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Stage-gate and agile development in the digital age: Promises, perils, and boundary conditions



Stefanie Paluch*, David Antons, Malte Brettel, Christian Hopp, Torsten-Oliver Salge, Frank Piller, Daniel Wentzel

School of Business and Economics, TIME Research Area, RWTH Aachen University, Kackertstr. 7, 52072 Aachen, Germany

1. Introduction

Some artists begin with careful plans, sketches, preliminary drawings and even paintings before settling on one particular direction. Claude Monet, for example, carefully planned and prepared his work to coincide with specific natural light, timing his activity according to when and how daylight touched his canvas (House, 2004). His work was revolutionary: masterpieces such as his famous *Impressions, Sunrise* and subsequent *Water Lilies* series were intended to capture the feelings initiated by observation and interpretation; they exceeded the mere recording of scenery details. Other artists seemed to obtain their inspiration internally, beginning with little formal preparation. They approached the canvas experientially. Jackson Pollock adopted this style with his famous drip paintings - action pieces that were acclaimed to show motion, depicting accidents and energy.

Like artists, organizations striving for innovation seek to find unique combinations of resources with the goal of creating something new – be it new products, services, business models, or any combination thereof. Importantly, though, organizations are multi-agent systems, with differing individual goals and with each agent's effort contributing towards the overall purpose (Weick, 1974). Yet, organizing is a process that is starkly different to (and should not be mistaken for) organizations themselves and is thought to differ widely depending on context and across temporal dimensions.

Early work on organizing was inextricably linked to economic production of material goods. Currently, and corresponding to our dominant current driver of value creation today, a growing perspective on organization looks into information technology (IT) and its role for organizing, but also how actors in the IT industry are organizing (Puranam, Alexy, & Reitzig, 2014).

“If you went to bed last night as an industrial company, you're going to wake up this morning as a software and analytics company.” This is how Jeff Immelt, Chairman and CEO of General Electric (GE), summarized the disruptive changes triggered by the digital transformation that hit virtually all companies. GE responded by creating GE Digital

and redefining itself as a “digital industrial company” with a focus on digitally enabled products (Rigby, Sutherland, & Takeuchi, 2016). In today's digital age, product development at GE and many other companies around the globe increasingly involves - and indeed resembles - software development. Over the last decades, the process of software development has been shaped by the adoption of so-called agile development methods such as scrum, extreme programming, or lean development (Cram & Newell, 2016). These agile approaches take the inherent unpredictability of software development into account and advocate highly iterative, time-boxed development cycles owned by self-organizing cross-functional teams that actively solicit and incorporate customer feedback at each iteration to improve the working software as the dominant measure of progress (Beck et al., 2001).

It is against this backdrop that this Special Issue (SI) on “Innovation in the Digital Age: From Stage-Gate to an Agile Development Paradigm?” explores whether traditional product development models such as Stage-Gate (Cooper, 1986, 2008) are still fit for purpose in today's digital age or whether they are set to be widely replaced by agile approaches even in more traditional contexts. The basic idea of conventional models to organize innovation is that they see innovation as a *deterministic* process that can be planned ex-ante and then be executed and controlled. The idea is to de-risk the innovation process by including a number of go-or-kill decision gates, where projects are vetted against predefined performance indicators. In contrast, agile approaches are *stochastic*. They follow the understanding of an iterative planning cycle where the outcomes of one short phase of execution inform the design of the following stage, and so on. Uncertainty is discovered and addressed continuously during the execution process. Stage-gate aims at controlling uncertainty upfront, thus avoiding subsequent changes, whereas agile development focuses on adaptation and the accommodation of change throughout the development processes. Table 1 provides a stylized comparison of the two development models at the center of this Special Issue.

This Special Issue presents six research papers that address the promises, perils and boundary conditions associated with agile product

* Corresponding author.

E-mail addresses: paluch@time.rwth-aachen.de (S. Paluch), antons@time.rwth-aachen.de (D. Antons), brettel@time.rwth-aachen.de (M. Brettel), hopp@time.rwth-aachen.de (C. Hopp), salge@time.rwth-aachen.de (T.-O. Salge), piller@time.rwth-aachen.de (F. Piller), wentzel@time.rwth-aachen.de (D. Wentzel).

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Table 1
Comparison of stage-gate gate and agile development (expanded from Cooper, 2016, p.2).

