. How do we get the concept to be as broad as we can make it?"

Practices used to broaden and deepen opportunity concepts included small group ideation exercises to envision use cases (i.e., applications of a technology), as well as environmental scanning (cf. Danneels and Sethi, 2011). Environmental scanning included attending professional trade conferences for industries related to markets the company did not yet serve, visits to potential customer and partners, and presenting to large audiences of the scientific community to provoke discussion about possible use cases. For example, an IBM researcher who discovered a previously unrecognized characteristic of Silicon Germanium presented at a technical conference to provoke discussion among his peers about possible applications that they could envision based on the needs in their respective companies. A scientist from a company in a very different industry approached the IBM researcher after the talk to let him know that there would be an important use for this technology on a project he was leading for his company. That use case had never been imagined by the IBM team.

Articulation Practices. Articulation involves describing the business concept to internal (and sometimes external) stakeholders in order to gain support. As NPV or market size figures for BI are suspect, gaining legitimacy for the new business ideas involves describing the possibilities in a manner that captures organizational leaders' attention. Successful articulation paints a picture of an attractive and rich possibility set that is aligned with the vision of the company's future. As breakthrough innovations are products that don't yet exist, conceptualization involves envisioning possible futures and then storytelling about how those futures will come to life (cf. Lounsbury and Glynn, 2001). An interviewee at John Deere described conceptualization as "generating the world of the possible and moving to something that can be tested." One manager

showed us the impressive list of possible applications which helped gain his leaders' commitment for his breakthrough idea because they realized that, even if any single specific application did not find traction in the market, there were numerous others to pursue.

Pull from mainstream. A commonly heard concern was that most internally generated ideas were incremental. The breadth of knowledge needed to generate a range of ideas that extend beyond the current scope of the firm is often not present, potentially narrowing the search scope of conceptualization. Several companies told us that they could not assemble an internal group of people with enough knowledge and experience to span a range of technology and market spaces. This led to conceptualization myopia, as only “close in” business concepts are generated or selected, leaving the rest of the opportunity space untapped (cf. Ahuja and Lampert, 2002).

The lack of second-order skills of people from the operating businesses contributed to this myopia (cf. Danneels, 2007; 2008). These team members had a first order competency in particular markets or technologies. If idea selection teams consisted of BU representatives, ideas aligned with current businesses were strongly favored, defeating the goal of conceptualization to generate ideas for new lines of business. Marketing members tended to be dysfunctional contributors because their knowledge basis is “local” as they have experience in a particular market (Danneels, 2008; Gruber, MacMillan, and Thompson, 2013). However, members of new business development groups or people who held ‘Strategic Marketing’ roles, whose prior role was to find new markets or develop new value chains, were valuable members of conceptualization teams. Similarly, R&D personnel with a scientific interest in manufacturing processes could see many alternative possibilities for a particular discovery as they could envision new business models, new applications, and new cost-volume relationships.

EXPERIMENTATION

Definition. Experimentation seeks to surface and test the technology, market, organizational, and resource *assumptions* of business concepts, and thereby reduce technological, market, resource, and organizational (TMRO) uncertainties. During experimentation, elements essential to the eventual business such as the value proposition, product/service specifications, the business model, partnerships, production and delivery processes, the target market, and the composition of the emergent value chain are proposed and tested.

Uncertainty. Experimentation teams tended to confront the uncertainties with which they were more comfortable and to ignore others. In particular, project managers dealt with technical uncertainties more than with market, resource and organizational uncertainties. Many of the study participants with new business development roles had technical backgrounds and started their careers in technical roles. The following was common: “Probably 90 percent of our organization has an engineering background. ... what little marketing got done in the business units, it was usually done by an engineer who ... got into a product leader role.” We observed those people gravitating toward what they knew best: resolving technical issues to reduce technological uncertainty. Even when there was expertise to address market uncertainties, these were not comprehensively considered. Often conventional market research practices were used, using current customers. One interviewee echoed the experiences of many others when he explained: “We do a good job of getting feedback from current customers; this is good for sustaining innovation but not as successful for radical type innovations.”

