Academy for DESIGN INNOVATION MANAGEMENT Conference 2019
LONDON, UNITED KINGDOM
19–21 JUNE 2019
Research Perspectives IN THE ERA OF Transformations

The Organization as a Prototype

STOIMENOVA Niya[a]*; STOMPH Sander[b] and DE LILLE Christine[c]

[a] Delft University of Technology, the Netherlands
[b] KLM Royal Dutch Airlines, the Netherlands
[c] The Hague University of Applied Sciences, the Netherlands
* n.stoimenova@tudelft.nl
doi: 10.33114/adim.2019.06.327

Some of the most valuable companies in the world accumulated their fortunes as a result of a business model innovation built upon matured technologies. Now the majority of them are investing and shifting their focus to the development of new technologies such as AI, blockchain and genetic editing. If an organization is to remain profitable, it needs to be able to quickly adjust its structure to the rapidly changing context. We contend that a way to do so is to build an organizational structure that is conductive to both generative and evaluative prototypes. We report on our action research with a leading European airline following the transformation of a team of four into a new department, through the lenses of continuous prototyping. We then propose an initial framework that conceptualises organizational prototypes and provides a rational and systematic way of approaching the devising of such. Finally, we outline several directions for further research.

Keywords: prototypes, ways of working, emerging technologies, organizational design, generative prototyping

Introduction

The past 25 years brought us some of the most valuable companies in the world today – Google, Amazon, Uber, Facebook. Their rise became synonymous to unprecedented growth and business model innovations built upon matured technologies. However, we're entering a new era of technological development that becomes so enmeshed in users' everyday lives that it is difficult to judge the extend and kind of impact it will have on them. In the past few years we have witnessed the exponential investment and developments in new technologies such as Artificial Intelligence (AI), blockchain and genetic editing, largely due to the unprecedented computational abilities and the amounts of generated data daily. In fact, it is not uncommon to see all these companies who made their money off long-established technologies heavily investing in new ones. For instance, in their 2018 product launch, "Made by Google", Google announced its focus to be "software + hardware + AI" (Made by Google, 2018). Amazon, the most valuable company in the world that started as an online retailer, owns the biggest cloud service – Amazon Web Services (AWS). Historically Microsoft has been largely dependent on Windows. Yet in 2018 the product Windows ceased to be a separate business unit, so the focus could be shifted to cloud services that can provide other companies with the infrastructure on which they can run their data (Warren, 2018). Furthermore, the infamous startup unicorn Uber is investing billions in the development of self-driving technology (Somerville, 2018), competing with Tesla and Alphabet's Waymo.

The current pace of development of emergent technologies is defined by high degrees of uncertainty and companies built on agile principles that continuously adapt and work in fast iterations. It is precisely the desire

to reduce the adverse feelings of uncertainty caused by the rapidly changing context that serves as a strong motivator guiding organizational adaptation (Beckman et al., 2004; Akgün et al., 2012). Yet some organizations continue to be more agile than others (Panditi, (2018). However, if an organization is to not only survive but become/remain profitable, it needs to be able to rapidly deal with uncertainty by thoroughly understanding the different contexts in which such technologies can be implemented. Moreover, they need to have the capabilities to develop solutions employing them. This notion necessitates the establishing of methods and consequent organisational structures that allow for rapid development (also termed as organizational adaptiveness (Gibson & Birkinshaw, 2004) or ambidexterity (Tushman & O'Reilly, 1996)).

This paper presents our attempts to reduce the abstraction associated with theories on how such organizational structures are created and sustained by utilizing the design practice of prototyping. Prototyping is widely recognized as a means to deal with high levels of uncertainty (Buxton, 2007). Furthermore, it accelerates the learning by serving as a means of communication and validating hypotheses early in the development process. As such, we will present the emergence of an adaptive organizational structure by tracing its evolution from the introduction of methods and tools to the full adoption of a new way of working (WoW). While the notion of organizational WoW certainly does not exhaust the entirety of what constitutes an organization, it is our contention that it can serve as a first step in building a new organizational structure (Stoimenova & De Lille, 2017;2018).

This article is structured as follows. First, we elaborate on the nature of prototypes in design. Then we explicate the methodology behind the study and the generated insights as a result. We will report on our attempts in transforming a 4-person team within the operational department of a European airline, Air, into a division that is continuously re-inventing itself. Initially created to check ideas' feasibility and desirability early in the NPD and eventually accelerate the firm's pace of innovation, the team's new approach has grown to almost the entire operation of the airline. Based on principles of Lean Startup (Ries, 2011), Scrum (Schwaber & Beedle, 2002) and Design Thinking (Brown, 2008), its premise is to create ideas, prototype them in a matter of days (using MVPs) and test as soon as possible with real passengers and employees either at the Departure hall, one of the three dedicated gates at the airport or during flights. As such we helped them to establish a new WoW tailored to their context. This allowed them to involve internal and external stakeholders early in the process and then create, test and implement new ideas in live environments with real passengers, employees and flights. The generated insights are used as a foundation for the creation of an initial framework on how to conceptualise organizational prototypes that could be conductive to rapid exploration and development of emerging technologies and continuous re-invention of the firm itself. We conclude the paper with recommendations for further research.