	Stage-Gate Development	Agile Development
Type	Macroplanning	Microplanning
Domain	Hardware Development	Software Development
Purpose	Investment model for sequential resource allocation	Tactical model for guiding largely self-managed teams
Focus	Risk and quality	Learning and speed
Logic	Deterministic	Stochastic
Directionality	Largely linear	Highly iterative
Scope	Idea to launch	Development and testing
Owner	Cross-functional team (R&D, marketing, sales, operations)	Technical team (software developers, engineers, project managers)
Customer Involvement	Episodic	Continuous

development in comparison to conventional development processes. We proceed as follows: We first summarize the main findings of the articles included in this Special Issue and then try to synthesize the trade-offs in organizing innovation that each study is addressing. Subsequently, we discuss the Special Issue articles and their respective contribution vis-à-vis new paradigms of organizing innovation. Additionally, we present the case of the e-mobility venture StreetScooter to illustrate how agile development processes can be applied in the traditional context of automotive development. We end by discussing managerial implications and summarizing central boundary conditions of agile and stage-gate innovation approaches. We hope this will support managers in their efforts of organizing innovation activities in a way that is carefully tailored to the idiosyncrasies of their respective organization.

2. Research synthesis

Article #1: Exploring innovative ideas marks the beginning of many organizational journeys. Yet, how can those be identified? What makes a good idea and how can they be turned into products? [Dziallas \(2019\)](#) studies front-end evaluation approaches and indicators for new product development. For incremental innovations in the automotive industry, the author identifies four central indicators, (1) high customer relevance, (2) strategic fit, (3) high communication potential, and (4) vision potential that foster more agile and faster front-end decision-making. Hence, even in innovation environments that appear incremental in nature, organizations can not only solve repetitive customer requirements (what we might refer to as exploitation), but also might be able to solve unique challenges (what we might refer to as exploration) when front-end innovation can be strengthened. Front-end innovation indicators may lead to more transparent, traceable, and reliable innovation decisions. To ensure success, however, information generation should be routinized to allow for organizational learning.

Article #2: [Ghezzi and Cavallo \(2019\)](#) study business model innovation in multisided platform startups that operate in structurally heterogeneous environments. Their analysis varies the context in which the start-ups find themselves. They specifically focus on how firms can execute temporary organizational tasks, such as defining markets, developing business models, or managing human resources. They highlight that lean start-up methods can be applied successfully to innovation organizing when there are continuous changes in customers' requirements and product value proposition. When environmental dynamism is moderate, the firm should emphasize value-capturing

activities to keep the costs of experimenting down. When environmental dynamism is high, however, firms should focus on value delivery and value creation activities, such as user onboarding and customer relationship management.

Article #3: [Bianchi, Marzi, and Guerini \(2019\)](#) study the inter-relation between agile and stage-gate driven innovation processes. The authors find that managing software development following stage-gate principles is detrimental to performance; it leads to time and cost overruns. Hence, when requirements are unknown and far from stable, early planning and commitment will not work properly. Yet, their work also reports that not all principles that are generally subsumed under agile methods will live up to expectations. Importantly, only sprints result in speed, cost and quality advantages. This might in turn, be related to the underlying innovation logic. When products to be developed are more incremental in nature, iterative, yet time-boxed cycles (hybrid agile stage-gate) processes may provide the best of both worlds. However, when the underlying product is more radical in nature, pure agile methods work better.

Overall, the first three articles in this Special Issue seek to identify critical boundary conditions that shape the comparative advantage of stage-gate and agile approaches to organizing innovation activities. As such, [Dziallas \(2019\)](#) identifies four key indicators related to the specific innovation context that are conducive to agile front-end innovation processes in the traditional automotive sector. [Ghezzi and Cavallo \(2019\)](#) then emphasize that agile methods work best in environments characterized by high dynamism. [Bianchi et al. \(2019\)](#) delineate and contextualize these findings further. They report that agile methods work best if task uncertainty and the degree of innovation involved is high, but that with moderate levels of task uncertainty and degrees of innovation firms would fare better with agile stage-gate approaches.

Broadly speaking, the decision between agile and stage-gate appears to resemble a trade-off that organizations face on the broader institutional level: the trade-off between efficiency and flexibility. Incremental innovation can be dissected and managed in discrete stages in an effort to enhance efficiency. However, this would be ill-suited for more radical innovation and fast-paced environments. Similarly, when task requirements are complex, unique, and frequently changing, the flexibility promised by agile approaches moves into the foreground.