In the vast majority of cases resource and organizational uncertainties were ignored, and so these were left unarticulated and unmanaged. Therefore these issues cropped up as surprises, requiring urgent redirection rather than carefully thought out strategic solutions. The projects

took longer than necessary and encountered setbacks that could have been avoided. In several cases, BI managers expressed ambivalence about how to staff teams to be effective at experimentation. Several companies began to consider skills at learning and designing experiments as more helpful than domain specific expertise. Although expertise in particular markets and technologies would seem valuable, the projects often needed to shift markets, applications, and technologies depending on experimentation results.

Goal. The objective of experimentation is to test the many application ideas that are described in the business concepts, through learning that reduces technical, market, resource, and organizational uncertainties. However, experimentation also reveals new uncertainties, so it may take longer than the other two stages. The ultimate outcome is a business proposal, based on what was learned, that suggests the value proposition, business model, first market entry point and follow on applications, proposed value chain partners, resources required to scale, and a tested revenue and cost model.

Portfolio. In experimentation a variety of business concepts identified in Conceptualization are tested and refined. Engaging in market and technical research generates additional ideas regarding opportunities. The outcome of experimentation is a set of interrelated proposals centered on a domain of innovation intent. During experimentation some proposals have proven attractive, while others are culled. In other words, the portfolio is ‘cleaned up’ as our respondents called it, based on what was learned. The number of business concepts identified in conceptualization is reduced to far fewer validated business proposals. Some business concepts in our study were revealed to be closer to the core business than originally envisioned, and hence transitioned to the existing businesses where they fit. The others proceed to scaling.

Metrics. Effective metrics for experimentation included two types. The first was the measurement of activity-based metrics: Examples include entering co-development partnerships or accessing beta customer test sites, value chain analysis, and customer visits. The second metric is outcome-based: projects were measured on the actual insight that was gained along each of the TMRO dimensions. Increase in clarity about the responsiveness of target markets and value chain partners measured market learning. Technical progress in the lab and field is a measure of reduction of technical uncertainty. Reduction in organizational uncertainty was measured by increasing clarity on how the business concepts fulfill the firm's innovation intent and its eventual home within the company's organizational structure. Continued funding as well as agreements with key partners that help conduct tests to develop the market and technology were resource metrics.

Practices for resolving uncertainty. Effective practices involve articulation of (sometimes implicit) assumptions regarding TMRO uncertainties, and the testing of these. Assumptions are tested through experience-based "probe-and-learn" learning approaches (Lynn, Morone, Paulson, 1996). The learning process is iterative, whereby assumptions are reformulated as learning progresses. Similar to Sethi and Iqbal (2008), we found that Stage-Gate, a very common practice in new product development, is counterproductive for BI. This statement by an innovation leader at P&G was echoed by others: "I feel stage-gate is not going to work for radically innovative projects. Even in later stage development, projects won't be ready for stage gate. We're trying to create a new market. It's too uncertain."

Experiments serve to reduce uncertainties. Prototypes were commonly used as "proof of concept" to get some initial market and technical validation. They serve to determine technical feasibility, and can be used in interaction with potential customers to obtain their input, gauge

their interest and identify previously unconsidered potential markets, thereby addressing market uncertainties. Prototypes also helped sell the project to the organization's upper management as a way of mitigating organizational uncertainty. One of the project managers commented: “If we didn't build our prototype and show them what could be done and show them there was a customer out there that really had a need for the technology, then management may not be interested in pursuing this thing.” Sometimes partners are engaged to help execute experiments, which requires that resource uncertainties in the form of partnership choices and terms, be addressed.

Effective experimentation follows a real options logic. “A real option is a limited-size commitment made in the present that provides the right, but not the obligation, to make more substantial investments in the future when more information is available” (McGrath, Keil, Tukiainen, 2006: 53). Options are formulated, their testing is funded in increments as milestones are achieved, and further resource allocation is contingent on the learning that has occurred. Decisions to further investment in certain directions (exercising options) are based on new information, i.e., milestone based funding.