The nature of prototypes in design

Prototypes are widely recognised as an important means to explore and communicate what it will be like to interact with future products, systems and services (Buxton, 2007; Lim, et al., 2008). As such, they can play different roles– evoke a focused discussion in a team, test hypotheses, confront theories, allow users to experience their world differently (Sanders & Stappers, 2014) and minimize design errors that may otherwise occur late in the process (Deininger et al., 2017). Many definitions of what constitutes a prototype exist complemented by a plethora of methods and tools serving each sub-field of design. Some of the most widely adopted types are summarized in Table1.

Table 1: An overview of the most popular types of prototypes

Type	*Description*
Minimum Viable Product (MVP)	*Contains the minimum number of features that allow companies to gain the maximum amount of insights and test their fundamental hypotheses on value and growth. As such, "an MVP is designed not just to answer product design or technical questions. Its goal is to test fundamental business hypotheses" (Reis, 2011).*
Experience prototype	*Aims to understand, explore or communicate what the experience of a solution might be. Its value lies in the prototyping attitude that requires the blending of multiple disciplines and a low-technology mindset (Buchenau & Suri, 2000).*
Boundary object	*Both designated (prototypes) or emergent objects can be used (Levina & Vaast 2005). It exhibits different meanings in different social/professional contexts. Yet, it has a structure that*

	is common enough to more than one community and thus it's able to transform knowledge in new product development (Carlile, 2002). This makes it a recognizable means of translation (Star & Griesemer, 1989; Eppler & Pfister, 2011).
Conscription device	*Enlists and engages participation of those who will later employ and/or build on it (Henderson, 1991; Roth & McGinn, 1998) to shape knowledge (Bendixen & Koch, 2007). It facilitates linkages between the meaning of the object and the knowledge of the network around it (Hölttä, 2013). It also aids with reasoning, reflection, and the linking of items in new ways to enable discoveries (Karsten et al. 2001).*

Prototypes are primarily seen as a tool to evaluate design's failure or success (Lim et al., 2008). For instance, to Sanders & Stappers, (2014), prototypes are usually put into action once the "design opportunity has been established". This view is complemented, among others, by Dong and colleagues (2016), Eekles and Roozenburg (1991) and Takeda (1994) to whom prototypes are to be used for evaluation and testing of hypotheses and requirements. This is in line with widely adopted approaches such as Agile, Lean Startup and Design Sprint (Knapp et al., 2016).

However, using prototypes in their evaluation capacity has its limitations due to the flexible, reflective and problem-setting nature of design (Schön, 1982). A design solution can never guarantee it is the best since there are many possible ways to tackle a (wicked) problem (Buchanan, 1992). Moreover, an examination of design practices shows that evaluative prototypes (i.e. during usability testing) are a relatively small part of the entire design process (Lim et al., 2008). Prototypes are also oftentimes used to help designers learn, discover, generate, and refine designs (Buxton, 2007) by stimulating framing, and discovering possibilities in a design space (Lim et al., 2008). In effect, becoming the means of a generative discovery that could play a pivotal role when new technologies and their impact on societies should be understood, as is the case with AI, for instance. The notion of externalisation of thought as an impetus for creativity (Clark, 2001; Magnani, 2007), a means to finding new aspects of a problem and generating new ideas to solve it is widely recognised in design (Suwa et al., 2000). By giving rise to new perceptual and cognitive operations that allow for reflection, critique, and iteration (Clark, 2001), externalisation helps designers develop and communicate their ideas through "physical" manifestations (Zucconi et al., 1990). These can take any form, shape, and appearance, based on the choice of material (Lim at al., 2008; Deininger et al., 2017) and provide help with the invention of important design requirements of a given problem (Schön & Wiggins, 1992).

To our knowledge, there are several attempts to define a taxonomy of prototypes (i.e. Lichter et al., 1993; Gutierrez, 1989) – all primarily based on different ways of using prototypes in a development and design process. However, developing generally applicable prototyping methods is not viable when faced with the complex variety of design (Lim et al., 2008). To understand how prototypes could be used in an organizational context, we will review the insights gleaned from our work with Air.

