Article

Project Management Journal
Vol. 50(4) 447–459

DOI: 10.1177/8756972819857881
journals.sagepub.com/home/pmx
SAGE

Crossing the Valley of Death: Managing the When, What, and How of Innovative Development Projects

Christophe Midler[1]

Abstract

The last few decades have seen a profound transformation of innovation project management within automobile firms. During the 1990s, the product development phase was revolutionized by the deployment of heavyweight project management, project portfolio processes, and platform strategies. The 2000s saw the forces of change move upstream in the innovation process, with the development of new methodologies intended to develop and orient creativity, as well as new upfront units acting as innovation labs. However, many upfront creative endeavors still encounter an *innovation valley of death* when they move into the rigid and risk-averse development phase. Thus, the frontier of innovative project organization seems to be the ongoing quest to reconcile the emergence of breakthrough innovations in the upfront phase with the more rationalized nature of development phases. Based on a case study of a disruptive low-cost car, this article analyzes how the product development phase can support innovative exploration to overcome the challenge of achieving a major cost breakthrough. We analyze the specific content of the project's innovations (*fractal innovation*) and the management practices and organizations used to implement them. We characterize how such *innovative product development* can contribute to a new economy of innovative effort within the global innovation funnel of the firm. We compare this global innovation process, where development projects play a major role as a locus for organizational learning, to the customary one in automotive firms, where learning happens essentially in front-end marketing and engineering departments.

Keywords

innovation, product development, project management, automobile industry, low cost disruption, emerging countries

Introduction

The dynamics of projectification in industrial companies have passed through several stages. During the 1990s, transformations focused on the product development phase, aiming to control the quality, cost, and/or timeframe of innovation projects. Although these efforts were successful, they were still criticized for their perceived inability to bring *really* innovative and valuable new solutions to market. Since the 2000s, organizational transformations have been focused more on revitalizing the creative upstream *fuzzy front end* of the innovation funnel. Today, this transition is well underway, with the creation of new innovation labs and the adoption of various methodologies to support exploration and ideation work.

At the same time, however, the limitations of this transition are becoming more and more apparent. There is much evidence that this upfront creative renewal still faces a gap similar to the so-called *innovation valley of death*[1] (Markham, Ward, Aiman-Smith, & Kingon, 2010) or *chasm* (Moore & McKenna, 1999), where projects must successfully navigate development phases in order to reach real, large-scale markets. Many attractive and innovative ideas and proofs of concept either fall at overly harsh stage gates, or are distorted or downgraded into incrementally innovative offers. This is particularly true for products that require heavy investments to be industrialized, such as new vehicles. Thus, the new frontier of innovative project organizing appears to be the quest to reconcile and better integrate the emergence of breakthrough innovations in the upfront phase with the rationalized development and implementation phases.

This article focuses on the unfolding of these two related dynamics—in innovation and project management—in the context of the automobile industry. On the practice side, it explains how projects can make it across the *valley of death*.

[1] Management Research Center, Innovation Interdisciplinary Institute (CRG I3), CNRS-Ecole Polytechnique, Paris, France

Corresponding Author:
Christophe Midler, Management Research Center, Innovation Interdisciplinary Institute (CRG I3), CNRS-Ecole Polytechnique.
Email: christophe.midler@polytechnique.edu

On the theoretical side, it shows how better cross-fertilization between the innovation and project corpuses can be a fruitful way to understand and theorize ongoing innovation strategies and practices.

The article is based on the study of an emblematic case: the development of a disruptive innovation in the automotive industry. This was the Renault Kwid project, which was originally triggered by a strategic impulse in 2010 and subsequently developed between 2012 and 2015 (Midler, Jullien, & Lung, 2017). Renault, like the auto industry in general, instigated a transformation of product development engineering in the 1990s and created new upfront innovation labs and processes in the 2000s. In this context, the Kwid emerged as an attractive concept to serve the low-end market in India. Renault's previous attempts to enter this promising and fast-growing market had failed, because the firm could not move beyond derivative solutions that did not meet specific local needs or customers' budget constraints.

However, crossing the threshold from the initial concept and mock-up to full-scale product development posed an unprecedented challenge. Renault needed to halve the production costs of its previous low-cost project (the Logan, launched in Romania in 2004 [Jullien, Lung, & Midler, 2013]) and develop an entire platform with completely new mechanical parts (engine, gearbox, axles . . .) at less than half the investment cost of a traditional mechanical unit. Traditional decision-making processes would have thrown up a *no-go* at this stage. Or, failing that, traditional development engineering management would have led to a profitability disaster, with massive overspending and an increase in ticket price that would have spelled commercial doom in the Indian market. The project escaped those two traps by experimenting with what we call *innovative development management*, which contrasts sharply with Renault's standard product development management—and that of other car manufacturers too. Ultimately, the project overcame its challenges and was a spectacular market success from day one. We analyze how the project team reconciled the need to innovate (to reach targets that could not be met through standard design rules and solutions) with the constraints of the product process development phase. We show that this reconciliation was due to both the characteristics of the project management of Kwid *and* the specific nature or content of the innovations.

Based on these findings, we propose a type of innovation, distinct from the traditional archetypes described in the literature (radical/incremental, architectural/modular, etc.), which we call *fractal innovation.* On one hand, time constraints ruled out radical innovation in terms of technology or architecture during the Kwid's development phase. On the other hand, however, we cannot call an innovation *incremental* when it slashed product costs in half. *Fractal innovation* refers to an approach in which standard design rules are systematically questioned, along with the full gamut of design variables (product, process, location, industrial options, suppliers, and marketing modes). This is done at every level—from the overall sizing of the project to the definition of individual components' characteristics—in order to adapt the solution closely to the project context. Just one vital limitation is imposed on this creative design activity: It must take place during the detailed development phase, which is highly constrained in terms of both time and budget. Therefore, implementing fractal innovation calls for specific project management techniques, which we analyze here.

This article is based on research conducted through a real-time analysis of the project from spring 2013 to spring 2015 (Midler et al., 2017). It is organized into five sections. Following this introduction, the second section analyzes the literature and our research question. The third section presents our methodology, whereas the fourth section analyzes the Kwid case. The fifth and final section discusses the results of the case from the perspectives of general trends in innovation processes and project management.

Literature Review: The Dynamics of Firm Projectification

The last few decades have seen an impressive proliferation of the project concept throughout business and working life (Lundin, Brady, Eksted, Midler, & Sydow, 2015; Schoper, Wald, Inagason, & Fridgeirsson, 2018). These developments have transformed so-called *permanent organizations* through a process of *projectification* (Aubry & Lenfle, 2012; Midler, 1995; Packendorff & Lindgren, 2014). The project management literature has characterized various patterns found in projectified organizations, which vary depending on the conventions of the sector and the business model of the firm. Keegan and Turner (2002) differentiate between (1) businesses where projects are *sold*, as typically happens in the construction sector or the film industry; and (2) firms where projects are used to *structure internal activities*. Building on this typology, Lundin et al. (2015) differentiate three different projectified archetypes: (1) project-based organizations (PBOs), which deliver projects as their business (similar to Whitley's [2006] *project-based firms*); (2) project-supported organizations (PSOs), which structure their internal activities through projects (similar to Hobday's [2000] *project-led organizations*); and (3) project networks (PNWs), where projects are the dominant means of structuring cross-organization cooperation. In this article, we will focus on a typical case of PSOs: automotive firms.

PSOs are related to the industrial transition from competition predicated on mass production to competition based on innovation (Ben Mahmoud-Jouini & Midler, 1999). As global competition is now the rule in most industries, product ranges are diversified and life cycles are shortened due to aggressive innovation strategies. To stay competitive in the market, firms must maintain a continuous flow of new and varied products. Therefore, developing the innovation capabilities of the firm (more creative ideas, faster and cheaper development, better product quality) emerges as a key source of competitive advantage. The deployment of project management within previously operations-based organizations has been an important component of such strategies to build innovation capability (Brady & Davies, 2004; Gemünden, Lehner, & Kock, 2018; Keegan & Turner, 2002; Schoper et al., 2018).