The second set of three articles in this Special Issue therefore extends this contingency perspective by shedding light on the temporal dimension of organizing innovation. These articles propose that organizations do not simply adjudicate between agile and stage-based innovation paradigms as a function of innovation context, customer

requirements and task complexity. Instead, they highlight the importance of time as an additional boundary condition with special emphasis on organizational learning and temporary forms of organizing.

Article #4: In this spirit, [Annosi, Martini, Brunetta, and Marchegiani \(2019\)](#) study an environment that connects an agile and stage-gate based model. Rather than focusing on trade-offs between either an agile or a stage-gate paradigm, they investigate how routine individual action and adaptation can be managed. Underneath a more dynamic view of change lies the notion of organizational learning. [Annosi et al. \(2019\)](#) therefore study self-managed, team-based organizations, and document how team members learn from projects, and show how they make sense of team-based experiences. Importantly, learning is not universal. To ensure that learning takes place, an agile environment needs management intervention to improve individual competence-based learning. The study highlights the different trajectories necessary to move from the process of organizing innovation (with a finite focus) to making the transition to an innovation organization (with an indefinite focus). Learning needs to be woven into the fabric of the organizational structure. When tasks are temporary and the organizing unit's life is finite, knowledge may disperse when the team achieved their purpose and the organizing team dissolves ([Bakker, 2010](#); [Sydow, Lindkvist, & DeFillippi, 2004](#)).

Article #5: [Fecher, Winding, Hutter, and Füller \(2019\)](#) analyze a similarly dynamic environment and show how knowledge that is individually generated needs to be integrated subsequently. By focusing on innovation labs in the banking industry, they show the promises and perils that agile knowledge generation has and how it can be re-integrated to lead not only to individual learning, but also to organizational learning. [Meyerson et al. \(1996: p. 168\)](#) define temporary systems as consisting of teams of people ‘who have never worked together before and who do not expect to work together again’. Once the team dissolves, the knowledge dissipates. If knowledge should proliferate within the organization, it requires a thoughtful process that manages participants’ expectations, team building, and can ensure knowledge re-integration. Corporations not only set-up new organizational entities with the sole purpose of being innovative, bringing the product to market, and to dissolve subsequently but also to re-integrate these teams and the learning into the organization subsequently. Managing agile teams over time and within an organization with an infinite time horizon therefore requires both carefully designed routines and strong leadership.

Article #6: [Mills, Berthon, and Pitt \(2019\)](#) study whether agile models can be of use beyond the more complex high-tech industries and whether stage-gate driven models could also be applied for information-based products. The authors employ the concept of innovation authorship, a product owner involved in an idea-to-launch process, where knowledge is person-specific rather than routine-based. The idea of authorship as exemplified by James Patterson's collaborative writing and coproduction is similar to the thousands of micro-entrepreneurs embedded in electronic and household appliance manufacturer Haier's organizational structure. With strong leadership and vision alongside a very pronounced individual employee's entrepreneurial drive do hyper-agile organizations flourish.

3. Towards an innovation organization

The articles in this Special Issue shed light on the critical interplay between task requirements, innovation objective and ambition, and time horizon in shaping the relative advantage of distinct modes of organizing innovation. This emerging pattern is illustrated in [Fig. 1](#).

Classic stage-gate models appear to best suited for incremental innovation in seemingly predictable contexts in which customer and task requirements are well understood ([Bianchi et al., 2019](#)).

Temporary organizational forms (special innovation vehicles), in contrast, might be the solution of choice when striving for radical

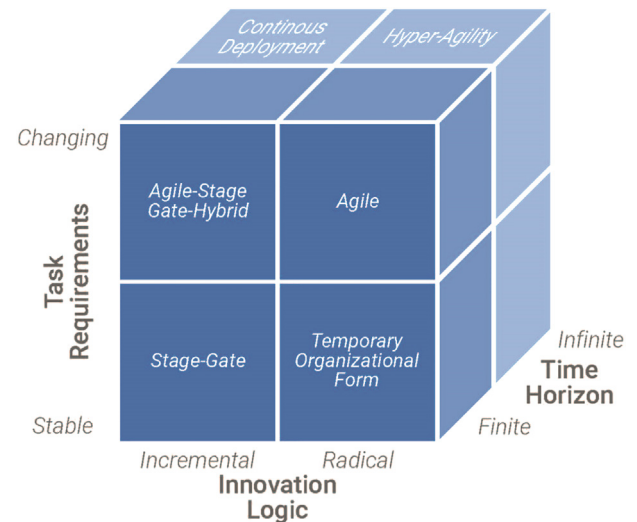


Fig. 1. Organizing task and innovation trade-offs in infinite time.

innovation in relatively well-understood contexts with repetitive task requirements, provided the knowledge will be re-integrated into the focal organization ([Fecher et al., 2019](#)).