Practices for coping with uncertainty. We found that experimentation was most effective in a culture of learning by doing. Projects always faced many setbacks, such as when an assumption about attractiveness of a market turned out to be false, a field test of a prototype produced disappointing results, or a partner that the team had been cultivating chose not to commit. In some companies, teams put a positive spin on their setbacks to avoid having a project killed, rather than engage in the open discussion necessary to derive learning from their experimentation efforts (cf. Danneels and Vestal, 2020). Since many experiments failed, team members needed to

be reminded of the value of their work. One experimentation leader told us: “These people need assurance that they’re okay because a lot of their work is failure.”

In learning-based project management team members have to admit to lacking the answer to many questions, and design clever experiments to gain knowledge (Colarelli-O’Connor, 1998). Accountability is not for success of experiments, but for the insights that their experiments revealed (cf. Danneels and Vestal, 2020); a perspective at odds with the mainstream organization. Emotional support was necessary to maintain BI project teams’ enthusiasm given their chaotic project environments. Several firms connected project leaders to managers of previous BIs who were legendary in their companies for purposes of mentoring and support. Experimentation leaders described their doors as “always open” to teams, since learning experiments could change the team’s direction rapidly and dramatically. One told us: “I get all the [BI project] leaders together every so often. It’s not a regular meeting. It’s when we have something to talk about. I meet with leaders when they just come by. My door is always open. My role I see as a coach, as a mentor and as a guide.”

Formal training from outside experts in business experimentation occurred in half the cases of Phase 2. Project members in one firm, after being trained in experimentation-based project management tools, said: “It’s ok now to admit we don’t know something. It may be an assumption that we have to test, but we do not have to appear as if we already know the answer.” In nearly every case innovation coaches and experimentation managers facilitated learning based project management work sessions to help teams identify not only the typical technical, market and resource uncertainties, but also the organizational uncertainties, and facilitated the meetings with senior leaders that were necessary to test them (cf. Kelley, Peters, and O’Connor, 2009). This contrasts with the mainstream operational excellence culture, which is oriented toward

accomplishing tasks that are known a priori, in accordance with a previously determined budget and timeline, and not questioning organizational norms or operating models.

Pull from mainstream. Experimentation, like Conceptualization, was open to pressure to fit the business proposals to the current business. Firms better at experimentation avoided business unit participation in this stage of the fledgling business, wary of pressures to align with the mainstream. In companies where the BI effort was dependent on the business units, we observed two types of responses.

First, some firms performed *perfunctory experimentation*, meaning they found one easy pathway to market, and transitioned the project to a business unit. “We have breakthrough ideas that are incrementally executed,” lamented one VP of R&D at Phase 2 case #8. He explained that the pressure for “quick hits” and “low-hanging fruit” led his firm to proceed with concepts most aligned with familiar markets, business models, and products. These could be quickly developed and transitioned to a business unit for market launch. The result was a failure to persist with experimentation of the full set of opportunities that the conceptualization team identified, underleveraging the opportunity domain and reducing it to a single product introduction. The BI goal of setting up a whole new line of business was never accomplished. Second, some of the companies (Phase 2 cases #1, 2, 3, 5, 8, 10, 11,12) *under-resourced* experimentation, such that only ideas serving the mainstream’s current customers could be pursued (cf. Christensen and Bower, 1997; Danneels, 2007). This again under-leveraged the innovation’s potential as a whole new platform of business. Commonly, a lack of dedicated resources and pressure to produce big results quickly, encouraged experimentation teams to seek market validation from the people most likely to talk to them: individuals and companies with whom their firms already had relationships.

SCALING

Definition. Scaling is the competency of ramping up the fledgling business to a point where it can compete with ongoing businesses in operating units for resources and attention. Scaling entails building the necessary infrastructure, responding to market leads and opportunities, designing and instituting repeatable business processes such as manufacturing to a quality standard, order delivery, customer contact and support and financial tracking. Its output is a viable business: only after scaling could ventures be considered as having gained operating status.

Uncertainty. We discuss technical uncertainties first. What works in prototype doesn't work the same way at full scale, and setting up a new manufacturing process is different from running an ongoing plant. Even after experimentation, technical uncertainties remain. In one case, the underlying scientific fundamentals of a material's biodegradability were not well understood, such that it proved inadequate in its first market application as it decomposed too quickly. Sometimes technological uncertainties hinge on unresolved or unarticulated market uncertainties. One firm developed permeable packaging that would retain the freshness of pre-washed produce longer, while retaining air inside the package. The latter was considered desirable because the firm assumed consumers desire bags to appear full. However, this market assumption was proven faulty, which made much cheaper technologies just as suitable.

