



INTEGRATED APPROACH TO THE AGILE DEVELOPMENT WITH DESIGN THINKING IN AN INDUSTRIAL ENVIRONMENT

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Abstract

The aim of this paper is to investigate the arrangement of creative techniques and flexible project management methods to enable innovative product development in one single process. Because innovation had become key factor, creative and agile methods - such as Design Thinking and Scrum - are interesting to combine. But contemporary methods of such integration to existing structures often fail and today no further applications are known. This paper challenges the implementation of the combined processes focussed to the modern product development. In a second stage, the authors present a methodology to overcome the deficits and introduce the EIVAmode process. As basis, there is a conflated Design Thinking process combined with a Scrum framework afterwards. The approach is designed for producing industries with the requirement of an accessible innovation process in product-related search fields. Finally, it was applied to the product development within an 8-month testing phase. It brought remarkable results by comparison with a project using static project management. The presented approach will provide a contribution to enhance the innovativeness in an industrial environment.

Keywords: Innovation, Lean design, Design process, Design Thinking, Agile product development

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Please cite this paper as:
Surnames, Initials: *Title of paper*. In: Proceedings of the 21st International Conference on Engineering Design (ICED17),
Vol. 2: Design Processes | Design Organisation and Management, Vancouver, Canada, 21.-25.08.2017.

1 INTRODUCTION

Contemporary development methodologies are currently challenged by a growing innovation pressure and a need for a more flexible project management. Coping with both challenges is seen as a key to stay competitive in a world of - partially disruptive - new technologies and new market players. Thus, well-established development methodologies may have to be extended, adapted or even completely rethought. Design Thinking and Scrum are two approaches discussed in this context.

With its origins in the early sixties as a design methodology and its evolution to a method for creative action in the nineties, Design Thinking became more and more mainstream for business usage and an industrial problem solver all over the world at the start of the 21st century (Kelley, 2016). Today, people expect to create innovative products and services with this approach for user-centered design, which is usually applied by designers to create new concepts without mental barriers. Design Thinking typically refers to the process used in design studios or business incubators to detect customer and end-user behaviours, to identify their needs (Uebernickel et al., 2015), as well as to transform market gaps into new business activity. For this reason, it became a popular first step for entrepreneurs planning new businesses without any idea about the product or the service they would eventually provide. This human centric innovation process, which formed hundreds of business models, is an inherent part of the start-up culture. It is quite useful to develop new and successful product solutions to enter entirely new markets. But that's not all. The process can also proceed as a methodical kick off for companies that plan a prospective change management program. Interdisciplinary teams without hierarchies and with courage to fail can convert concerned people into participants of the transformation (Weinberg, 2015). If it is assumed, that new ideas will end up in any kind of entrepreneurial transformation, the creative core team has the spirit to carry the whole company along the change by building a design-driven culture. But with all the benefits Design Thinking provides in theory, the implementation into industries is quite difficult. Several supplying or service companies have to develop in frame conditions, so there is no requirement for disruptive technologies or new products to enter a whole new market segment. Often these companies just have to release a makeover of their current product or an optimization of an existing service. Innovation management is often applied under the perspective to generate a new evolution in a products common lifecycle. In this context, the critical transformation of creative output to physical hardware or a running program indicates the need of agile project or product management methods, especially to meet the stringent timetable of the product development process.

An agile process model to manage complex product development is the Scrum framework. It has been established in recent years as a lean approach to employ various processes within and was initially introduced to the software development (Sutherland et al., 1995). Today, Scrum is primary used as an efficient framework for developing and sustaining complex products.

The goal has to be to combine both scopes - the designer's approach of thinking and the agile project management for product development. This means to build a set of tools that meet the project challenges and requirements as well as focus on the purpose. There has to be a selection of creative and agile product management methods that are easy to apply and will bring competitive results for producing industries.

This paper will present an adapted Design Thinking approach that strives to meet these needs. As a basis, chapter 2 will shortly introduce the relevant state of the art of product development methodology and an overview of Design Thinking and Scrum. Then, in chapter 3, the authors will present the methodology of the integrated approach and will provide an elucidation of the relevant steps. Chapter 4 will show an exemplary eight-month test use of the application within an industrial environment in comparison to a conventional stage-gate process. In conclusion, chapter 5 will give a summary of the results as well as recommendations for the usage.