The literature on project management, new product development, and innovation management paints a more detailed picture of the dynamics of projectification within PSOs. During the late 1980s and early 1990s, the initial focus of projectification was on the product development phase. Researchers, including Wheelwright and Clark (1992), Clark and Fujimoto (1991), and Midler (1993) have emphasized the importance of empowered project-management functions (*heavyweight project management*) in order to push forward specific project objectives in the face of permanent functional strategies, as well as implementing communication and negotiation between experts in line with project aims. Another change during this period was a clearer division between research and development. Previously, new product development was the space where various experts conducted their innovative experiments, often with significant negative effects on development lead times and new product quality. The empowerment of project management instigated the *golden triangle* of project performance (cost, lead time, and project quality) (Westerveld, 2003).

The rapid proliferation of projects within firms called for a multiproject approach. Cooper and Kleinschmidt (1986) and Cooper, Edgett, and Kleinschmidt (1999) developed the project portfolio approach based on their stage-gate process and the related governance committees. This approach produced better alignment and control of global innovation strategy and the implementation of innovation projects. Adopting stage-gate processes clarified the segmentation of the innovation funnel (Wheelwright & Clark, 1992) into various steps (research, advanced engineering, development, production, and sales) and the criteria and conditions for progressing from one step to the next. Project management offices (PMOs) developed as new organizational units to support these processes (Aubry, Müller, Hobbs, & Blomquist, 2010; Hobbs & Aubry, 2007).

Another important transition in the 1990s, associated with product-variety strategies, was the move toward using platforms and modules for complex products such as cars (Cusumano, Nobeoka, & Kentaro, 1998). A platform can be defined as a set of product components and/or modules with standardized interfaces that is physically connected as a stable subset of a stable global product architecture, which can be shared among various final products. Many authors have pointed out the benefits of platformization in terms of lead time, development cost, product quality, and product variety (Cusumano, Nobeoka, & Kentaro, 1998; Gawer, 2009, 2014; Simpson, Siddique, & Jiao, 2006). To manage such a strategy, a new role of platform manager (generally called *program manager* [Blomquist & Müller, 2006]) was created, one level above the product development project manager. The platform manager's role is to manage the dynamics of the common components of the platform, and ensure they are ultimately reused as much as possible in product development projects (Ben Mahmoud-Jouini & Lenfle, 2010).

Adopting a platform strategy induces a new step in the dissociation of innovation activity and product development. Now, product development is focused on integrating reused components or modules within the global product. Innovative features, technologies, and/or modules are developed in advanced engineering departments or sourced from suppliers in order to be *plugged into* the developed vehicle (Maniak, Midler, Lenfle, & Le Pellec, 2014).

The 2000s saw both project management and innovation refocus upstream, on the so-called *fuzzy front end* of the innovation funnel (Kim & Wilemon, 2002; Reid & de Brentani, 2004). This can be seen as a consequence of a new phase in innovation-based competition. The transition of the 1990s successfully established an ongoing and abundant flow of new products within existing dominant designs (Abernathy & Utterback, 1978), without compromising on time to market, design costs, or quality. But saturated traditional markets, along with the increasing number of global competitors, called for more radical innovations to create real differentiation and escape from price wars on undifferentiated products. Unfortunately, the changes of the 1990s could only do so much in this respect. As McDermott and O'Connor (2002, p. 425) put it: "As Concurrent engineering, Design-For-Manufacturability, and the Stage Gate Model all aim to bring the functional areas together early and frequently in the new product development process. This stream of research has helped improve our understanding of the new product development (NPD) process but has implicitly focused on the development of products that are of an incremental, evolutionary nature."

Hence, upfront innovation processes, where new ideas emerge, seem crucial for developing such radical innovation capabilities. This refocusing is seen in both the project management and innovation management literature (Khurana & Rosenthal, 1997; Koen et al., 2001; Midler, Killen, & Kock, 2016). *Reconstructing project management* (Morris, 2013) and *exploration projects* (Lenfle, 2016, 2008; Lenfle & Loch, 2010) are important examples of the project side of this trend. These examples demonstrate that (1) upfront phases are pivotal for project success, and hence must be included in the analytical scope of project management theory; and (2) existing project management models that are tailored to implementation projects are less suitable for managing uncertain upfront explorations. On the innovation literature side, at the strategic and macro levels we saw the development of the ambidexterity literature (Gibson & Birkinshaw, 2004), which explores strategic and organizational patterns that can support both the exploitation of existing designs and the exploration of radically new offers. At a more micro level of innovative design activity, new methods were formalized to support the upfront exploration and ideation phase: Design Thinking (Ben Mahmoud-Jouini, Midler, & Silberzahn, 2016; Brown, 2009; Brown & Katz, 2011); more theory-oriented approaches, such as Concept Knowledge Theory (Hatchuel & Weil, 2008; Le Masson, Weil, & Hatchuel, 2010); and the analysis of experimental processes and role of specific design artefacts, such as *proofs of concept*

(Ben Mahmoud-Jouini & Midler, 2014). At the empirical level, firms built an impressive array of new organizational units devoted to finding breakthrough innovations, such as innovation labs and incubators (Ben Mahmoud-Jouini, 2015; Magadley & Birdi, 2009), and adopted new methodologies to manage exploration and ideation in these new contexts.

Our focus in this article is on a PSO context: automotive firms. The auto industry has largely followed the trajectory of projectification described above, leading to two clear specializations. On one side, there is development vehicle engineering, which focuses on optimizing the quality, lead time, and cost of vehicle development projects. On the other side, we see the development of innovation labs and advanced engineering departments, which explore and experiment with new mobility concepts and features to bring them to maturity (Maniak, Midler, Beaume, & Pechmann, 2014; Midler & Navarre, 2004).

These approaches have significant effects on the efficiency of the global innovation funnel (Markham, 2013). They orient upfront exploration efforts toward relevant value targets that had been neglected by existing approaches that focused on sustaining markets (Christensen, 1998). They help radical concepts to emerge and be tested through adequate experimental processes (Ben Mahmoud-Jouini, Midler, Cruz, & Gaudron, 2014). Yet there is ample evidence that this upfront creative renewal still faces a type of *innovation valley of death* (Markham et al., 2010) that must be crossed in order to bridge development phases and reach real, large-scale markets. Many attractive and innovative ideas and proofs of concept either fall at overly harsh stage gates, or are distorted or downgraded into incremental innovative offers (Christensen, Kaufman, & Shih, 2008; McDermott & O'Connor, 2002). As Christensen et al. (2008, p. 38) put it: "The Stage-Gate system assumes that the proposed strategy is the right strategy; the problem is that except in the case of incremental innovations, the right strategy cannot be completely known in advance. The Stage-Gate system is not suited to the task of assessing innovations whose purpose is to build new growth businesses, but most companies continue to follow it simply because they see no alternative." This is particularly true for products that require heavy investments to be industrialized, such as new vehicles. *Thus, the new frontier of innovative project organizing appears to be the quest to reconcile and better integrate the emergence of breakthrough innovations in the upfront phase with the rationalized development and implementation phases*.

Improving integration in this way can be achieved through two different efforts. The first is improving upstream processes for evaluating innovation, which are usually enacted in go/no-go steering committees. Markham and Lee (2013) emphasize the role of innovation boards as important governance systems to ease the contradiction between the explorative front-end and the exploitative development process. This topic is also addressed by Christensen et al. (2008); the domain of real option value (Kester, 1984; Schwartz & Trigeorgis, 2004; Trigeorgis, 1996); and Maniak's concept of the *full value* of innovation (Maniak, 2010; Maniak et al., 2014), which is concerned with capturing the potential value of innovation.