Methodology

This paper reports the result of an action research in Air. It was carried out in the span of 3 years and followed the transformation of a 4-person team into a new department. The first author carried out participant observations, complemented by more than 20 sessions and 10 semi-structured interviews with the growing team during the first year. Furthermore, she was involved in the creation, shaping and initial implementation of their new way of working (WoW). The study also followed the way the team tried to involve internal and external stakeholders and grow to the entire operational side of the firm. She was supported by a design MSc student, who helped her to facilitate some of the sessions. Subsequently 5 more interviews were carried out to gauge new developments in the last two years. All interviews were transcribed and cross-referenced with the accounts of participant observations and extensive literature review stemming from the areas of design cognition and methodology, and Participatory, Engineering and HCI design. As such, both inductive (Patton, 2014) and deductive (Crabtree & Miller, 1992) coding was used. The second author initiated and oversaw the transformation. The third author was regularly involved in the research through three MSc students performing research for the team.

The initial research is discussed in our previous work on implementing design principles and establishing the foundations for a new organizational structure in Air (Stoimenova et al., 2016; Stoimenova & De Lille, 2017) and cross-referenced with a study in a technology B2B company implementing the generated insights as discussed in (Stoimenova & De Lille, 2018). However, this research adopts a different frame of looking at the results – that of the role prototypes played in the change of the organizational design.

Results

In this section we will explicate the initial stages of how the team grew to an entire department through the lens of the different prototypes we used. The starting point was the new WoW the first author helped the team develop. As already mentioned, it's based on well-established principles from Lean Startup, Scrum and Design Thinking manifested in six main phases. Each new project starts with formulating a clear ambition (a purpose). This is followed by understanding of the problem using qualitative and quantitative data. Once such understanding is obtained, the team starts ideating on possible solutions. They then build an MVP (prototype) and test it in a live environment part of the airline's operations. The project ends with a thorough reflection and the making of a decision whether to adjust, kill or scale the solution. The WoW is carried out in increments of 2-week sprints.

The research employed a nested principle, in which MVPs and experience prototypes devised for user testing and hypotheses validation were used as a foundation around which prototypes of sessions, tools, templates and methods can be built. We started by understanding how the new WoW can be implemented in the Air's context. Such necessitated a better grasp on how to enable the team of non-designers to understand their context by using design principles and tools. The first step was to create a way to elicit insights from passengers waiting to board their planes quickly. To do so we used more than 10 sessions at the gates to prototype and test different tools, approaches and templates. This triggered the need to enable the team to work with such insights and involve stakeholders throughout their process. Thus, optimal ways to involve stakeholders had to be discovered by prototyping different sessions around on-going projects. These sessions were used as conscription devices, as not only stakeholders but also team members were involved to understand how to facilitate and organise such. They were also used as boundary objects allowing for the communication of the importance of such to other departments and new additions to the team.

These prototypes helped us reflect on the WoW and detail it for the context the team was in. This was enabled by vicarious learning and creating a shared understanding of the rationale behind each used method. The multiple sessions complemented by templates, explanations and modified to the context tools and methods created a noticeable change in the capabilities of the team. They also provided the foundation for a new (shared) mental model (Rouse & Morris, 1986) on how the WoW could be carried out. We label the changes in capability and mental model as culture. Finally, we observed changes in the infrastructure of team and subsequently the department regarding the needed resources (both human and monetary) and the extent of involvement of stakeholders. As such, our definition of infrastructure is similar to the one of Star and Ruhleder (1996). These three elements – WoW, culture and infrastructure – coincide with the factors crucial to design adoption discussed in Stoimenova and De Lille (2017; 2018).

In Table 2, an overview of the purpose of the prototypes we used, and their descriptions can be found. These initial attempts are also described in detail in Stoimenova and colleagues (2016; 2017; 2018). The table is structured as follows: the purpose of the used prototypes is stated paired with a short description. Then the form in which the prototype manifested itself is noted.

Table 2: An overview of the different types of prototypes used in building up a department

Purpose	*Description*	*Prototypes of*
Understand how to gain insights from passengers at the airport (in less than 15 minutes)	*Used over 10 sessions at the gates of the local airports to gauge how to involve passengers who are waiting to board their plane and usually have less than 15 minutes to spare. We went through several iterations of what set up to use, how much time should be spent per passenger, find tools and methods that are effective and efficient in the environment, how to elicit tacit insights and latent knowledge and overcome language barriers. In the process we worked with tools such as context mapping (Sleeswijk Visser et al., 2007), Lego, Brainwriting and Journey mapping. The sessions are described in detail in Stoimenova and colleagues (2016) and were later used as boundary objects to communicate the importance of involving passengers to the team.*	*Templates* *Generative methods* *Method setup* *Tools* *Passenger communication* *Sensitization*
Increase the amount of time team spends on exploring the	*Initially the team spent on average 2 hours during every 2-week sprint on exploring the context and coming up with new ideas. To increase the time spent, first the results from the passenger sessions were used as a boundary objects, then two four-hour ideation sessions were carried out*	*Templates* *Tools*