2 STATE OF THE ART

2.1 Product development methodology

Product development methodology has been established and more and more formalized over the last two centuries (Heymann, 2005). Today, a variety of (often academic) process models exist which describe the way from idea generation and requirements specification to start of production in a more or less formalized way. Product development methodology is a strong, partially abstract discipline especially in Germany (e.g. Pahl and Beitz, 2007, VDI2221, 1993), but with varying focus also internationally (e.g. Ulrich and Eppinger, 2011, INCOSE 2015). The process models formalize and combine activities to sequential, iterative or network-based processes and provide links to a multitude of development methods. In industrial practice, development methodologies are often even more formalized and squeezed into elaborated stage-gate development systems and project plans (Cooper, 1990). However, contemporary methodologies are often also criticized as too formal, inflexible and not enough customer and/or innovation focussed. They are challenged by upcoming, partially disruptive new technologies such as digitalisation or electric mobility as well as new market players on traditionally well-covered fields - Tesla and Apple being just two examples in the automotive OEM market. Whereas an early, thoroughly elaborated requirements specification has been a paradigm untouchable in traditional approaches, highly innovative companies and products see requirements as "permanent beta", i.e. emerging and evolving throughout the process.

Thus, development methodologies may require extensions, adaptations or even complete redesigns to cope with the challenges of the future described.

2.2 Design Thinking

Created and developed by the design agency IDEO in the nineties, Design Thinking was the decisive factor to found the d.school in Stanford by David Kelley, Larry Leifer and Terry Winograd with support from the SAP-founder Hasso Plattner (Kelley, 2016). In cooperation with the d.school in Stanford, the HPI School of Design Thinking in Potsdam became an important pioneer in the research, further development and spreading of Design Thinking and interacts with design schools all over the world.

Design Thinking describes an experience design process to solve unknown problems through the development of new ideas, using divergent thinking first and then convergent thinking to get focused on a final concept (Weinberg, 2015). It is used in design studios, innovation departments and start-ups to methodically create new products or services.

The users of Design Thinking reach from global acting companies, to small and mid-sized businesses and public institutions as well as Fortune 500 organizations and business consultancy companies like McKinsey and Accenture (Pinheiro, 2014) covering topics from all social fields, such as health, energy, mobility, security, education, finance, logistics and sustainability (Uebernicketl et al., 2015).

The fundamental of this process is that not only technology and business behaviours are relevant to innovation. Design innovation is always user centric and focuses on the intersection of feasibility, viability and desirability (Kelley, 2016).

Design Thinking in its original form follows five iterative modes (respectively one more considering the HPI School of Design Thinking process), see Figure 1. In the first mode, empathize, the designers focus on humans and their behaviours in the context of their lives. They immerse themselves in the user experience with observations and interviews. The define mode is the synthesis of all empathy findings and results in a point of view focused on specific users. With this point of view, the next mode, ideate, explores a wide variety of possible solutions using ideation methods like brain writing. This depository of ideas will be used in the prototype mode to transform them to the physical world. The last mode test is used to refine the solutions and make them better (d.school, 2013).