Second, market uncertainties. The leader of the emerging business has to determine which of the promising markets to pursue first and which to hold for later. While the activity of experimentation reduces market uncertainty, it also generates new market uncertainty. In several cases, potential customers learned about the technology, and inquired regarding potential

applications to their business. The increasing variety of applications caused leaders to lose focus and spread resources too thin. One manager at DuPont was inundated with inquiries, and worked on 21 applications at the same time, each requiring different form factors, performance specifications, and business models. Ultimately he prioritized a dramatically reduced set.

The key activity in scaling is to build a critical mass of resources and design repeatable processes, but uncertainty about attracting those resources is high. Scaling a business requires substantial investments of money and attention to set up new manufacturing facilities, a sales force, an accounting and financial system, and leadership for each functional area of the business. Many companies tried to scale an emerging business within a current operating unit or division. These units, however, were unwilling or unable to make the substantial investment in scaling. Business unit leaders were not in a position to provide those investments given the pressure they faced for delivering near-term profit: “When there are hiccups with new breakthrough businesses, it’s easy for the operating units to say, “It’s not working; let’s keep making our bread-and-butter stuff.” That’s because there’s more volume on other projects ... moving on to something else that makes more revenue.” The leader of Phase 2 case #2’s remote monitoring venture was transferred to a business unit to scale it, but found he could not get the attention or resources needed from BU leaders, given that he had only a few customers at the time, although the market potential was very attractive. He explained: “My big successes are rounding errors to them.” Ultimately he left the company and the venture died.

In scaling, the entry of the fledgling business into the mainstream organization is imminent. We found organizational uncertainty during scaling to revolve around two issues. The first involves uncertainty regarding the ultimate *destination of the venture*. There are three possible transitions paths: transfer to an existing operating unit (for emerging businesses which

align fully or partially with a current part of the organization); creation of a new business unit (for emerging businesses that fit with a domain of innovation intent but not with the current organizational structure); or spin off outside the company (for emerging businesses that have evolved in a direction such that they no longer align with the company's innovation intent). The second aspect of organizational uncertainty regards whether the venture can meet the metrics expected of typical mainstream businesses. Scaling focuses on achieving reliability and predictability of the fledgling businesses' sales and operations. Organizational uncertainty declines as the venture institutes repeatable processes such as manufacturing and order fulfillment, delivery, contracting, customer service and support, and achieves predictability regarding yields, sales, and costs. Eight of the twelve projects studied in Phase 1 were transitioned into Business Units that were unwilling to absorb remaining uncertainties, and subsequently failed.

Goal. The desired outcome of scaling is a viable business that has reached a sufficient level of maturity to stand on its own relative to other businesses in whatever operating unit/business unit/division it will ultimately reside. At the end of this stage, the venture will be able to sustain transition to an existing business unit or stand-alone status as a new business unit. It has established a market presence, and built a market and operational infrastructure necessary to deliver on its value proposition, and to eventually provide consistent quality and yield/cost. In other words, it has growing revenues and a demonstrated path to profitability.

The end result of effective scaling is that the once new venture now becomes part of the mainstream organization. Scaling brings organizational renewal through BI to fruition. In successful cases, assimilation into the mainstream organization is complete: "One of the things we are noticing is that, over time, these businesses blend into the organization. Over time, it will

be harder to carve out the original project, because it becomes part of what we are. ...And so what we're going to find over time is that measuring the revenue contribution [of our breakthrough businesses] is going to be harder for us to articulate, but that's not a bad thing; that's because it's part of the company” (VP Business Development, IBM).

Portfolio. There are two levels of portfolio: one is the portfolio of domains of innovation intent, which was overseen at the corporate senior leader level. The second is at the domain level; each domain is a portfolio of products that grew from conceptualization of and experimentation within the opportunity landscape. Each domain of innovation intent is formulated with the objective of creating an entire new product platform, a new business for the company.