Agile-stage-gate hybrids, in turn, are a particularly attractive form of organizing incremental innovation initiatives in the presence of task uncertainty ([Ghezzi & Cavallo, 2019](#)).

Agile models in their pure form, finally, move center stage for radical initiatives in dynamic contexts with unique and yet to be discovered task requirements.

Yet, how can firms develop dynamic capabilities to be routinely innovative regardless of innovations being radical or incremental or task requirements being unique or repetitive? In the following, we synthesize a potential trajectory as to how organizations can embed stage-gate routines or agile development processes into the heart of an innovation organization whose innovation management process is unfolding dynamically.

[Hopp and Greene \(2018\)](#) remind us about the simple but vital fact that temporal dimensions are an important driver of when and how organizational processes are effective or ineffective. The ancient Greeks used two expressions to denote time: *chronos* and *kairos*. *Chronos* is the objective, linear, and mechanical absolute time. *Kairos* is qualitative and permanent in nature and describes an opportune and critical moment. The former refers to chronological or sequential time, while the latter signifies a proper or opportune time for action. For organizations, it is paramount to understand when to transition from one paradigm to the other ([Ansari, Reinecke, & Spaan, 2014](#)).

To advance our understanding of how firms can transition from organizing for innovation to an innovation organization, we need to account for the institutionalization of organizational learning. [Crossan, Cunha, Vera, and Cunha \(2005\)](#) found “that a lack of temporal fit between the individual and organization will impede, or completely block, the alignment between the organizational and environmental rhythms” (p. 142). Importantly, organizations need to find a way to memorize learnings from agile teams to make them widely accessible throughout the organization. Knowledge needs to be codified where possible to ensure a certain level of economies from repetition and to develop capabilities that can be accessed again at a later point in time. While temporary organizations can manage and solve problems, it is paramount that learnings can be institutionalized ([Bakker, 2010](#); [Sydow et al., 2004](#)).

While agile software development places an emphasis on early and close customer feedback during the product development process, there is very little room for learning from customer experience after software delivery and deployment. The concept of *continuous deployment* focuses

on the ability to not only deliver software but also to continuously learn (in real-time) from customer usage. Continuous deployment therefore enables companies to shorten feedback loops substantially. Similarly, this may also allow eliminating features that do not produce any customer value (Olsson, Alahyari, & Bosch, 2012). Continuous deployment then follows several inter-related steps. Software updates are kept to a minimum and reasonably small; deployment follows development immediately (after appropriate testing); the decision to deploy is at the developer's discretion; and the deployment is fully automated (Savor et al., 2016). Continuous deployment is now being used by the likes of Amazon, Facebook, Google, and Netflix.

Continuous deployment provides several benefits over other existing software development methods ranging from enhanced productivity to increased developer motivation, decreased software risks and higher software quality. However, the use of continuous deployment may naturally come at the expense of a lack of control and predictability in software life cycles (Savor et al., 2016). Hence, it is dynamic but clearly not for all and sundry.

At the company level, the Chinese appliance company Haier has taken their organizational structure to new extremes. CEO Zhang Ruimin describes his vision as follows: “We encourage employees to become entrepreneurs because people are not a means to an end, but an end in themselves. Our goal is to let everyone become their own CEO [...] to help everyone fully realize their potential.” This *hyper-agility* in organizational structure has led to thousands of micro-enterprises run by small teams under the Haier umbrella (Hamel & Zanini, 2016). Haier represents an organization capable of continuous transformation; one that is able to maintain a co-creation ecosystem. The overall strategic vision delegates decision-making power very deep into the organization. Senior management occupies a strategic position, yet with very limited operational influence. “Haier doesn't authorize employees to do their work. Instead we provide a platform for them. We are committed to providing the platform in which there are different kinds of businesses.” (Leavy, 2016:33).

The notion of hyper-agility as evidenced in the case of Haier is consistent with Aggarwal, Posen, and Workiewicz (2017) who show that an exploration policy in the formative period of developing routines for organizations can influence a firm's capacity to adapt to change in maturity. Hence, agile firms can exhibit properties of routines: efficacy and organizational memory. Organizations that ‘entrain’ (“the process by which activity cycles of one system synchronize to those of another, more dominant system” (Khavul, Pérez-Nordtvedt, & Wood, 2010: 106)) their innovation activities with a dominant firm, a disruptive technology, a client requirement are more likely to fit with their external environment and thereby achieve better organizational outcomes (Ancona & Chong, 1996).