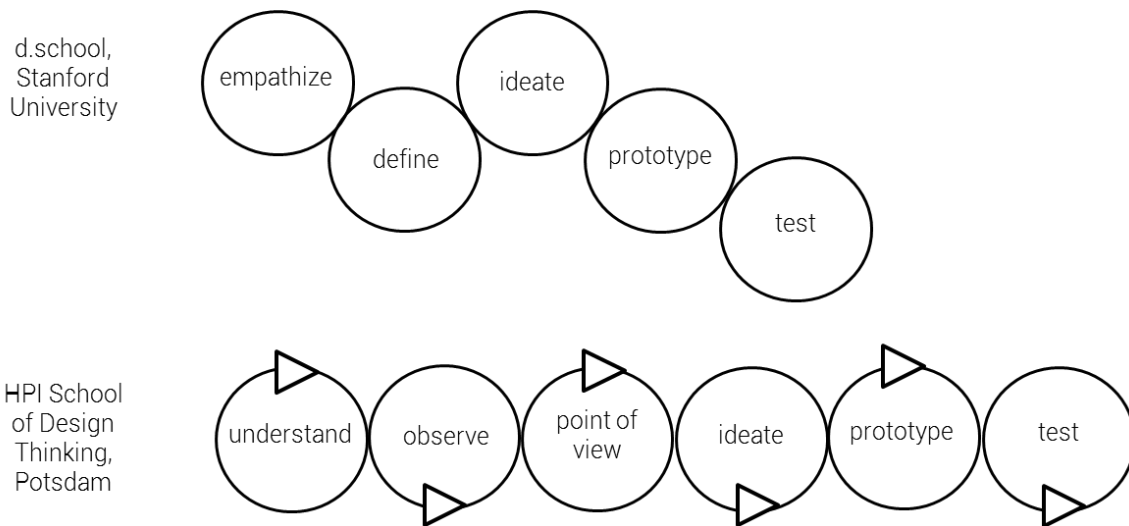


Figure 1. The Design Thinking Process in five steps as provided by d.school / Stanford University (2013) and the six step process educated at HPI-School of Design Thinking Potsdam, respectively (Hilbrecht, 2013)

2.3 Scrum

This agile project or product management framework was first introduced to the IT industries for software development. Scrum was first jointly published by Sutherland and Schwaber (1995) with the central statement that the development process cannot be anticipated. As a guideline or direction, there is only the given target. Thereby the teams work together in self-organized units that decide their tactical proceeding to reach the targets by their own.

This feedback-driven approach is the opposite of the order and control organization, in which employees get detailed operating instructions. Scrum believe in highly qualified, interdisciplinary development teams using so called sprints: short, predefined time frames, to deliver single increments of the product (Gloger, 2011).

Scrum consists of three team roles in a so-called Scrum framework, see Figure 2.

The Scrum master ensures that the Scrum theory, practices and rules are understood and enacted. He optimizes the interactions between the Scrum team and the organization and helps to maximize the created value (Sutherland and Schwaber, 2016).

The product owner is one person responsible for maximizing the value of the product and gives the development team the requirements within the product backlog - a dynamic list of all features, functions and requirements of the product and a record of all changes and new requirements within the project (Sutherland and Schwaber, 2016).

The development team consists of a maximum of nine professionals and represents a self-organizing, cross-functional group. They manage the sprint backlog, which contains the required work as well as the timing to realize the target for one sprint. The team is empowered by the company to deliver the releasable increment at the end of each sprint. The increment describes the completeness of the product and is the sum of all product backlog items finished in usable condition (Sutherland and Schwaber, 2016). Finally, the Scrum framework consists of events such as sprint planning, daily scrum, sprint review and sprint retrospective: time-boxed events, which enable transparency and inspection during the project and are used to create process regularity (Sutherland and Schwaber, 2016). In this set, Scrum is an agile framework used to handle complex product development including the opportunity of involving process partners and stakeholders online.

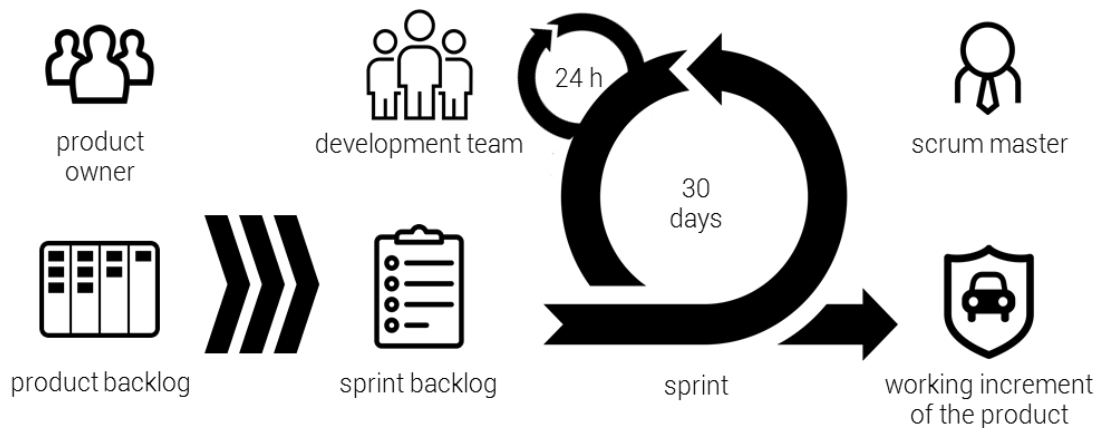


Figure 2. The Scrum framework for agile product development according to Sutherland et al. (1995)