The other benefit is improving innovative design capability during the development process in order to confront the uncertainties that remain at the go/no-go milestone, because the front-end stage cannot address issues that will emerge from detailed design activity. We address this second issue. Our research question, then, is as follows:

After two decades of dissociation and specialization between innovation and development work, can we reintroduce innovative effort to the product development process—and, if so, how?

In a recent article, Davies, MacAulay, DeBarro, and Thurston (2014) analyzed how an innovation process was recently implemented within the development of an infrastructure megaproject—a typical PBO context. This article addresses the same issue in the PSO automotive context by exploring it at the levels of development work and project team management.

Methodology

To explore our research question, we draw on case-based research into a disruptive project developed by Renault. This study is part of a longitudinal research program focused on the original reverse-innovation strategy (Govindarajan & Trimble, 2012) that Renault has pursued since the late 1990s. A first project, studied in the 2000s (Jullien et al., 2013), dealt with the major cost challenge of developing a profitable car that would sell for €5,000. The resulting product—the Logan—was launched in 2005 and was a great success, leading to an impressively profitable lineage of different models, sold in many different markets around the world (Midler, 2013). In 2013, this low-cost disruptive strategy moved to a new level, with the ambition of developing a profitable and cost-effective car for the Indian market, which would sell for €3,500.

The program director, who we knew from our earlier research, asked if we would study his new project. As this challenge promised a major breakthrough in the auto industry, we accepted and studied development in real time, from spring 2013 to spring 2015 (Midler et al., 2017). When the program obtained a *go* at the development stage-gate, the cost-cutting breakthrough was deemed essential—but that would have been impossible within the usual development rules and best practices of the firm. Thus, innovation during the development phase was a prerequisite if the project team was to succeed. Therefore, this case made a good empirical experiment to study our research question.

Three visits to the project site in Chennai, India, gave us the opportunity to interview the key actors of the team (about 30 people) at three different stages of the development, which provided a non-biased perspective on the progress of the project and a real-time view of events, learnings, achievements, and surprises. We interviewed all the engineers in charge of submodules (engine, gearbox, chassis, and bodywork) as well as functional managers (quality, cost, functionalities, prototype, logistics, marketing, and sales). The interviews, which lasted one to two hours, were aimed at analyzing: (1) development practices, through elementary component-case analysis; (2) the methodologies and design process in use; (3) the ongoing results on the perimeter, based on the trajectory of key performance indicators; and (4) the problems that were encountered. The interviews, invariably conducted by two different researchers, were triangulated with an exhaustive analysis of internal documents produced for project committees. This project-centric analysis was complemented with interviews with five key strategic leaders of the Renault-Nissan Alliance, including the CEO, the Senior Vice President of the Renault-Nissan Alliance, and the Senior Vice President in charge of Renault Design. A monograph describing the project was written (Midler et al., 2017) and discussed with the project director for validation.

Innovative Product Development: The Kwid Case

In this section, first we describe the global project monograph, before focusing on characterizing the innovation that was deployed and how it was managed. Finally, we analyze the Kwid case as a new step in the historical transition of Renault's projectification.

The Kwid is an emblematic case of low-cost disruption (Christensen, 1998; Gemünden, 2015) and reverse innovation (Govindarajan & Trimble, 2012). It was part of a global program based on the assumption of expanding middle classes in the emerging countries, with India regarded as a major lead market (Beise, 2001). Renault's ambition was to conquer the Indian entry-level segment, which represents 70% of the entire Indian market and is rapidly growing. Industrialization was sized for more than 100,000 units a year for the Indian market. The go-decision was made by the CEO himself, Carlos Ghosn, who specifically endorsed the project—over the reluctance of the Nissan side of the alliance. In fact, Renault had already experimented with a successful low-end disruption strategy with the Logan, which had been driven forward by its previous CEO, Louis Schweitzer (Jullien et al., 2013). Nissan's strategy, in contrast, is traditionally more oriented to high-end market segments.

After a rather long and difficult strategic exploration phase, which began in Q1 2010 and lasted through the end of 2012, the go decision for the product[2] development phase was made in January 2013, targeting a commercial launch in September 2015. One important point of agreement was on the exterior design of the car: a mini SUV style that fit in with a major style trend in India and elsewhere, and would clearly differentiate the new product from existing small cars in the Indian market (See Figure 1).

Renault targeted a timespan of about three years from design freeze to commercial launch—a fairly standard challenge for a new automotive platform project in terms of lead time.

Figure 1. The Renault Kwid. (Source: Renault)

The biggest area of risk was the unprecedented challenge in terms of production cost and investment. India's low-end car market comprises cars sold for under €4,000. Since the new product had to show a profit at a price of €3,500 in 2015, the project therefore targeted a 50% reduction in manufacturing cost compared to the Logan, which had itself cost 50% less than Renault had ever managed when released in 2005 (Jullien et al., 2013). On top of this, the project had to achieve a new engine, a new gearbox, and two different vehicles based on the platform (the Renault Kwid and the Datsun Redi-GO)—all for a target cost of €400 million, or one-third of the cost of an equivalent industrial capacity under Renault's normal processes.

The graphs in Figures 2 and 3 show the success of the project in terms of cost reduction and sales. The Kwid established itself as the first competitor to Maruti and Hyundai, which together accounted for 75% of the Indian low-end market.

To understand how such a breakthrough was implemented, we will first analyze the specific innovations that were implemented during the development, before characterizing the project management practices that supported this innovative design.

The What: Fractal Innovation and the Kwid

Among the standard typologies of innovation (Garcia & Calantone, 2002), the dichotomy between *breakthrough innovation* and *incremental innovation* is probably the most well-known. *Breakthrough innovation* involves profoundly destabilizing the incumbent design system, whereas *incremental innovation* involves the continuous, cumulative improvement of a *dominant design* (Abernathy & Utterback, 1978) within the existing design system. However, the case of the Kwid revealed the ambiguities within this apparent contrast. As a car, the Kwid did not introduce any remarkable breakthrough—it represented neither a major technological leap nor a change in mobility business model. However, as a modern, attractive car priced at €3,500, there was no doubt that it represented an unprecedented automotive experience. Indeed, it was precisely this match between price and value proposition that created the breakthrough.

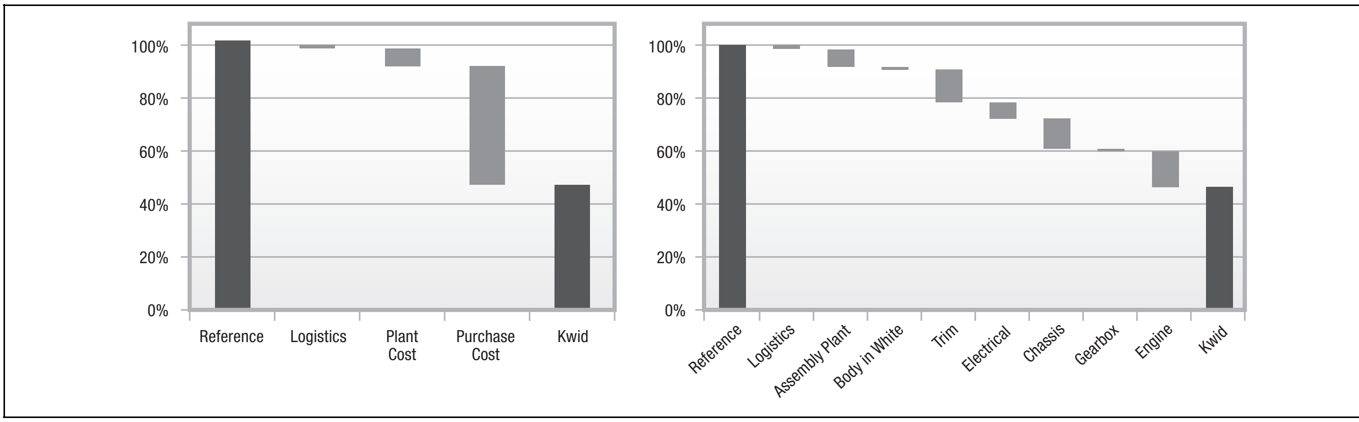

Figure 2. Decomposition of costs relative to the reference vehicle. (Source: original research)