4. Practical implications

Agile innovation approaches are far from being only theoretical considerations, as the articles in this Special Issue show. The focus of agile development on rapid execution, customer validation, and iterative refinement appears valuable. It is particularly important when customers exhibit changing preferences and high willingness to collaborate, when problems are complex but can be broken down into distinct modules for successive iterations, and when interim mistakes constitute valuable learning opportunities rather than major risks to be avoided at all cost (Rigby et al., 2016). Yet, the question obviously remains as to whether or not agile organizing is the panacea to all organizational trade-offs companies face. In fact, granularity of development tasks and rapid iterations are much easier for purely digital products like software than in the case of complex, mechatronic products. The tragic death of a Tesla driver using a beta version of the firm's “autopilot” function illustrates the inherent risks and ethical challenges associated with using agile approaches in more conventional contexts with high safety requirements. This highlights the need to better

understand if companies can really develop complex physical products like gas turbines or medical devices at Internet pace and in constant, agile iterations. The following case study of StreetScooter nicely illustrates the use of – and preconditions for – agile development in a traditionally hardware-centric industry.

5. An agile StreetScooter¹ story - think big, start small

The StreetScooter, an electric delivery vehicle produced by the company of the same name (www.streetscooter.eu), is an example of how agile innovation can be accomplished, even in traditional, entrenched industries and despite the vast presence of established global players. Interestingly, the StreetScooter started as a research project at RWTH Aachen University where two professors – Günther Schuh and Achim Kampker – aimed to explore whether it was possible to develop and produce an affordable electric vehicle in a high-wage country such as Germany. In 2010, the research team joined forces with over 80 industry partners and several university institutes and started developing the StreetScooter, an affordable and cost-effective electric car for short journeys.

In 2011, only a year later, the team presented the first version of the StreetScooter – then called A12 – at the International Motor Show in Frankfurt, the world's largest motor show. The media coverage following the presentation in Frankfurt eventually caught the attention of Deutsche Post DHL, the world's largest logistics company. At the time, Deutsche Post DHL faced a large organizational challenge: While e-commerce and, thus, the demand for fast and reliable deliveries in urban areas were continuously growing, cities across the world were struggling with increasing pollution and CO2 emissions. In other words, Deutsche Post DHL was in a need for mobility solutions that were cost-efficient and environmentally friendly. To solve this challenge, the company had reached out repeatedly to the major players in the German car industry, but was turned down every single time. Owing to these negative experiences, Deutsche Post DHL decided to partner with StreetScooter and awarded a development contract to the young company.

The partnership quickly proved to be a successful one. In 2012, the StreetScooter team presented the “Work” utility vehicle, a fleet vehicle specially tailored for the everyday work of postal delivery. In 2014, Deutsche Post DHL acquired StreetScooter, putting itself in a position to produce its own delivery vehicles. As of 2018, more than 8000 StreetScooter vehicles are in daily use on the road. Gradually, Deutsche Post DHL is looking to replace up to 30,000 vehicles with the StreetScooter and has also started offering the StreetScooter concept to third-party firms and public organizations that are also in need of electric mobility solutions for urban environments.

While the StreetScooter case is undoubtedly a noteworthy example of entrepreneurial vision and audacity, the more interesting question is: How is it that a small spin-off from a German university was able to compete against well-funded, technologically sophisticated car companies and come up with a mobility solution that these companies were either unwilling or unable to provide? In their book “Think Big, Start Small”, the founders of StreetScooter reflect extensively on the development principles that allowed the company to come up with an electric vehicle in a very short amount of time and at a fraction of the typical development costs. These principles are typical of agile approaches and include 1) relying on rapid prototyping, 2) integrating customers continuously in the development, 3) managing risk at an early stage of the development process, and 4) building an entrepreneurial culture that seeks to learn from mistakes. These principles are briefly elaborated below.