2.4 Deficits

Contemporary methodologies are often lacking in innovation focus and agility. Known processes such as Design Thinking and Scrum are powerful stand alone and in theory, they are however difficult to link and to industrialize. Design Thinking in its original form must be uncoupled from the industrial product engineering process. There are several efforts to integrate more creativity to the product development process, but none of them works accurate without reducing design to a mechanical and predictive form of problem-solving (Pineiro, 2014). On the one hand, the project should be open-minded and without barriers to generate the maximum of creative output (Weinberg, 2015). On the other hand it must be exactly planned with detailed descriptions from the start to the product integration (Cooper, 1990). Scheduled project flow charts and the detailed definition of interim results can be extremely destructive for the creative approach. Especially in the manufacturing industry, innovation is often understood as an evolutionary inducted development. For common problems, the solution space is constrained in the more or less narrow given frame. Product development is mostly pertaining to the current lifecycle process and less to create end-user orientated products build entirely from scratch with a disruptive market penetration in mind (Pineiro, 2014).

Usually, the innovation management in the manufacturing industry is confronted with these kind of stage-gate processes, which feels challenging to install a creative "fail fast" process in front - especially in the development departments. Cost-triggered and time-critical project targets make uninhibited and open-minded thinking, e.g. for customer observations, difficult.

Within the agile project and product management framework Scrum, various processes and techniques can be employed (Sutherland and Schwaber, 2016). It seems to be advantageous to integrate Design Thinking with its agile and iterative process model, but the usage of incremental development sprints will prevent from divergent thinking and will restrict the fundamental principles of Design Thinking, by running in parallel. The challenge is to investigate the overlapping area between the creative stage and the product development stage in general and to add agile methods such as Scrum, in particular. Chapter 3 will present an integrated approach to overcome these deficits.

3 METHODOLOGY

For the industrial environment, the authors have created the so called Empagile process. An adaptation of the Design Thinking process combined with agile process methods, in order to realize a releasable product in a cost- and time efficient manner, building upon the empathy insights and the validated concepts of the creative team. A successful product development consists of the team, the area and a well-orchestrated process (Hilbrecht and Kempkens, 2013). Both, Design Thinking and Scrum, are using iterations, consisting of self-organizing and interdisciplinary teams and integrate stakeholders to the process. Design Thinking is fundamental to find the solution, Scrum provides the required framework to build the solution. This is what is applied in Empagile with a single process: first creating innovative ideas in three divergent modes and then ramping up in mode four with agile methods to realize the product. The shift from the creative stage to development stage is called fading.

3.1 Process overview

The course of action begins with the stakeholder kick-off together with the creative team to ensure all members have the same understanding of the topic. The kick-off is best held in an innovation studio, a modular room concept with special areas to support creative work and spatial arrangement for the focused work of sprint teams. The team gets a first impression of how the zones and flexible modules can help in getting creative.

An optimal creative team size for the Empagile process consists of about 8 to 12 interdisciplinary members to ensure different roles and perspectives. Small teams represent dynamic, punch and often succeed (Uebernicketl et al., 2015). The creative coach manages all upcoming workshops and is therefore not included in the sum of members. He or she is also responsible for the first introductions and team building exercises. The creative coach is a passive moderator, who takes care that the rules are strictly adhered to and helps everyone to get familiar with the process. The creative stage consists of a merged Design Thinking process with a selected set of methods. There are three separated modes that first create several insights, which are then streamlined through clustering into a selection to begin the next mode with. The second mode moves on with the selected insights and uses ideation techniques to generate a variety of ideas. The third mode is extended to a third divergent mode for the iterative enhancement of the prototypes together with customers and end-users, mutually agreed with stakeholders and the development team. This enables the team to start the agile mode with an aligned target to describe the product backlog. It helps to start the agile phase as a committed team and will be a contribution to lean management. The modification includes these three divergent and convergent thinking modes instead of only two contained in Design Thinking or in the double diamond theory on Lateral Thinking (De Bono, 1970).