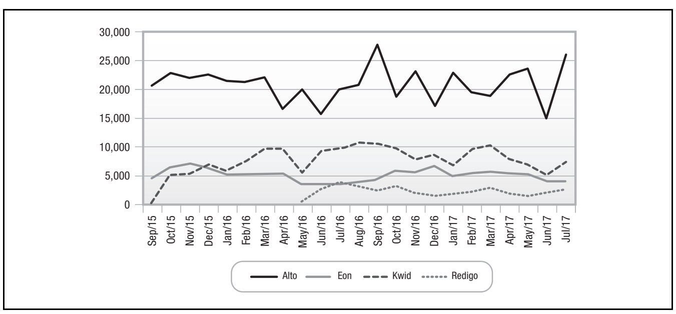

Figure 3. Comparison of main competitor sales in the Indian low-end market. (Source: original research)

The typologies proposed by Abernathy and Utterback (1978) and Henderson and Clark (1990) in their classic works on innovation and engineering, emphasize the architectural characteristics of products. Innovation can take place in the components of the product (*modular* or *component* innovation), through a change in the product's architecture itself (*architectural* innovation), or through a combination of the two (*radical* innovation).

According to these traditional views, the Kwid would be placed in the *incremental* box: it featured no new architecture and no new technology that radically changed any of its components. However, this erases the significance of the breakthrough heralded by the Kwid's design. For example, the processes and organization of the engineering teams were utterly destabilized. Moreover, look at the results achieved: How could anyone claim that cutting the cost of a firm's cheapest product in half was in any sense *incremental*?

Another important type of innovation is known under its Japanese denomination: Kaizen (Imai, 1986). Often translated as *continuous improvement*, Kaizen takes an existing process and improves it incrementally over time. What the Kwid innovation shares with Kaizen is the distributed scope of innovative effort. The global cost-cutting breakthrough was made by systematically redesigning all the components of the product and the process, right down to the tiniest detail. However, that is where the similarities end. Kaizen is basically a progressive, path-dependent approach that improves extant situations in a marginal way. In contrast, the Kwid represented a decisive break from the existing situation (halving the cost of the Logan). Moreover, it did not build on existing solutions, but was driven by completely exogenous top-down objectives imposed by competitor performance and/or the economic imperatives of the market.

Faced with the inadequacy of existing categories to typify the Kwid breakthrough, we proposed the concept of *fractal innovation* (Midler et al., 2017) to describe the nature of the innovative content implemented in the detailed design phase. *Fractal innovation* refers to a design process in which the product definition and design rules are systematically questioned—and, more often than not, broken. Also called into question is the full gamut of design variables: product, process, location, industrial options, suppliers, and marketing modes. This process takes place at every scale, from the overall sizing of the project to the characteristics of each and every component, from cable diameters to screwdriver specifications.

The example of the Kwid's electrical system illustrates the importance of micro-analyzing every last part, no matter how small, with an understanding of all the systems in which it would be used. This approach revealed that relatively few levers were available for saving costs on the alternator, which would otherwise have put a strain on the whole electrical system for the sake of reducing electrical consumption. The team set a maximum limit on the power of the fan, but tweaked the dimensions of the radiator grille so that more air could be sucked in with the same power. The team also changed the shape of the blades for better efficiency at the same power and practically the same cost. "We saw that in Japan, Honda uses less powerful and smaller engines in its higher-end cars, which helped us leverage our options," says the engineer in charge of the domain. On cable ducts, the group found that if the section size was reduced, the cables inside overheated. Thus, they had to stay within acceptable limits—particularly for sweltering India. "We had to modify the circuits so that the key areas weren't overexposed to heat. We don't normally do this, because it is a long and cumbersome process. But we hoped to sell in India, so we were mindful of saving a few rupees. In Europe, we just would not have measured those micro-economies in euros ... However, finally, we saved two kilograms of copper and the cabling was half as heavy as in a Sandero."

The fractal category specifies the *what* of the innovation, not the *why*. In the field of strategy, the Kwid can be perfectly defined as a low-end disruption innovation (Christensen, 1998), a bottom-of-the-pyramid innovation (Prahalad, 2012), or a Jugaad innovation (Radjou, Prabhu, & Ahuja, 2012). Such categories characterize the market position of an innovation in relation to competitors. The notion of fractal innovation characterizes the innovation physically, linking it to a design process that results in innovation. These notions do not overlap or contradict each other. The Kwid is a case of fractal innovation oriented toward a low-cost or bottom-of-the-pyramid target, whereas the Toyota Prius provides an example of fractal innovation oriented toward another value target—in that case, an optimization of the vehicle system around hybrid technology (Itazaki, 1999).

The How: The Kwid's Innovative Development Process

When the Kwid got the go-ahead in January 2013, it raised an unprecedented challenge in terms of cost and investment reduction. Such a challenge could not have been met with the usual practices used by the development engineering team in Renault's central headquarters. Instead, innovation had to be brought into the development phase. Capitalizing on the project capability of the firm (Midler, 1995)—and, more specifically, Renault's previous low-cost success story (Midler, 2013)—the project adopted what we call an *innovative development process*. This approach contrasts with the general model in the automotive industry, where innovation takes place upstream, and development engineering is a near-industrialized process based on implementing standardized design rules targeted at minimizing quality risk, development lead time, and engineering costs. The analysis of the project's practices made it possible to identify eight characteristic components of this innovative development process: (1) design to cost, (2) concurrent engineering and colocated project team, (3) openness to the local environment, (4) intrusive management, (5) agile learning and decision making, (6) adapting standard development planning, (7) heavyweight project management, and (8) ambidextrous governance. These components are described as follows.

1. *Design to cost.* The overarching aim of this innovative development process was to cut costs. The design work for the electrical/electronic domain of the vehicle exemplifies managing fractal innovation from a design-to-cost perspective. "On the whole, it went well," says the manager in charge of the domain, who was present right from the start of the project. "Overall, we reduced the cost of cabling by half, from 6,000 to 3,000 rupees [€80 to €40]. We also minimized the weight. The work involved was very creative. The group studied 250 to 300 ideas—some at two, five, or ten rupees [2.5, 6.5, and 13 Euro cents, respectively], and even some at 100 rupees." The group engaged three suppliers: an Indian supplier who was already supplying a competitor with whom they were fully familiar, a European supplier who had already worked on the Logan and understood the *design to cost* approach, and a Japanese supplier.

The group started off by analyzing their benchmark: Maruti's Alto. It soon emerged that the Alto had very different specifications from Renault-Nissan models. Both Renault and Nissan rules required fastenings to be fixed every 10 to 15 centimeters. But Indian competitors were placing fastenings at intervals of 20 centimeters, which could save Renault many fastenings per vehicle. So why were these rules in place? "Corporate had no answer when we came back to them on the reason for this technical specification," explains the engineer. "The company had forgotten the reason behind the standard. So they agreed to waive it if we showed that it could work." Such clearances are not always easy to obtain. "For connectors, we looked at what was on the market. In India, none of the horn switches in the market were waterproof—but this was prohibited within Renault. Approving a new connector would take two years. We went for an off-the-shelf solution from a supplier based in India. We had to convince [Corporate] that getting thousands more cars on the Indian roads was worth two years on the test bench at Lardy."