Since scaling businesses is expensive, uncertain, and introduces much newness into the organization, companies could not scale many emerging business at a time. Most companies that succeeded in experimenting to the point of having something to scale had to pace their scaling investments rather than trying to scale multiple ventures at the same time. Those that did try to scale multiple ventures simultaneously found their resources (financial and attention) stretched too thin to adequately build critical mass within each new business.

In most cases, the initial product was not a killer application, but a niche application. TI's Digital Micro Mirror device was originally considered an opportunity for a large market of conference room projectors, but along the way to that killer application, was used in movie theater projection equipment, and later made its way into televisions, holographic disks, head-mounted displays, laser beam machining, and optical computing. In several cases, new applications beyond those that had been imagined and examined presented themselves, as the market became aware of the technological innovation. Sometimes manufacturing process innovations developed during scaling offered new pathways of growth. At Analog Devices a new

sensor that detected changes in the rate of speed appeared to offer an entree into the growing industry of automotive electronics, a domain of innovation intent. Its accelerometer could serve to detonate the airbag upon detection of a dramatic and sudden decrease in speed. However, they became aware of many other application opportunities as the market learned about the technology including, for example, videogame controllers, gyroscopes, and medical equipment. Analog selected those opportunities that could help them hone their manufacturing process capabilities and refine the technology. Eventually, they were able to reduce costs enough to compete in the automotive applications they were originally seeking.

Metrics. We found that effective metrics for scaling included three types. One set of metrics for scaling show gains in resources, such as formation of partnerships or setting up a manufacturing facility, as well as the effective use of these resources, such as growth in sales or high quality production output. The other metric assesses positive market reactions, such as number of new customers, repeat purchase or referrals, and number of new inquiries.

We found the financial metrics of revenue growth and demonstrated path to (but not current) profitability to be effective for scaling. This includes evidence that the venture is moving towards profits, such as process improvements that reduce costs. However, a lack of future-oriented financial metrics led ventures to focus on one application instead of developing the whole platform. For example, in Phase 2 case #10 the innovation group leaders described a pressure to get one project ‘out of the door,’ to show progress by transitioning an incubated project into a business unit. This required focus on the most mature of the products, to the detriment of the other opportunities in the portfolio. Ultimately the company de-funded the innovation group, since the portfolio had grown so thin.

Practices. Three sets of activities constitute the scaling competence: garnering resources for scaling (which far outweigh those required for conceptualization or experimentation); preparing the BI businesses to comply with the operational excellence system; and preparing the organization to accept the new business. The key activity to achieve operating status is the assembly of resources: management team, marketing capabilities, manufacturing or operations and delivery systems, and alliance partners. Often the team composition is changed to incorporate those with acumen in running high-growth businesses. GE's scaling of its business in biotechnology and bioinformatics, for example, required relationships in new markets. They therefore scouted for acquisition candidates to help them build market access. Ultimately, they acquired Amersham for complementary technology and access to customers. Moen added electrical and computer systems engineering to their primarily mechanical engineering stable of technical expertise in order to scale their BI in "motion-sense" faucets. In the experimentation stage, that expertise was accessed through external contractors. Once the commitment was made to scale the business, Moen invested to add those capabilities internally.

We found that alliances supporting experimentation vs. scaling were different; oriented to learning and growth, respectively. Typically scaling requires a re-examination of earlier partnerships. Partners that helped with learning may not be suited for growth into larger volumes. For example, Air Products' oxygen separation technology was developed in a partnership with a much smaller company, to access its ceramics expertise. However, that learning partner was too small to be a partner for scaling as well.

Preparing the BI business to succeed within the operational excellence system in the mainstream organization is the second practice. One firm (Phase 2 case #9) coached emerging businesses about manufacturing efficiency, development of collateral material, and metrics

related to sales and costs, to prepare them for transition to operating units. Scaling coaches, usually senior corporate leaders, oversaw these transitions, such as this interviewee: “I’ve talked to each one of these accelerating businesses’ teams and leaders. We’re working through the status of the business, and where it’s at with regard to scaling. Some of them are scaling and blending into the fabric of the rest of the company ... to become a major force in the various divisions that they reside in.” The challenge was to continue to protect the fledgling businesses from the pull of the mainstream while inculcating new sets of operating norms. Companies that did not provide this protection ended up with failed attempts and frustrated employees, like Phase 2 case #3, which lost its experimentation and scaling leaders during our observation period, and Phase 2 case #12, which lost its BI leader.