context and generating multiple solutions	*with the team and a few stakeholders. The duration of the sessions grew to 2 days of context exploration and ideation with stakeholders as part of a Design Sprint. The sessions were used as conscription devices.*	*Methods* *Sessions (duration)*
Create capabilities in non-designers to facilitate ideation sessions	*We carried out 6 different sessions to first understand the needed level of capability. Then, to create such, explanatory materials, templates and new methods were introduced to the team and used as conscription devices. The sessions were also used to train the team in facilitating such by sharing the process and creating a template and guidelines. These were paired with vicarious learning and explanation of the basic principles behind each activity. All prototypes were used as conscription devices.*	*Explanatory materials* *Templates* *Methods and tools* *Guidelines*
Understand how to create a sense of ownership among stakeholders	*Used the different sessions to involve operational employees in the ideation sessions, paired with regular involvement of operational employees in testing of on-going MVPs. Also, a dedicated moment in which stakeholders come together to ask difficult questions, called a "roast" became a standard procedure.*	*Team composition* *Involvement structure* *Tools* *Templates*
Understand how to test in live environments	*All MVPs during the first year of the research were used to gauge how to test and collect information from the users (both passengers and employees).*	*Solutions* *Test setup* *Communication* *Interviewing methods* *Result analysis* *Adjusting solutions in the field*
Understand how to prototype services in live environments	*A Design Sprint was carried out with the core team (6 people at the time) to prototype the structure of the sprint itself and adapt it to the context of Air. Further, ways to prototype a service in a live environment, the necessary time allocated for each day and the level of detail of a service MVP were explored. The sprint was used as a conscription device which was later further elaborated upon.*	*Team composition* *Design Sprint structure* *Test setup*
Understand how to involve a different department	*Prepared and facilitated a design sprint with another department of Air to understand who and when to involve, manage expectations, share insights, how elements of the way of working can be translated to the department and determine a possible way of communication. The sprint was used as a boundary object.*	*Communication* *Inter-departmental collaboration* *Method setup* *Test setup*
Understand when, how and what employees to involve	*A Design Sprint and the aforementioned sessions were used to understand what type of people need to be involved, when and in which manner to involve them. They were later used as a boundary object to communicate the importance of the WoW and ultimately help it spread to the entire operational side of the firm.*	*Employee involvement* *Team composition*
Understand how to combine and communicate qualitative and quantitative data	*Initial attempts were based on the research done with passengers. They were used during the design sprints and the sessions. However, they were mainly qualitative-oriented. This research is currently ongoing as the first author is involved in establishing a deeper understanding of how to combine and communicate thick and thin data.*	*Method* *Communication* *Templates*
Understand how to structure the newly-established department	*Two 1-day events were carried out once the newly department was established to understand the future of the department, the topics it needs to tackle, the culture and communication it needs to have through the means of multiple break-out sessions*	*Methods* *Communication* *Templates* *Tools*

The use of prototypes helped us explore the unusual context of the team and rapidly define an initial version of a WoW through the use of conscription devices, boundary objects, MVPs and experience prototypes.

However, using these generally applicable prototyping methods is not always viable when faced with the complex variety of design (Lim et al., 2008). Therefore, the creation of a rational and systematic way to approach the devising of prototypes in an organizational context is necessitated. A way that will provide the guidelines on how prototypes with evaluative and generative purposes can be devised on both project and organizational level.

Framework for Organisational Prototypes

To our knowledge, one of the most prominent works on conceptualising prototypes' dual nature by providing a systematic and rational way of devising them comes from Lim and colleagues (2008). Developed for the field of Human-Computer Interaction (HCI), their anatomy of prototypes is based on two dimensions that are interconnected and influenced by each other – filters and manifestations. The former identifies an initial set of design aspects a prototype might exhibit such as appearance (i.e. size, color, shape), data (i.e. size, type, privacy), functionality (i.e. system function), interactivity (i.e. input and output behavior), and spatial structure (i.e. arrangement of interface). The decision of what to filter is always based on the purpose of prototyping. Once a filtering dimension has been selected, choices should be made about the way the idea will be manifested. Lim and colleagues identify three manifestation dimensions – prototype's material, the resolution of its details (corresponding to the notion of fidelity), and the scope (whether the prototype covers one or several aspect of the design idea). These dimensions can be determined, they claim, by following the economic principle of prototyping: "the best prototype is one that, in the simplest and most efficient way, makes the possibilities and limitations of a design idea visible and measurable.".