The interviews with the members of the team made it possible to analyze the design practices implemented in the project on the basis of two materials: on the one hand, the descriptions of the processes and methods implemented by the actors (nature and participants of the meetings, reporting implemented, decision-making processes); and on the other hand, the detailed account of the design of particular sub-assemblies (cabling, gearbox, chassis, etc.) illustrating the implementation of these processes and methods as their results. We then characterized what seemed to us to be the seven salient features of these practices. Most of them—such as concurrent engineering, open innovation, heavyweight project management, agile learning or ambidextrous project governance—embody principles already described in the literature on project management. The originality of the approach lay in the simultaneous and extremely rigorous implementation of these principles in a detailed product development phase. This is an approach we have named innovative development project (Midler et al., 2017).

2. *Concurrent engineering and colocated project team* (Garel, 1996; Teasley, Covi, Krishnan, & Olson, 2000) was implemented systematically. Right from the start, the whole team was colocated at the Chennai site, far from the headquarters of both parent firms. At the component and system levels, as demonstrated by the example of the electric system, all the analyses involved multidisciplinary teamwork encompassing product, process, marketing, and purchasing—whoever could offer expertise in cost-cutting.

3. *Openness to the local environment.* Locating the team in Chennai did more than stimulate the cross-professional

optimization of the design. It also immersed the project team in the Indian context, cultivating major knowledge integration (Berggren & Bergek, 2011). In terms of mobility usage and product functionality, the team saw huge differences between Indian mobility and usage in mature auto markets. In term of industrial context, they could appreciate new opportunities and the constraints on technological solutions and component supply, which represented 75% of the product cost. The strategy was to involve Indian suppliers as active and early contributors in the product design process, and adopt their solution if it proved reliable. The major impact of this supplier co-design strategy appears clearly in Figure 2, where the purchase contribution to the global cost reduction is largely dominant. Here we see a complete transgression of the usual professional practices in the automotive sector, which generally adopts a *transplant* strategy (Florida & Kenney, 1991): first, copy-paste the industrial system of the mature market, then choose the supplier from the existing certified supplier panel.

4. *Intrusive management.* Flouting the firm's standard design rules was a constant in the design-to-cost approach. We analyzed many examples of such transgressions, on product functional requirements as well as on technical specifications or process and industrial norms. The following anecdote, from the chief engineer, exemplifies the inflexibility of design norms. "At the beginning of the program, we sent our main competitor product to testing services at Renault headquarters. It's the Maruti Alto, the most popular model in India. We got the results of the benchmarks in terms of comfort, performance, and braking. Head office's verdict was that this car was unsellable! But it's the top selling car in India . . . " This merely goes to show why the standards of product testing—the basis of the car industry in the developed world—should be called into question and adapted accordingly. Of course, such a mismatch in quality standards generated much debate and conflict between central services, the guardians of the standards adapted to mature markets, and the Kwid project team. For the latter, the experience of repeated failures with derivative products clearly showed that adopting such standards simply would not support entry into the target market.

5. *Agile learning and decision making.* When developing a product, inertia leads to conformism. Because every solution has to be properly validated, it is much easier to choose a standard solution over an original and untested alternative. To avoid such inertia, the design to cost process forced a permanent and systematic exploration of new scenarios to reach the cost target. In the Kwid's design-to-cost Friday meetings, true metronomes of the permanent innovation process, the new solutions explored during the week were discussed and decided to be implemented the following week. The normal loop in a big auto firm would have taken weeks, and would have included the reporting process to technical and product central departments and arbitration meetings between hierarchies. Such rapid, iterative learning loops, conducted by multidisciplinary groups, strongly resemble the agile principles seen in software development (Beck et al., 2001). These agile learning processes were also useful in managing the risks of the project. Obviously, the rigorous design-to-cost approach generated quality risks that had to be controlled. One example is noise level, which is difficult to evaluate before products resulting from mass-production processes can be tested. In this case, the early preparation of alternatives and short decision-making loops allowed the products to be realigned by minimizing the time losses during production ramp-up.

6. *Adapting standard development planning.* To make such agile innovative approach work, the standard development planning was modified. The global body style freeze, a key turning point in the automotive process, was brought forward, so engineers and suppliers could begin the detailed study earlier. But at the same time, this global freeze has left room for adaptation for the implementation of fractal innovations. When these innovations challenged the exterior style, the stylist in charge of the perimeter in the project team submitted the proposed change to the central design studio. The decision was then made jointly by the company's design director and the program director. Further downstream the development process, the final contracting decision was delayed until the design-to-cost approach succeeded in reaching its cost target.

7. *Heavyweight project management* (Clark & Fujimoto, 1991). Such transgressions cannot be pushed through without a heavyweight project management model. In this case, success depended on the charismatic leadership of a highly legitimate and skilled manager (the former project manager of the Logan). Behind the leader stood a heavyweight project management team, its 30 members[3] comprising highly experienced people drawn from a range of departments. Their abilities and backgrounds gave them the autonomy to break free from copy-paste design norms, but without losing sight of the associated risks—as illustrated by the example of the electrical design. As the engineer in charge observed: "Wire harness is a domain that seems less technical, but in fact requires an understanding of the whole vehicle—everything that consumes power, and everything that generates electricity. We got results via a snowball effect: once we improved the performance of the fan, we could shrink its motor. Having minimized power consumption, we could reduce the diameter of the wire, alternator size, and so forth. Ultimately, we could use an alternator that weighed 3.4 kilograms—1.5 kilograms less than the one we initially targeted." Another important point is that the team, though far from headquarters (HQ) and often at odds with its rules, could count on back-office support if necessary, through its members' broad and deep informal professional networks.

8. *Ambidextrous governance.* Such heavyweight project management is associated with high-level governance that enjoys strong support from the CEO, in line with the archetypal structure of an ambidextrous organization (Tushman & O'Reilly, 1996). The many transgressions of usual best practices and design rules created many conflicts between the project team and technical and marketing departments back at HQ.

Table 1. Connecting the When, What, and How of Innovation Work Along the Design Process

Phase: When?	Research/Lab	Advanced Engineering	Product Development	Production
Innovative content: What?	New technologies, architecture, and concept exploration and ideation	New features and technological components or module maturation	Fractal innovation on vanguard project at the detailed design level	Incremental improvements of existing products and processes
Innovative methodologies and project management: How?	Exploration projects, Design Thinking, Concept Knowledge methodology, POC…	"On the shelf" testing and validation of components; TRL (Technology Readiness Level) maturation	Innovative development, agile learning, intrusive management, heavyweight project management	Kaizen innovation processes

On many occasions, the CEO had to intervene directly to arbitrate such conflicts, and maintain the autonomy of the project to *do differently* from *business as usual*.

Discussion

Returning to our research question, the Kwid project demonstrates how innovation effort can also take place in the product development phase, focusing on a specific innovation scope and using specific project management practices.

Reopening Downstream Phases to Innovation

For a decade, the spotlight of innovation remained fixed on the pre-engineering design phases, as if collective creativity could spring from nowhere else. This was true of both academia and industry. The best that could happen in the rest of the story—the development project—was that this early creative vision would be preserved. In contrast, the Kwid team's implementation approach offered to give product development back its creative dimension—something it had lost as a result of the previous strategy of streamlining design.