The agile development stage is based on a Scrum framework. As described earlier, a product owner is responsible for the requirements in the product backlog and an agile coach ensures that the team follows the rules of the stage. Considering lean management, modifications to the product backlog are done by the product owner and the agile coach in the grooming event at the beginning of every sprint. The development team plans the upcoming iteration in the planning event, including all necessary suppliers to reach the target of a sprint. Fading is the method used in the Empagile process to find the transition among creative and development stage as well as to ensure the transfer of knowledge within both stages. Referring to Sutherland and Schwaber (2016), Scrum in its pure form is founded on empirical process control theory, asserting that making decisions is based on what is known. Regarding to the concept validation mode in Empagile, fading will raise efficiency by transferring this experience to the development stage.

All workshops and team meetings are subject to the Empagile process and take place in the innovation studio. The described process can be broken down into four single steps, see Figure 3 and Figure 4: empathize mode, ideate mode, validate mode and agile delivery mode.

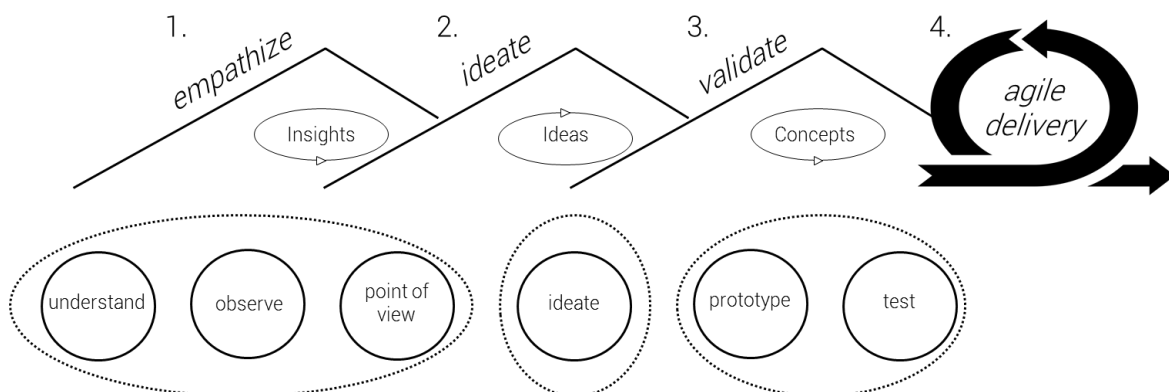


Figure 3. Conflation of Design Thinking (HPI process) to the first three modes "empathize", "ideate" and "validate" of the Empagile process (Grashiller and Gruenberg, 2016)

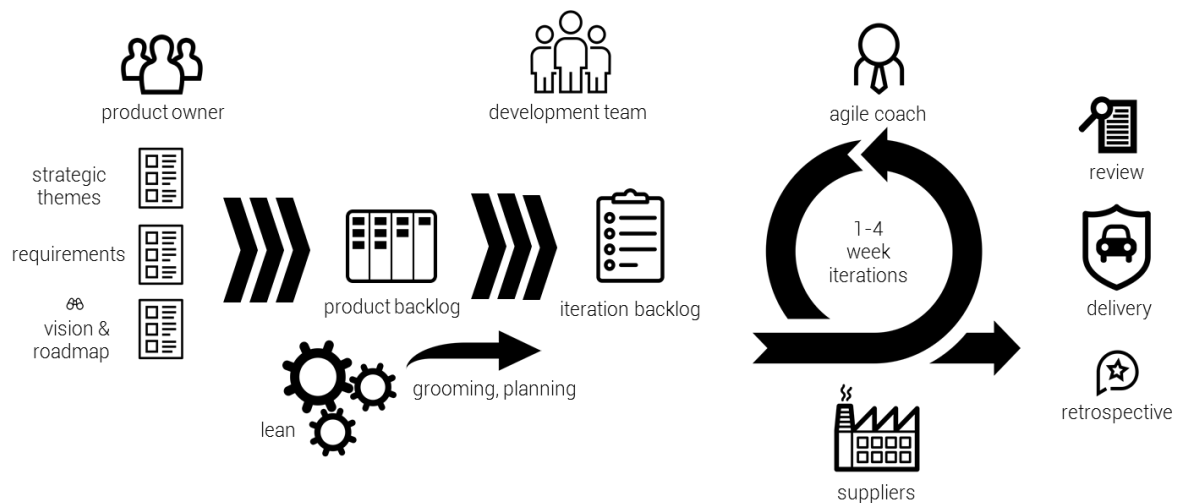


Figure 4. The agile product development process for innovation (Sailer et al., 2016) as a basis for the fourth mode "agile delivery" of the Empagile process

3.1.1 Empathize Mode

The innovation process is usually initiated by a stakeholder topic. What the field of action exactly looks like depends on the stakeholder requirements: either a rough idea or a first approach.