Combining their anatomy with the gathered insights from Air on how a WoW is prototyped, we propose the following framework that can assist organizations in creating organizational prototypes. First, we start with the filtering dimensions. As already suggested in the Result section, the WoW influenced the culture and infrastructure of the department. Therefore, we contend that the dimensions through which to filter could be **way of working**, **culture** and **infrastructure**. However, although the filtering dimensions could provide an initial direction for prototype formation, knowing only what to filter can neither fully determine how to form a prototype nor provide strategies for devising it. Therefore, once the purpose of the prototype is filtered, the proper manifestation should be selected. To do so, all of its three dimensions must be considered: material, fidelity and scope, as they all inform and impact the way a prototype is being devised. We stayed close to the dimensions provided by Lim et al. (2008) by substituting only resolution with fidelity as the term is more regularly used both in design and software development literature. However, the majority of the example variables we provide stem from our research in Air. The dimensions and their corresponding sub-dimensions can be found in Table 3. These dimensions and their variables are not exhaustive, however. They simply provide a general guideline of factors that might be considered. However, this framework requires further research and elaboration.

Table 3: An overview of the manifestation dimensions

Manifestation	*Description*	*Example variables*
Material	*Different types of physical and digital materials that can be used when prototyping products and services*	*Physical material (e.g. paper, plastic, wood, Lego)* *Methodology* *Data* *Sessions*
Fidelity	*Fidelity refers to how closely the prototypes resemble the final product in terms of visual appearance, interaction style, and level of detail (Petrie & Schneider, 2007).*	*Low* *Medium* *High* *Mixed (Petrie & Schneider, 2007)*
Scope	*The number of aspects of the design solution a prototype covers*	*e.g. Template* *Tool* *Method*

We believe using such framework will assist in creating a common understanding of the nature of prototypes used in similar contexts. Further, it will help to design an organization that can further develop new technologies, explore contextual implications and generate profitable business models. It will also provide a language for articulating the characteristics of a particular prototype that could be used to prototype organizations.

Conclusion

This article started with the contention that in order for an organization to continue being relevant and profitable, it needs to create an organizational structure that will allow it to rapidly and iteratively develop emergent technologies and understand how they impact its context. Then to exemplify how this could be done we reported on our initial efforts of growing a small team into a department, whose purpose is to rapidly develop, test and implement new ideas. The transformation was achieved largely by the extensive use of both generative (boundary objects and conscription devices) and evaluative (MVPs and experience) prototypes. This allowed us to outline a framework that can explicate and systematise the conceptualisation of organizational prototypes in a rational way. As such, this research provides an ample ground for further investigation in two directions – understanding the way both generative and evaluative prototypes can be used to further develop and implement emerging technologies and discerning the role a department that continuously prototype its parts could play within an organization.

Discerning possible ways to further develop emerging technologies

The first direction stems from the fact that we are still in the early stages of development of technologies such as AI (what Vinge (1993) terms narrow AI) and their potential impact and implications are still largely unknown. The discernment of the possible implementation areas and their business value is also in its infancy stages. While the presented here WoW's build-up does not directly specify how to deal with such emergent technologies, it provides a solid foundation for such due to its iterative and adaptive nature. Therefore, more research is needed to determine how to work with a technology that continuously changes the value it delivers as it interacts with data and the users, as AI does. We contend a viable initial direction to be the use of prototypes due to their ability to make the abstract future effects of a solution tangible (Lim et al., 2008).

However, to do so attention has to be paid to both generative and evaluative prototypes. Based on our action and literature research, we argue the former to be suitable for the exploration of the problems connected to emerging technologies and their implications on society. Evaluative prototypes such as MVPs are already largely recognised for their ability to test assumptions and validate business hypotheses (Reis, 2011). Both types are of equal importance and should be continuously employed throughout the development process of a solution to ensure its successful deployment/implementation.

More research is needed in this area, however, to identify the ways such prototypes can be created and built upon. It is our contention that the structure we developed in Air provides a solid foundation for doing so. Moreover, it is conductive and favourable to both generative and evaluative prototypes since the department's organizational structure was largely a result of multiple prototypes. Last but not least, further research is needed to understand the ways such prototypes can be implemented within existing ways of working, cultures and infrastructures and the implications they will have on organizational structures. We are currently carrying an action research to gain initial insights on the topic.