This approach could be used to open up new horizons and bring authentically original products to market (Gemünden, 2015). In the case of the Kwid, ingenuity and agile learning in the development phase were mobilized to cut costs. On another project, however, they might serve other performance dimensions. At Toyota, for example, the first Prius project implemented fractal innovation to enhance the energy-saving performance of the new hybrid car (Itazaki, 1999). Research on electric vehicles shows how decisive development engineering phases were in expanding the sphere of innovation to the electric mobility system more globally—encompassing the car, infrastructure, and services required for this new technology (von Pechmann, Midler, Maniak, & Charue-Duboc, 2015). Tesla's autonomous driving strategy is even expanding the innovation effort beyond the customer's purchase, through a process of Over the Air upgrading driving assistance software strategy (Weinman, 2016). This once again shows the close relationship between the nature of innovation (software, in this case) and the moment it can be designed (here, the commercial life cycle)—just as we saw a relationship between fractal innovation and development with the Kwid.

Innovation Content and Project Management: Connecting the When, What, and How

We have characterized the specific nature of innovation content that takes place in the innovative development process. It does not involve significant technological or architectural changes that can only be implemented in the upfront phases, because of the necessary long validation processes. Such upfront breakthroughs, although spectacular, are limited in their scope: Ilab or advanced engineering teams cannot go deep in the detailed redesign of new products, when dealing with complex products and processes as the automotive vehicle and production line.

On the contrary, fractal innovation works on renewing every component, in detail, across the entire scope of product and process. We have shown how different this is from traditional approaches: It involves the systematic rethinking and transgression of existing design rules; the concurrent, open exploration of potential solutions to reach the goal of the project; and agile learning loops and decision-making processes. We have also seen the resources that are needed to implement such innovative development: heavyweight project management, highly expert team members, and ambidextrous governance to support the autonomy of the project.

We also demonstrated how fractal innovation differs from Kaizen innovation. Kaizen is a path-dependent, incremental process that takes place during the production phase of a product's life cycle. Fractal innovation, meanwhile, is a top-down, goal-oriented, intrusive change process that can affect all process and product variables, regardless of existing practices. Thus, it is far more systematic and powerful in its capacity to renew.

Table 1 synthetizes the nature of innovative work and content at the various phases of the new product design project.

Toward a Dual Economy of Innovative Effort and Organizational Learning

Broadening our perspective from development to the global scope of innovation within the firm, we can see how the Kwid case exemplifies a new way to deploy innovative effort along the innovation funnel.

In the usual process, innovation effort is concentrated in the upstream phases of exploring and ideating breakthrough concepts within innovation labs and in the maturation of new technological solutions in advanced engineering departments (Maniak et al., 2014). Subsequently, the product development phase is essentially devoted to implementing, reusing, and integrating those components in the global system of the product (Midler, 1995; Midler & Navarre, 2004). Following product launch, incremental innovation is implemented within the production system through a Kaizen approach. In this sequence, learning is essentially done in strategic marketing, technology departments, and innovation labs, while projects are essentially implementation projects.

In the Kwid case, the development project was a key phase of learning and innovation for the firm. The initial breakthroughs initiated a new project lineage (Midler, 2013) beyond the initial Kwid project, as shown by the launch of the Redi-GO (a Nissan vehicle based on the Kwid platform), the deployment of the Kwid in Brazil, and the development of an electrified Kwid in China (Chen & Midler, 2016). In previous research on the Logan project (Jullien et al., 2013; Midler, 2013), we analyzed how such early breakthroughs could instigate a more global learning track through the deployment of a lineage (Gemünden et al., 2018; Maniak & Midler, 2014; Midler, 2013). A lineage crystallizes a project-to-project learning process that has been initiated by a vanguard project (Brady & Davies, 2004). Lineage management, based on a program management structure (Maylor, Brady, Cooke-Davies, & Hodgson, 2006), preserves the original DNA of the initial concept from project to project over time, while adapting and developing it based on new learnings and contexts. In the case of the Logan, the engineering teams on the Entry program created a series of five different products from 2004 to 2011—from the Sandero hatchback, a station wagon, and a pickup to the SUV Duster and monospace Lodgy. These models were made increasingly profitable by taking advantage of short-loop market feedback (Midler, 2013). In such a sequence, new product development projects are key loci for organizational learning.

The coexistence of those two different innovation processes within contemporary firms is certainly an interesting topic for management research. A key factor in such project-based learning is the capacity of the so-called *permanent organization* to capitalize on and deploy local project learnings (Berggren & Bergek, 2011). A difficult issue here, as we saw, is that such vanguard projects systematically question and transgress the best practices of head office departments.

Conclusion

In this article, we studied how innovative effort is deployed through the global process of the innovation funnel. We characterized the place and role of product development projects in the global learning process of the firm, and analyzed the consequences for the way development projects are managed.

Our case study of an innovative low-cost car for the Indian market demonstrates that, in contrast to the usual sequence, where development projects are essentially implementation processes aimed at minimizing risks, *development can provide space for significant innovative work within the strict constraints of this phase*. We characterized such *innovative development* as *fractal innovation*, and specified the project management practices required to implement it: heavyweight project management; systematic concurrent design in a colocated, autonomous and highly skilled project team; open innovation practices to capture local knowledge; agile learning and decision loops; intrusive management to systematically question existing design rules; adapted planning; and ambidextrous governance. We showed how such creative development projects could take place in a specific global innovation sequence from upfront innovation lab to downstream Kaizen processes within existing production lines. We specified (1) the content of innovative effort; and (2) the process at each step of this sequence, thus connecting the when, what, and how of innovation management. We characterized two different sequences: the dominant one in contemporary firms, where the locus of learning is essentially within upstream functional departments; and the one we studied, where the development project was an essential means to explore and deploy new knowledge.

As a managerial contribution, this article shows how firms can ensure that risky breakthrough ideas that emerge in upfront innovation labs make it across the *valley of death* by implementing innovative development project management. It proposes a new economy of the deployment of innovative effort across the whole scope of the innovation funnel, specifying its content (what?) and process (how?) at each step. Today, traversing the *valley of death* depends on the *gut feeling* of powerful, innovation-friendly leaders who can impose go decisions during stage-gate processes. Indeed, the history of the Kwid illustrates precisely that. But such stories are the exception rather than the rule, and do not guarantee that the decisions made will be properly implemented. Developing innovative development capability is the best way to make upstream go/no-go decisions something more than risky bets based on the hunches or enthusiasm of a few managers.

Received wisdom suggests that significant value breakthroughs can only be achieved in the upstream creative phases of projects. The detailed development phase only figures as an implementation step that, at best, merely preserves this value at minimum cost. Our study shows that this phase can also be a major lever for value creation, and identifies the necessary conditions for this to happen through seven process and organizational characteristics: (1) concurrent engineering and colocated project teams, (2) opening to local market as industrial environment, (3) intrusive management, (4) agile learning and decision making, (5) adaptation of the standard development planning, (6) heavyweight project management, and (7) ambidextrous governance.

As a theoretical contribution, we demonstrate the fruitfulness of bridging the project management and innovation literature to better characterize the nature of innovative work within new product development projects. Our study opens up new perspectives on the role of product development projects in organizing exploration and exploitation in industrial firms. It characterizes the management conditions that allow agile exploration and learning within the constrained phase of detailed development. Some of those conditions are in harmony with the existing literature on vanguard projects (such as heavyweight project management, concurrent and colocated project teams, autonomy, and support from ambidextrous sponsorship). They also connect agile development and open innovation literature. More globally, by connecting the *when*, *what*, and *how* of innovation work within the innovation funnel, our study complements literature that, in general, either focuses on just one phase or encompasses the entire process without going deeply into the content of its constituent phases.

A promising avenue for future research would be to further explore the two different innovation sequences we identified within firms: one driven by permanent organizational units, where projects are essentially vehicles for implementing and integrating existing knowledge and components; and another, where development projects are an essential locus for new knowledge exploration, and permanent organizational units are a means to capitalize on and deploy those project findings.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received financial support for the research, authorship, and/or publication of this article: This research has been supported by the Institut de la Mobilité Durable (Sustainable Mobility Institute), a join research program between the French ParisTech Grandes Ecoles and the Renault Group.