First, the research team at StreetScooter emphasized the importance

¹ Unless otherwise indicated, information on the Streetscooter are based on the book: “Think big, start small: Streetscooter the e-mobility success story.”

of building and testing prototypes in early phases of the development process, an idea that is also propagated by Design Thinking approaches. As such, the team set out to learn as early as possible, which, in turn, required physical, tangible prototypes that could be handled, experienced, and evaluated. Unlike the prototypes that are constructed in traditional, stage-gate development approaches and that are typically stripped-down versions of a test model, the prototypes at StreetScooter were built quickly from materials such as cardboard, wood, and aluminum. In particular, the emphasis on early prototypes, called primotypes at StreetScooter, served three different purposes in the development process. From a *knowledge* perspective, building primotypes allowed the team to swiftly test many different hypotheses and to move gradually to the most effective solution. From a *functional* perspective, the developers did not set out to build a prototype for the entire car but different prototypes for different functional problems. For instance, to test the ergonomic properties of the interior, the team built a specific prototype from wood and cardboard, a testing procedure that was quick and inexpensive but sufficient for solving this particular kind of problem. From a *communication* perspective, the prototypes acted as translation and communication platforms – known as boundary objects (Carliè, 2002) –, allowing everybody involved in the process to develop a shared idea of the car.

Second, another key feature of the development process consisted in integrating customers right from the very start. In doing so, the research team aimed to ensure that the StreetScooter would effectively address the customers' specific needs, that is, the needs of postal couriers working their daily delivery routes. To this end, over 150 couriers were invited to participate in workshops and encouraged to voice their specific needs, leading to numerous changes to the vehicle. For instance, the development team learnt that the passenger seat was rarely, if ever, used in conventional delivery vehicles. Hence, they decided to do without a passenger seat in the StreetScooter and to use the space next to the driver's seat for installing additional trays for storing packages. While such changes may seem minor at first sight, collectively they resulted in a vehicle that allowed couriers to complete their daily routines more effectively.

Importantly, however, this emphasis on customer needs was combined with a strict prioritization of requirements. That is, all customer requirements were intensively discussed to understand which ones were crucial requirements that would necessitate customized solutions and which ones were basic requirements that could be satisfied with standard solutions. For example, the team discovered that the quality of some of the copper wire used in the car could be reduced by a factor of 10 without sacrificing quality in the final product. The advantages of this two-pronged approach to customer integration are easy to discern: On the one hand, the approach leads to a product that is aligned with customers' specific needs; on the other hand, it ensures that “over-engineering” is avoided and keeps the costs of customization at bay.

Third, the development approach at StreetScooter was also characterized by a desire to manage the risk of the development process at a very early stage. As such, a strategy that is aimed at shortening development cycles and ensuring cost-efficient customization necessarily carries a considerable level of risk – both from a technological and an economic perspective. To manage these risks, the development team set out to test the prototypes of the StreetScooter as early as possible under realistic conditions (i.e., testing the vehicle in the delivery routines of couriers). From a technological perspective, these trials provided valuable feedback, thereby reducing performance risk. Moreover, this approach also entailed that the StreetScooter was never “finalized” in the strict sense of the word; rather, the car went (and is still going) through continuous iterations and feedback loops, similar to the continuous deployment strategies that have proven successful in the software industry. From an economic perspective, early and continuous testing under realistic conditions also helped to reduce the uncertainty regarding the marketability of the vehicle. That is, in environments of high uncertainty, the only possible way to assess the sales potential of a

product may consist in actually testing the product in controlled “market expeditions” that are conducted with select groups of lead customers.

Fourth, the rapid development of the StreetScooter was also facilitated by a culture that fostered an entrepreneurial spirit and a sense of shared ownership. Similar to the Chinese company Haier, management at StreetScooter established a culture where trying and learning were prioritized over validating and where failures were not considered as defeats but as valuable opportunities for learning. While such a “failure-friendly” culture is likely to encourage employees to move beyond their comfort zone, StreetScooter also implemented specific management practices that ensured that the lessons learned from these mistakes were actually captured and diffused throughout the development teams. Put differently, establishing a culture where employees feel confident to try their ideas even at the risk of failing is only one side of the coin; in addition, management needs to ensure that the learning opportunities provided by failures are actually seized.

In sum, the four agile principles outlined above – rapid prototyping, customer integration, risk management, and failure-friendly culture – helped a small start-up in developing a cost-efficient electric vehicle, a feat that the incumbents in the automotive industry had failed to achieve. However, the case of StreetScooter does not only deserve attention because it shows how agile approaches can be implemented successfully in “hardware-heavy” industries, but also because it aligns with many of the findings presented in this Special Issue.