The role of the department-prototype

In the process of this research we continuously prototyped every single element of what later became a newly-formed department. This led to a department built upon an amalgamation of several layers of prototypes serving different purposes. Therefore, we argue that the department itself could be seen as a big prototype geared towards the continuous exploration of its changing context and validation of its ongoing hypotheses. Seeing the Air's department as a prototype is not far removed from the way the most successful startups in the past two decades have made the development of an MVP central to the way they grow and

structure themselves. The definition of a startup is a "temporary organisation whose goal is to search for a sustainable and profitable business model" (Livingston, 2007). The ability to be flexible and continuously pivot in terms of market or product strategy is another marker of what being a successful startup entails (Hoque, 2012). These definitions are well-aligned and complementary to the transformation of the Air's four-person team. However, the development of the department we described needs to be further researched to explore the roles such organizational unit can play within a bigger organizational structure and how it can contribute to the profitability of the firm. Moreover, additional insights are needed to discern how such a department can continuously prototype itself and foster both generative and evaluative prototypes.

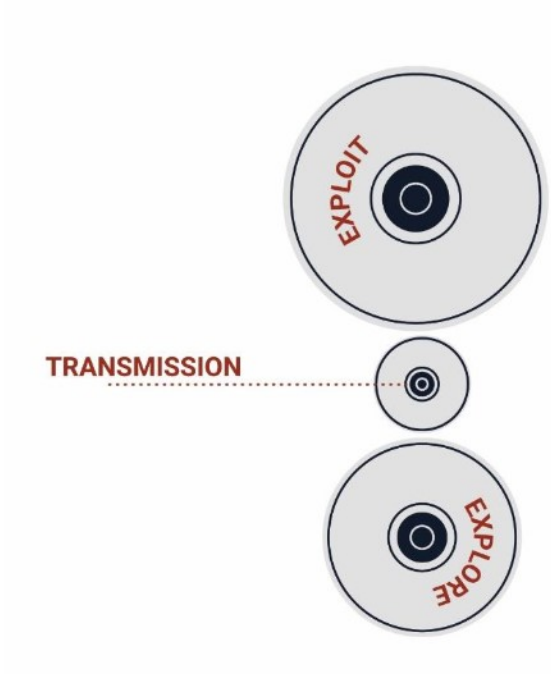

Figure 1: the three wheels of DLA (Stoimenova & De Lille, 2016).

A concept that can point at initial search directions is that of design-led ambidexterity (DLA) introduced by Stoimenova and De Lille (2017; 2018). DLA is based on the notion of ambidexterity defined as "the ability to simultaneously pursue both incremental and discontinuous innovation… hosting multiple contradictory structures, processes, and cultures within the same firm" (Tushman & O'Reilly, 1996). As such, implementing organizational ambidexterity allows companies to simultaneously manage current business demands and adapt to environmental changes (Mom et al., 2015). It constitutes of three elements, employing the metaphor of three constantly rotating wheels. Exploitation allows the firm to improve the efficiency of implementation and production of its already existing capabilities and knowledge. Exploration is characterized by search, experimentation, play, flexibility and investigation, and can result in new knowledge (Tabeau et al., 2016). However, many challenges exist when trying to make the collaboration between exploration and exploitation wheels smooth (i.e. rotate in the same direction) (Oehmichen et al., 2016) due to their distinct nature, roles and influence they have on innovation outcomes (Tabeau et al., 2016).

The Transmission is designated with the task of ensuring the smooth and profitable collaboration between the other two wheels. As its name suggest, it transmits and adapts the signals from Exploration, so the Exploitation can pick them up easily. Moreover, it gives signals back to each wheel to ensure their corresponding structures, processes and cultures could be adjusted accordingly. It is also in its nature to continuously adjust its size and rotation pace to ensure the smooth collaboration of the exploration and exploitation wheels. From the three elements depicted in Figure 1, we argue the structure and role of the transmission can provide a fertile ground for a department that continuously prototype itself. However, further research is needed to understand how to fully build a department that acts like a Transmission and its implications on a firm's structure and profitability. As such we are continuing our investigation of the department through the means of action research.

We are entering a new innovation era of multiple emerging technologies. Organizations are faced with three options: don't adopt new technologies, rely on companies such as Microsoft, Amazon and Google to provide them with the infrastructure that can run (or provide) data, or further develop and understand how the technology can be applied to their specific context. It is the latter two options that offer multiple benefits to firms, if employed well. The impact and potential of such technologies are still largely unknown, so are their business models. Therefore, both cases require companies to create the necessary capabilities to quickly adapt and respond to such changes. We are too early in the technology development cycle to fully understand and predict its implications. However, an organizational structure that can continuously and rapidly adapt to its changing social and technological environment is of paramount importance.