Notes

1. The *valley of death* metaphor was used to describe gaps in the trajectory of innovations, from basic research to commercialization: the resource gap between publicly funded research and the privately supported development phase, or gaps between advanced research labs and development units within firms (Markham, 2002). The *chasm* metaphor was introduced by Moore and McKenna (1999) to describe the same type of gap in the context of the development trajectory of technology start-ups.
2. In fact, the program was a platform project with two different products: the Renault-branded Kwid and the Datsun-Nissan Redi-GO. We focus our monograph on the Renault Kwid part, which was the first to be developed and launched.
3. These 30 were mainly Renault people, with a few from Nissan. The other 350 members of the project team were Indian engineers and technicians.

References

Abernathy, W. J., & Utterback, J. M. (1978). Patterns of industrial innovation. *Technology Review*, *80*, 41–47.

Aubry, M., & Lenfle, S. (2012). Projectification: Midler's footprint in the project management field. *International Journal of Managing Projects in Business*, *5*(4), 680–694.

Aubry, M., Müller, R., Hobbs, B., & Blomquist, T. (2010). Project management offices in transition. *International Journal of Project Management*, *28*(8), 766–778.

Beck, K., Beedle, M., Van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., . . . Thomas, D. (2001). *Manifesto for agile software development*. Retrieved from http://www.agilemanifesto.org/

Beise, M. (2001). *Lead markets: Country-specific success factors of the global diffusion of innovations* (Vol. *14*). Berlin, Germany: Springer Science & Business Media.

Ben Mahmoud-Jouini, S. (2015, June). Innovation units within established firms: Towards a cartography. *IPDMC Proceedings, Copenhagen, Denmark*.

Ben Mahmoud-Jouini, S., & Lenfle, S. (2010). Platform re-use lessons from the automotive industry. *International Journal of Operations & Production Management*, *30*(1), 98–124.

Ben Mahmoud-Jouini, S. B., & Midler, C. (1999). Compétition par l'innovation et dynamique des systèmes de conception dans les entreprises françaises—Une comparaison de trois secteurs (Innovation-based competition and the dynamics of design systems of firms: A comparison between three sectors). *Entreprise et Histoire*, *23*(4), 36–62.

Ben Mahmoud-Jouini, S., Midler, C., Cruz, V., & Gaudron, N. (2014). How physical artefacts contribute to design processes. *Academy of Management Proceedings*, Academy of Management, Briarcliff Manor, NY, *2014*(1), 14113.

Ben Mahmoud-Jouini, S., Midler, C., & Silberzahn, P. (2016). Contributions of design thinking to project management in an innovation context. *Project Management Journal*, *47*(2), 144–156.

Berggren, C., & Bergek, A. (Eds.). (2011). *Knowledge integration and innovation: Critical challenges facing international technology-based firms*. Oxford, UK: Oxford University Press.

Blomquist, T., & Müller, R. (2006). Practices, roles, and responsibilities of middle managers in program and portfolio management. *Project Management Journal*, *37*(1), 52–66.

Brady, T., & Davies, A. (2004). Building project capabilities: From exploratory to exploitative learning. *Organization Studies*, *25*(9), 1601–1621.

Brown, T. (2009). *Change by design: How design thinking transforms organizations and inspires innovation*. New York, NY: HarperCollins.

Brown, T., & Katz, B. (2011). Change by design. *Journal of Product Innovation Management*, *28*(3), 381–383.

Chen, B., & Midler, C. (2016). Designing strategy for the globalization of innovation: Perspectives for foreign electric vehicle manufacturers in China. *International Journal of Automotive Technology and Management*, *16*(4), 436–463.

Christensen, C. M. (1998). *The innovator's dilemna: When new technologies cause great firms to fail*. Cambridge, MA: Harvard Business School Press.

Christensen, C. M., Kaufman, S. P., & Shih, W. C. (2008). Innovation killers. *Harvard Business Review*, *86*(1), 98–105.

Clark, K. B., & Fujimoto, T. (1991). *Product development performance: Strategy, organization and management in the world auto industry*. Boston, MA: Harvard Business School Press.

Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (1999). New product portfolio management: Practices and performance. *Journal of Product Innovation Management*, *16*(4), 333–351.

Cooper, R. G., & Kleinschmidt, E. J. (1986). An investigation into the new product process: Steps, deficiencies and impact. *Journal of Product Innovation Management*, *3*(2), 71–85.

Cusumano, M. A., Nobeoka, K., & Kentaro, N. (1998). *Thinking beyond lean: How multi-project management is transforming product development at Toyota and other companies*. New York, NY: Simon and Schuster.

Davies, A., MacAulay, S., DeBarro, T., & Thurston, M. (2014). Making innovation happen in a megaproject: London's crossrail suburban railway system. *Project Management Journal*, *45*(6), 25–37.

Florida, R., & Kenney, M. (1991). Transplanted organizations: The transfer of Japanese industrial organization to the US. *American Sociological Review*, *56*, 381–398.

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: A literature review. *The Journal of Product Innovation Management*, *19*(2), 110–132.

Garel, G. (1996). L'entreprise sur un plateau: Un exemple de gestion de projet concourante dans l'industrie automobile. *EUROPE*, *6*, 8.

Gawer, A. (2009). *Platforms, markets and innovation*. Cheltenham, UK: Edward Elgar Publishing.

Gawer, A. (2014). Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research Policy*, *43*(7), 1239–1249.

Gemünden, H. G. (2015). When less is more, and when less is less. *Project Management Journal*, *46*(3), 3–9.

Gemünden, H. G., Lehner, P., & Kock, A. (2018). The project-oriented organization and its contribution to innovation. *International Journal of Project Management*, *36*(1), 147–160.

Gibson, C. B., & Birkinshaw, J. (2004). The antecedents, consequences, and mediating role of organizational ambidexterity. *Academy of Management Journal*, *47*(2), 209–226.

Govindarajan, V., & Trimble, C. (2012). *Reverse innovation: Create far from home, win everywhere*. Brighton, MA: Harvard Business Press.

Hatchuel, A., & Weil, B. (2008). C-K design theory: An advanced formulation. *Research in Engineering Design*, *19*(4), 181–192.

Henderson, R. M., & Clark, K. B. (1990). Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*, *35*, 9–30.

Hobbs, B., & Aubry, M. (2007). A multi-phase research program investigating project management offices (PMOs): The results of phase 1. *Project Management Journal*, *38*(1), 74–86.

Hobday, M. (2000). The project-based organisation: An ideal form for managing complex products and systems? *Research Policy*, *29*(7–8), 871–893.

Imai, M. (1986). *Kaizen* (Vol. *201*). New York, NY: Random House Business Division.

Itazaki, H. (1999). *The Prius that shook the world*. Tokyo, Japan: Nikkan Kogyo Shimbun.

Jullien, B., Lung, Y., & Midler, C. (2013). *The Logan epic: New trajectories for innovation*. Paris, France: Dunod.

Keegan, A., & Turner, J. R. (2002). The management of innovation in project-based firms. *Long Range Planning*, *35*(4), 367–388.

Kester, C. (1984). *Today's options for tomorrow's growth*. Brighton, MA: Harvard Business Review.

Khurana, A., & Rosenthal, S. R. (1997). Integrating the fuzzy front end of new product development. *Sloan Management Review*, *38*(2), 103–120.

Kim, J., & Wilemon, D. (2002). Focusing the fuzzy front–end in new product development. *R&D Management*, *32*(4), 269–279.

Koen, P., Ajamian, G., Burkart, R., Clamen, A., Davidson, J., D'Amore, R., . . . Wagner, K. (2001). Providing clarity and a common language to the "fuzzy front end." *Research-Technology Management*, *44*(2), 46–55.