Preparing the mainstream organization to accept the new business. Readyng the mainstream organization, or the unit that will ultimately house the new business, forms the counter-part to the practice of readyng the new business. In the few companies where emerging businesses transitioned into the mainstream, we observe these practices: internal communications, resource sharing, broadening the mandate of the receiving unit, and shared governance between the BI unit and receiving unit. We discuss each of these in turn.

The first practice involves legitimizing the new businesses by internal and external communications to build awareness and enthusiasm. Breakthrough businesses that seemed promising were given high visibility in senior leaders’ speeches, in company newsletters, and on company websites. Attention from senior leaders and others promoting the new business helped gain commitment from the rest of the organization and prepared the mainstream to contribute to its success. Second, most firms required that the units where the new business would ultimately be housed had ‘skin in the game’ through shared funding and oversight as the business matured.

The purpose was for the mainstream to feel a sense of ownership and accountability. While conceptualization and experimentation received corporate funding, many of our participating companies required existing businesses to help fund scaling, if they were intended recipient. Third, in two cases the mandate of the receiving unit was broadened, as the breakthrough innovation was not completely aligned because it required a new business model. In cases #1 and #5 specific BU's mandates were modified to incorporate a breakthrough business, since the BU's had little incentive to take on unaligned opportunities. Fourth, some firms composed high-level governance councils whose role was to oversee the transition of fledgling businesses into mainstream operations, comprised of representatives from the dedicated unit and people from the receiving unit. This ensured that the transitioning business would be protected and assisted. However, we noted that BU representatives on these boards tended to incrementalize innovation.

Pull from mainstream. The purpose of scaling is to grow the nascent business so it can operate effectively in the mainstream. If scaling is not done, or is done inside an existing business, the mainstream tends to destroy the fledgling business. Companies struggled with the question of where scaling should be located. Most company leaders tried to scale their emerging businesses inside an operating unit, with the promise to be patient while it grows. In these cases, we observed operating units under-invested in the new ventures, leading to neglect and a slow demise.

We noted that operating units, especially when they house scaling, tend to incrementalize the ventures and relinquish the possibility of creating a new line of business, which is the very purpose of the BI effort. They pull towards exploitation by funding more aligned and nearer-term avenues. At Phase 2 case # 5 each BU wanted only to commercialize the application that fit its business; no BU would take on commercializing “white spaces.” This tendency to exploitation

ignores the rest of the opportunity landscape . Phase 2 case #8 transitioned the application with the closest fit to its mainstream product lines. Once the first product was transitioned, the excitement about the follow on applications died back, and they remained untended. What was initially intended as an emerging new business platform resulted in one new product with typical incremental revenue growth.

DISCUSSION

Our article offers three main contributions. First, we explicate what breakthrough innovation (BI) looks like as an organizational *capability*. Based on 613 interviews with managers involved in BI efforts in 42 companies over 21 years, we present fine-grained insights into goals, metrics, and practices that support this capability. We therefore contribute to the broader stream of research on microfoundations of capabilities, defined as their “distinct skills, processes, procedures, organizational structures, decision rules and disciplines” (Teece, 2007: 319). We distinguish and elaborate three organizational competences, involving the generation of new business ideas, their testing and validation, and setting up the new business. We show that they are all necessary, and that neither alone is sufficient.

BI as a capability contrasts with BI as exception. BI as exception is a one-off project shepherded by a visionary CEO, or bootlegged by a heroic and heretic champion. We showed that to achieve BI reliably and repeatedly, that is for the organization to develop a BI competence, requires persistent and deliberate efforts and investments (cf. Kale et al, 2002; Ethiraj et al. 2005). It is not ad hoc problem solving in which a business may “solve” a problem on a one time basis by setting up a successful exploratory venture (cf. Winter, 2003). We also show the interdependence of the elements that need to be in place for BI to occur. For example,

idea generation per se is useless; ideas fall fallow or are incrementalized without thorough elaboration of the opportunity landscape, validating and well-resourced scaling. Technological innovation is not enough. Without an effective BI capability, many potential breakthroughs are left sitting on the shelves in R&D labs, collecting dust.