Despite the plethora of innovation frameworks such new developments can instigate, they will always need to be adapted to a context. However, due to the unexplored implications and changes such new era will entail, it

is difficult, if not pointless, to attempt to create such. This, in fact, is the epitome of a wicked problem to which we cannot find the best answer. However, we need an approach to deal with it. Our work with Air leads us to believe that a viable way to tackle such a problem is through continuous prototyping that essentially turns the organization into a prototype. However, we intentionally did not specify how such structure should look like. Instead we introduced the initial stages of a framework that allows organizations to rapidly discern which way of working, culture and infrastructure are most suitable for their context and fit with their ambitions. We believe establishing such capabilities in a firm can prove invaluable for its sustained profitability and relevance.

References

Akgün, A. E., Keskin, H., & Byrne, J. (2012). Antecedents and contingent effects of organizational adaptive capability on firm product innovativeness. *Journal of Product Innovation Management*, *29*, 171-189.

Beckman, C. M., Haunschild, P. R., & Phillips, D. J. (2004). Friends or strangers? Firm-specific uncertainty, market uncertainty, and network partner selection. *Organization science*, *15*(3), 259-275.

Bendixen, M., & Koch, C. (2007). Negotiating visualizations in briefing and design. *Building Research & Information*, *35*(1), 42-53.

Brown, T. (2008). Design thinking. Harvard business review, 86(6), 84.

Buchanan, R. (1992). Wicked problems in design thinking. *Design issues*, *8*(2), 5-21.

Buchenau, M., & Suri, J. F. (2000, August). Experience prototyping. In *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques* (pp. 424-433). ACM.

Buxton, B. (2010). *Sketching user experiences: getting the design right and the right design*. Morgan Kaufmann.

Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization science*, *13*(4), 442-455.

Clark, A. (2001). Natural-born cyborgs?. In *Cognitive technology: Instruments of mind* (pp. 17-24). Springer, Berlin, Heidelberg.

Crabtree, B. F., & Miller, W. F. (1992). A template approach to text analysis: developing and using codebooks.

Deininger, M., Daly, S. R., Sienko, K. H., & Lee, J. C. (2017). Novice designers' use of prototypes in engineering design. *Design studies*, *51*, 25-65.

Dong, A., Garbuio, M., & Lovallo, D. (2016). Generative sensing: A design perspective on the microfoundations of sensing capabilities. *California Management Review*, *58*(4), 97-117.

Eekels, J., & Roozenburg, N. F. (1991). A methodological comparison of the structures of scientific research and engineering design: their similarities and differences. *Design studies*, *12*(4), 197-203.

Eppler, M. J., Hoffmann, F., & Pfister, R. (2011). Rigor and relevance in management typologies: Assessing the quality of qualitative classifications.

Gutierrez, O. (1989, March). Prototyping techniques for different problem contexts. In *ACM SIGCHI Bulletin* (Vol. 20, No. SI, pp. 259-264). ACM.

Henderson, K. (1991). Flexible sketches and inflexible data bases: Visual communication, conscription devices, and boundary objects in design engineering. *Science, Technology, & Human Values*, *16*(4), 448-473.

Hölttä, V. (2013). Beyond Boundary Objects–Improving Engineering Communication with Conscription Devices.

Hoque, F. (2012, December 10) Why most venture ba- cked companies fail. Retrieved from: https://www.fast-company.com/3003827/why-most-venture-backed-companies-fail.

Karsten, H., Lyytinen, K., Hurskainen, M., & Koskelainen, T. (2001). Crossing boundaries and conscripting participation: representing and integrating knowledge in a paper machinery project. *European Journal of Information Systems*, *10*(2), 89-98.

Knapp, J., Zeratsky, J., & Kowitz, B. (2016). Sprint: How to solve big problems and test new ideas in just five days. Simon and Schuster.

Levina, N., & Vaast, E. (2005). The emergence of boundary spanning competence in practice: implications for implementation and use of information systems. *MIS quarterly*, 335-363.

Lichter, H., Schneider-Hufschmidt, M., & Zullighoven, H. (1994). Prototyping in industrial software projects-bridging the gap between theory and practice. *IEEE transactions on software engineering*, *20*(11), 825-832.

Lim, Y. K., Stolterman, E., & Tenenberg, J. (2008). The anatomy of prototypes: Prototypes as filters, prototypes as manifestations of design ideas. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *15*(2), 7.

Livingston, J. (2008). *Founders at work: Stories of startups' early days*. Apress.

Made by Google. (2018, 10 9). *Made by Google 2018*. Retrieved from YouTube: https://www.youtube.com/watch?v=EsoQGTA1SxY

Magnani, L. (2007). Abduction and chance discovery in science. *International Journal of Knowledge-based and Intelligent Engineering Systems*, *11*(5), 273-279.

Mom, T. J., Fourné, S. P., & Jansen, J. J. (2015). Managers' work experience, ambidexterity, and performance: The contingency role of the work context. Human Resource Management, 54(S1), s133-s153.