Le Masson, P., Weil, B., & Hatchuel, A. (2010). *Strategic management of innovation and design*. Cambridge, UK: Cambridge University Press.

Lenfle, S. (2008). Exploration and project management. *International Journal of Project Management*, *26*(5), 469–478.

Lenfle, S. (2016). Floating in space? On the strangeness of exploratory projects. *Project Management Journal*, *47*(2), 47–61.

Lenfle, S., & Loch, C. (2010). Lost roots: How project management came to emphasize control over flexibility and novelty. *California Management Review*, *53*(1), 32–55.

Lundin, R. A., Brady, N., Eksted, T., Midler, E. C., & Sydow, J. (2015). *Managing and working in project society: Institutional challenges of temporary organizations*. Cambridge, UK: Cambridge University Press.

Magadley, W., & Birdi, K. (2009). Innovation labs: An examination into the use of physical spaces to enhance organizational creativity. *Creativity and Innovation Management*, *18*(4), 315–325.

Maniak, R. (2010, May 19–22). *Mapping the "full value" of innovative features in projectified firms*. EURAM Conference, Rome, Italy.

Maniak, R., & Midler, C. (2014). Multiproject lineage management: Bridging project management and design-based innovation strategy. *International Journal of Project Management*, *32*(7), 1146–1156.

Maniak, R., Midler, C., Beaume, R., & Pechmann, F. V. (2014). Featuring capability: How carmakers organize to deploy innovative features across products. *Journal of Product Innovation Management*, *31*(1), 114–127.

Maniak, R., Midler, C., Lenfle, S., & Le Pellec-Dairon, M. (2014). Value management for exploration projects. *Project Management Journal*, *45*(4), 55–66.

Markham, S. K. (2002). Moving technologies from lab to market. *Research-Technology Management*, *45*(6), 31–42.

Markham, S. K. (2013). The impact of front-end innovation activities on product performance. *Journal of Product Innovation Management*, *30*(1), 77–92.

Markham, S. K., & Lee, H. (2013). Use of an innovation board to integrate the front end of innovation with formal NDP processes: A longitudinal study. *Research-Technology Management*, *56*(4), 37–44.

Markham, S. K., Ward, S. J., Aiman-Smith, L., & Kingon, A. I. (2010). The valley of death as context for role theory in product innovation. *Journal of Product Innovation Management*, *27*(3), 402–417.

Maylor, H., Brady, T., Cooke-Davies, T., & Hodgson, D. (2006). From projectification to programmification. *International Journal of Project Management*, *24*(8), 663–674.

Midler, C. (1993). *L'Auto qui n'existait pas: Management des projets et transformation de l'entreprise. (The car that did not exist: Project management and transformation of the firm)*. Paris, France: InterEditions.

McDermott, C. M., & O'Connor, G. C. (2002). Managing radical innovation: An overview of emergent strategy issues. *Journal of Product Innovation Management*, *19*(6), 424–438.

Midler, C. (1995). "Projectification" of the firm: The Renault case. *Scandinavian Journal of Management*, *11*(4), 363–375.

Midler, C. (2013). Implementing low-end disruption strategy through multi-project lineage management: The logan case. *Project Management Journal*, *44*(5), 24–35.

Midler, C., Jullien, B., & Lung, Y. (2017). Rethinking innovation and design for emerging markets: Inside the Renault Kwid project. Oxford, UK: Taylor & Francis.

Midler, C., Killen, C., & Kock, A. (2016). Project and innovation management: Bridging contemporary trends in therory and practice. *Project Management Journal*, *47*(2), 3–7.

Midler, C., & Navarre, C. (2004). Project management in automotive industry. In P. W. G. Morris & J. K. Pinto (Eds.), *The Wiley guide to managing projects* (pp. 1368–1388). Hoboken, NJ: John Wiley & Sons, Inc.

Moore, G. A., & McKenna, R. (1999). *Crossing the chasm*. New York, NY: HarperBusiness.

Morris, P. W. (2013). *Reconstructing project management*. Hoboken, NJ: John Wiley & Sons.

Packendorff, J., & Lindgren, M. (2014). Projectification and its consequences: Narrow and broad conceptualisations. *South African Journal of Economic and Management Sciences*, *17*(1), 7–21.

Prahalad, C. K. (2012). Bottom of the pyramid as a source of breakthrough innovations. *Journal of Product Innovation Management*, *29*(1), 6–12.

Radjou, N., Prabhu, J., & Ahuja, S. (2012). *Jugaad innovation: Think frugal, be flexible, generate breakthrough growth*. Hoboken, NJ: John Wiley & Sons.

Reid, S. E., & de Brentani, U. (2004). The fuzzy front end of new product development for discontinuous innovations: A theoretical model. *Journal of Product Innovation Management*, *21*(3), 170–184.

Schoper, Y.-G., Wald, A., Ingason, H. T., & Fridgeirsson, T. V. (2018). Projectification in Western economies: A comparative study of Germany, Norway and Iceland. *International Journal of Project Management*, *36*(1), 71–82.

Schwartz, E., & Trigeorgis, L. (2004). *Real options and investment under uncertainty: Classical readings and recent contributions*. Cambridge, MA: MIT Press.

Simpson, T. W., Siddique, Z., & Jiao, J. R. (2006). Platform-based product family development. In *Product platform and product family design* (pp. 1–15). New York, NY: Springer.

Teasley, S., Covi, L., Krishnan, M. S., & Olson, J. S. (2000, December). How does radical collocation help a team succeed? *Proceedings of the 2000 ACM Conference on Computer Supported Cooperative Work*, ACM, Philadelphia, PA, pp. 339–346.

Trigeorgis, L. (1996). *Real options: Managerial flexibility and strategy in resource allocation*. Cambridge, MA: MIT Press.

Tushman, M. L., & O'Reilly, C. A., III. (1996). Ambidextrous organizations: Managing evolutionary and revolutionary change. *California Management Review*, *38*, 8–29.

von Pechmann, F., Midler, C., Maniak, R., & Charue-Duboc, F. (2015). Managing systemic and disruptive innovation: Lessons from the Renault Zero Emission Initiative. *Industrial and Corporate Change*, *24*(3), 677–695.

Weinman, J. (2016). The economics and strategy of manufacturing and the cloud. *IEEE Cloud Computing*, *3*(4), 6–11.

Westerveld, E. (2003). The Project Excellence Model®: Linking success criteria and critical success factors. *International Journal of Project Management*, *21*(6), 411–418.

Wheelwright, S. C., & Clark, K. B. (1992). *Revolutionizing product development: Quantum leaps in speed, efficiency, and quality*. New York, NY: Simon and Schuster.

Whitley, R. (2006). Project-based firms: New organizational form or variations on a theme? *Industrial and Corporate Change*, *15*(1), 77–99.

Author Biography

Christophe Midler is Research Director at the Management Research Center and Innovation Management Professor at Ecole Polytechnique, Paris. He is a member of National Academy of Technologies of France, Doctor Honoris Causa at Umea University, Sweden and 2013 PMI Research Achievement Award. His research topics are product development and project and innovation management. He has explored these topics in various industrial contexts, especially the automotive industry. He has published his work in various journals including *Research Policy*, *International Journal of Automotive Technology Management, Project Management Journal,* and *International Journal of Project Management*. Christophe has authored or co-authored books are *Working on Innovation* (Routledge, 2010), *The Logan Epic; New Trajectories for Innovation* (Dunod, 2013), *Managing and Working in Project Society—Institutional Challenges of Temporary Organizations* (Cambridge University Press, 2015), and *Rethinking Innovation and Design for Emerging Markets: Inside the Renault Kwid Project* (Taylor and Francis, 2017). He can be contacted christophe.midler@polytechnique.edu