Second, our results show that exploitation and exploration commingle in the pursuit of organizational renewal. We therefore help to clarify these core organizational learning constructs (cf. Gupta, Smith, and Shalley, 2006). Renewal is not only about exploration. Contrary to the image of exploration as free play, our findings show that, for a company to benefit, the disciplined application of metrics and practices is required. What is newstream now will become mainstream later (cf. Kanter, 1989). Exploration is done at the service of ultimate exploitation: the creation of a new business that is efficient, reliable, and self-sustaining. Scaling in particular fosters this transition from exploration to exploitation. In sum, the exploitation-exploration dichotomy may have been overly simplified.

Third, we have illuminated how the uncertainties of four varieties (market, technological, resource, and organizational) inherent in BI can be addressed with distinct metrics and practices. In practice, of course, projects will fall along the uncertainty spectrum. The more intense and interwoven the uncertainties, the more the innovation project will be rejected by the mainstream organization. Input and influence from BUs leads to incrementalization. As such we help delineate NPD (new product development) from NBC (new business creation), and by extension the fields of product innovation and corporate venturing. Incremental innovation is a form of exploitation (cf. March, 1991) and has a natural home within ongoing BU operations, while BI as exploration involves setting up an entirely new business. Prior research has shown the classic stage gate process is ill-suited for the latter (Sethi and Iqbal, 2008). We elaborate what is

necessary for creating a new business within an established firm – as opposed to merely creating a new product.

In closing, we highlight a few limitations of our study, which also point to possible future research directions. First, we did not address the organizational arrangements in which BI competences can thrive, in particular how they can be protected from the pull of the mainstream and yet serve corporate renewal. This delicate balance between separateness and integration is a crucial topic for future research. What organization design helps the BI capability work in parallel with the operational excellence of the mainstream organization? Second, we relied primarily on interview accounts. Even though our results are based on a very large number of interviews (613), on-site observations and analysis of internal documents could provide a more detailed picture. Third, we focused the study on large manufacturing firms, albeit across a range of industries. We don't know if our findings are generalizable to service or smaller firms. Fourth, we don't know the relative merits of organic innovation to other modes of renewal, such as alliances and acquisitions. Since BI takes so much time and the devoted resources are somewhat diffuse (such as management time and attention), its merits are hard to determine. Fifth, we don't know if the elements of BI competence we derived, such as goals, metrics, and practices, apply to other competences as well. Future research could examine if these or other factors are key to examining competences more generally.

In this paper we have examined companies' efforts to achieve breakthrough innovation on a repeated basis. Through observing the struggles and successes of 42 firms over three phases that, together, lasted over 20 years, we have contributed to theory of organizational organic renewal through breakthrough innovation. Achieving a BI capability is not easy, as our findings abundantly show.

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TABLE 1: BI COMPETENCE'S THREE SUB-COMPETENCES

	Conceptualization	Experimentation	Scaling
Definition	Generate use cases	Test TMRO assumptions	Ramping up
Goal	Business concepts	Business proposals	Viable business
Portfolio	Interrelated ideas within a domain. Matched to domains of innovation intent	Focus on validated concepts Cull use cases with little promise	Portfolio of new businesses, each with a product family
Uncertainty	Exploration. Identify most pressing TMRO uncertainties	Reduce TMRO uncertainties	Achieve predictability and repeatability
Metrics	Magnitude Richness Strategic alignment Feasibility	Assess learning Clarification of strategy of emerging business	Gain in resources Revenue growth Path to profitability
Practices	Generation Elaboration Articulation	Resolving uncertainty Coping with uncertainty	Assembly of resources Preparing the BI business to succeed within the operational excellence system Preparing the mainstream organization to accept the new business
Pull from mainstream	Incrementalize Conceptualization myopia	Pressure to fit with current business Target current market De-resource	Force-fit into mainstream rather than create new business

Exhibit 1: Research phases and participants