For example, the analysis of Ghezzi and Cavallo (2019) suggests that start-ups that need to cope with highly dynamic and unpredictable environments are most likely to benefit from agility. The relationship between characteristics of the environment on the one hand and the use of agile development approaches on the other hand may also help to explain the extraordinarily rapid development process at StreetScooter. As such, the market for electric vehicles can be characterized as a highly dynamic and relatively unpredictable one. As a point in case, the successful diffusion of electric vehicles is not only contingent on customer demand but also on the development of a wider power infrastructure and advances in associated technologies such as battery technology and renewable energies. Arguably, this environment may have benefited smaller firms such as StreetScooter that can react more quickly to changes in the environment or customer demands compared to larger and more entrenched players. Put differently, the dynamism and unpredictability associated with e-mobility may have discouraged incumbents from entering the market, thus opening a window of opportunity for smaller firms that had relatively little to lose.

Furthermore, the study of Bianchi et al. (2019) indicates that while the use of sprints may lead to more effective development processes, early and frequent user feedback may potentially prolong time-to-market. To account for these findings, the authors speculate that (p.13) “extensive beta testing may result in information overload without discerning high-priority from low-priority information (...), potentially causing bottlenecks (...) and hence slowing down the NPD process”. At first sight, these findings seem to contradict the experiences at StreetScooter where continuous feedback loops were considered as one of the key strengths of the development process. However, it is important to note that StreetScooter followed a two-pronged strategy where the collection of continuous feedback was coupled with a strict prioritization of user requirements. Hence, the findings of Bianchi et al. (2019) as well as the learnings from StreetScooter suggest that while continuous user feedback is crucial for an effective development process, it is equally important to have a process in place that effectively separates the “wheat from the chaff”.

Finally, Annosi et al. (2019) as well as Fecher et al. (2019) point to the importance of organizational learning in the context of agile development. That is, both articles note that transitioning to an innovation organization requires management interventions that deeply engrain agile principles in an organization's day-to-day routines. Again, the StreetScooter case study provides support for this idea. As such, one

Table 2
Selected boundary conditions of stage-gate and agile development.

	Stage-Gate Development	Agile Development
<i>Technological Characteristics</i>	Low technological dynamism	High technological dynamism
	Solution space defined	Solution space undefined
<i>Customer Characteristics</i>	Stable and known customer preferences	Changing and/or unknown customer preferences
	Limited customer willingness to interact	High customer willingness to interact
	Customer in need of fully specified product	Customer open to engage with interim products (beta versions)
<i>Task Characteristics</i>	Low task modularity	High task modularity
<i>Organizational Characteristics</i>	Low tolerance for interim failure	High tolerance for interim failure
	Strong need for managerial control	Weak need for managerial control

of the key tasks of the management team at StreetScooter was to ensure that the insights gained in the development process were not isolated instances of learning but were continuously diffused throughout the entire organization.

6. Managerial lessons learned

Drawing on the insights from the papers presented in this Special Issue, the StreetScooter case and our additional theorizing, we propose a number of principles that appear to be redefining the innovation process as we know it. Table 2 is helpful in this regard, as it summarizes the central boundary conditions that help to facilitate managers' decision for a stage-gate or an agile development approach.

(1) Find the appropriate innovation approach for a given context

Agile innovation is not the panacea for all organizational challenges when managing innovation. Alas, managers need to carefully analyze the environment and the strategic objectives of their company before deciding for an innovation approach. Stage-gate or hybrid approaches aim at reducing uncertainty at the beginning of the innovation process. Accordingly, when targeting continuous improvements, these approaches are a simple and efficient approach. Agile innovation, in contrast, is more suitable for dynamic environments when the solution is expected to be more unique, should result in a more radical innovation, but also is subject to large uncertainties both with regard to the market and the technological base (e.g. the StreetScooter) (Bianchi et al., 2019).

Another contingency informing the choice of agile versus deterministic innovation models (like stage-gate) is the preferred level of control by management (Mills et al., 2019). We believe that in practice the decision for or against agile or stage-gate approaches crucially depends on the desire for control during different phases of the innovation process. Organizations (managers) in favor of control will demand a stage-gate model which provides pre-defined objectives and continuous stages of report and review. On the other side, managers who can live with (or even embrace) a moderate level of control will call for hybrid models. Hence, managers calling for agile innovation really have to understand what this means: to break with the common dominant paradigm of planning and control!