Panditi, S. (2018, March 22). *Survey Data Shows That Many Companies Are Still Not Truly Agile*. Retrieved from Harvard Business Review: https://hbr.org/sponsored/2018/03/survey-data-shows-that-many-companies-are-still-not-truly-agile

Patton, M. Q. (2005). Qualitative research. *Encyclopedia of statistics in behavioral science*.

Petrie, J. N., & Schneider, K. A. (2006, July). Mixed-fidelity prototyping of user interfaces. In *International Workshop on Design, Specification, and Verification of Interactive Systems*(pp. 199-212). Springer, Berlin, Heidelberg.

Oehmichen, J., Heyden, M. L., Georgakakis, D., & Volberda, H. W. (2016). Boards of directors and organizational ambidexterity in knowledge-intensive firms. The International Journal of Human Resource Management, 1-24

Ries, E. (2011). The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses. Crown Books.

Rouse, W. B., & Morris, N. M. (1986). On looking into the black box: Prospects and limits in the search for mental models. Psychological bulletin, 100(3), 349.

Roth, W. M., & McGinn, M. K. (1998). Inscriptions: Toward a theory of representing as social practice. *Review of educational research*, *68*(1), 35-59.

Sanders, E. B. N., & Stappers, P. J. (2014). Probes, toolkits and prototypes: three approaches to making in codesigning. *CoDesign*, *10*(1), 5-14.

Schwaber, K., & Beedle, M. (2002). Agile software development with Scrum (Vol. 1). Upper Saddle River: Prentice Hall.

Schön, D. A. (2017). *The reflective practitioner: How professionals think in action*. Routledge.

Schon, D. A., & Wiggins, G. (1992). Kinds of seeing and their functions in designing. *Design studies*, *13*(2), 135-156.

Sleeswijk Visser, F., Van der Lugt, R., & Stappers, P. J. (2007). Sharing user experiences in the product innovation process: Participatory design needs participatory communication. *Creativity and innovation management*, *16*(1), 35-45.

Somerville, H. (2018, August 27). *Toyota to invest $500 million in Uber for self-driving cars*. Retrieved from Reuters: https://www.reuters.com/article/us-uber-toyota/toyota-to-invest-500-million-in-uber-for-self-driving-cars-idUSKCN1LC203

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology,translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social studies of science*, *19*(3), 387-420.

Star, S. L., & Ruhleder, K. (1996). Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information systems research*, *7*(1), 111-134.

Stoimenova, N., de Lille, C. & Ferreira, C., (2016). Co-Designing Innovation in Fast-Paced Environments: Organizational Challenges and Implications*. In Proceedings of 20th DMI: Academic Design Management Conference Inflection Point: Design Research Meets Design Practice*. Boston, USA, 22-29 July (2016)

Stoimenova, N., & De Lille, C. (2018). Building the Foundation for a Design-Led Ambidexterity in a Medium-Sized Tech Company . *DRS* (pp. 2946-2962). Limerick: Design Research Society.

Stoimenova, N., & De Lille, C. (2017). Building Design-led Ambidexterity in Big Companies. Conference Proceedings of the Design Management Academy: Research Perspectives on Creative Intersections (pp. 1043-1060). Hong Kong: Loughborough University, London.

Suwa, M., Gero, J., & Purcell, T. (2000). Unexpected discoveries and S-invention of design requirements: important vehicles for a design process. *Design studies*, *21*(6), 539-567.

Tabeau, K., Gemser, G., Hultink, E. J., & Wijnberg, N. M. (2016). Exploration and exploitation activities for design innovation. Journal of Marketing Management, 1-23.

Takeda, H. (1994, January). Abduction for design. In *Formal design methods for CAD* (pp. 221-243).

Thompson, B. (2019, January 14). *AWS, MongoDB, and the Economic Realities of Open Source*. Retrieved from Stratechery: https://stratechery.com/2019/aws-mongodb-and-the-economic-realities-of-open-source/

Tushman, M. L., & O'Reilly III, C. A. (1996). Ambidextrous organizations: Managing evolutionary and revolutionary change. *California management review*, *38*(4), 8-29.

Vinge, V. (1993). The coming technological singularity: How to survive in the post-human era.

Warren, T. (2018, March 29). *Microsoft's Windows chief departs as the company pushes further toward AI and the cloud*. Retrieved from The Verge: https://www.theverge.com/2018/3/29/17176220/microsoft-windows-reorg-business-terry-myerson-ai-cloud

Zucconi, L., Mack, G., & Williams, L. G. (1990, February). Using object-oriented development for support prototyping. In *Proceedings of the 12th international conference on Software engineering* (pp. 129-132). IEEE Computer Society Press.