(2) Become customer-centric – integrate the customer early

Put the customer in the front and center. What may sound simple has many companies struggling, especially when it boils down to

understanding customer needs. Agile approaches strive for addressing customer requirements continuously. Regular input and feedback in different stages of the innovation process is a necessity. *Integrating customers* in early testing activities helps to uncover hitherto unused potential. Dziallas (2019) emphasize the important strategic role of customer integration in the front-end of product development. It is a crucial juncture for innovation managers to decide whether to follow up on or reject an idea. Relatedly, *communication with the customer* (Dziallas, 2019) is another central but often overlooked aspect. As a consequence, companies often develop products that do not meet customer requirements or that exceed their needs (over-engineering), as a result of too little communication. StreetScooter integrated feedback and suggestions from DHL's couriers very early in the development process. Couriers could test the primotype, experience the innovation first-hand, and gradually help to adjust the vehicle to meet their specific needs. Quintessentially, innovation managers need to identify key customers and carefully select suitable participants for ideation workshops, test runs, and feedback sessions. In accomplishing this, they should communicate the additional value that participants receive when jointly creating innovations: higher product satisfaction with the final product and lower acceptance barriers. Along these lines, many companies are starting to create innovation labs – organizational spaces where creativity is stimulated to facilitate new ideas and innovations (Magadley & Birdi, 2009). These labs represent a new form of customer integration: a method to incorporate customers and other stakeholders in an agile innovation process (Fecher et al., 2019).

(3) Implement a failure culture – learning from mistakes

People often strive for perfection, yet it is practice that makes perfect. In fact, an agile paradigm is about making mistakes and learning from them. “Fail fast, and fail often!”, a frequently quoted mantra from Silicon Valley, reflects the agile innovation approach vividly. Albeit, managers and the thinking around them need to get acquainted with this new way of innovating. Managers mandating agile innovation have to recognize that they also have a mandate to fail (in a project by one of the authors with a large financial institution even a “minimum failure rate” was established to foster more radical innovating (and hence risky thinking)). How fast companies can learn from their mistakes depends on many factors, including their size, company structure, or environment (Ghezzi & Cavallo, 2019). Admittedly, it will be particularly challenging for larger established companies with well-proven structures to overcome old habits and develop the open culture required to make agile innovation work. Rather than judging people when mistakes occur, firms should focus on motivating employees to see mistakes as an

opportunity to learn and to grow, individually and collectively. Annosi et al. (2019) pick up on the topic of agile organizational learning and point out that agile organizations are complex structures and managers must first of all get familiar with the concept of organizational leadership without control. Organizational learning from failure must also be learned. The authors suggest that shared values, routines, and carefully designed processes are the necessary foundation to further encourage organizational learning.

7. Conclusion

Cooper's (1986) book "Winning at New Products: Accelerating the Process from Idea to Launch" drew deeply on decades of academic work to develop an innovation model that ever since resonated well with researchers and managers alike. Stage-Gate has been reported to be employed by firms extensively (Cooper, 2008; Cooper, Edgett, & Kleinschmidt, 2002). Yet, much as the originator of the work did, one may ask the question: What's next: after Stage-Gate?

One prominent response in this respect has been agile practices which have already been integrated into the innovation management practices of many organizations. More theoretical work has also started to explore agile-hybrid forms of organizing. The articles selected for this Special Issue paint interesting avenues for researchers, managers, and students of innovation management alike. We are sure that a careful reading will proliferate many of the ideas and topics studied.

As the initial reference to artists highlighted, despite the differences in approaching the canvas, both Monet and Pollock shared a common element inasmuch as that they worked from their own imagination to turn mere ideas into physical reality. Yet much like the companies, industries, and innovation strategies exemplified in this Special Issue, both painters widely differed in how they pursued this process. Pollock's work was virtually impossible to anticipate, but is well-recognized for its innovation, creativity and beauty (Frank, 1983). However, at times he chose to destroy elements of his art when he felt his creations were no longer in harmony with his artistic spirit (Frank, 1983). Monet painted countless water lilies, yet he also became a perfectionist who was very selective about which paintings to sign and sell and at times he even destroyed several paintings out of frustration before exhibiting them (Levine, 1986).

Together, the research presented in this Special Issue highlights an important delineation: What may work for one company under predictable conditions may not work under uncertainty, what may work for individual projects becomes problematic for organizations. Our introductory essay to the Special Issue also suggests that when organizational exploration is embedded into the development of organizational routines, firms can create the capacity to be routinely adaptive and innovative either employing continuous deployment or hyper-agile structures. This offers the potential to tackle the challenges involved in moving from project-based organizations to true innovation organizations.

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