The first part is dedicated to the understanding of this topic. It starts with opening the mind for creativity through empathizing with the topic and getting insights into the market. Insights should be brought by the team. In addition it is recommended to obtain them from an innovation research agency or trends service. This first impulse translates into defining personas, specifying a future target group and creating a prospective use case. If it is challenging to define personas, it is useful to first create an empathy map, a tool to get deeper into the feelings of customers. It collects people's behaviours, like what they hear, see, think, say and do. With the understanding of how a future target group will live, the next task is to build a journey map over a specific timeline for each persona. A journey map runs through different phases, with emotional peaks and valleys through happiness and frustration in one day in the life of the persona (Uebernickel et al., 2015).

The information is then correct once there are valuable insights over the daily routine of the personas. The goal is to identify touchpoints with your company's portfolio and to transform them into potential future use cases.

3.1.2 Ideate Mode

The second part is dedicated to the formulation of possibilities. First the team should catch up on the insights from the empathize mode. To define the team's perspective, it is necessary to create a question beginning with "how might we...?" (d.school, 2013). This point of view represents the central question for all upcoming activity. With different creative methods like brainstorming or brain writing the team starts the ideation to generate new ideas. The ideation should be conducted iteratively with divergent thinking first to explore many possibilities in a wide solution space.

After each brainstorming session, the creative coach manages the team in clustering the ideas to a range of subjects. These so called search fields are the basis for further ideation by using brainstorming, until an evenly spread outcome for every topic is accrued. In this step ideas evolve to concepts, however it is important not to think too much in detail in order to encourage unblocked thinking. Afterwards the team selects and specifies the suitable concepts. Every concept should be sketched and described, which can be done in small groups. All the information is now concluded to a one pager which must be presented to the rest of the team. These idea pitches include all basic information as well as the uniqueness of the concept in a short term not longer than 60 seconds (Uebernickel et al., 2015).

3.1.3 Validate Mode

The third part comprises the construction of prototypes. By using simple materials, the team creates rough prototypes to proof the concepts. There are several ways to build prototypes. From paper models or role plays to mock-ups, the creative coach advises the team which methods are particularly suited. As

long as the prototype demonstrates the functions and benefits of the concept, it will be appropriate. No matter what kind of prototyping is applied, it helps to get a deeper understanding of the future use case. Storytelling or storyboards including scenarios of daily use cases help proofing the concepts. Moreover the team validates the prototypes and inquires the end-user thoughts with future customers. It is also possible to invite stakeholders to receive further user-oriented feedback at this stage. It is strongly recommended to involve an industrial designer to the validate mode. Realistic sketches can help to discuss and improve the concepts. This iterative validation results in a final concept including all user experience and modifications. Economic considerations can also be elaborated by using tools like the business model canvas.

The valid concept must be presented in a pitch with a maximum of ten minutes to the stakeholders, including a realistic sketch or final prototype for direct feedback; e.g. Pecha Kucha which is limited to 20 slides with 20 seconds per slide (Uebernickel et al., 2015). To bring in the product owner to the final pitches is key-functional; it means a faster transition to the product backlog. The validate mode is applied as long as the concept is sharpened enough and the team and stakeholders agree to move on with the realization. The more details are known whether an idea is feasible, the less modification loops are needed for the development stage.

3.1.4 Agile Delivery Mode

The validate mode will provide all necessary information to start the product development stage. Past projects have shown that it is useful to have some members of the development team as stakeholders in the validation pitches. For lean management it is recommended that someone from the creative team continue on with the development team. The knowledge transfer will maximize effectiveness and reduce the risk of expensive modification loops. The fundamental step to begin with the development will be the handover of the final concept to the product owner.

The agile delivery mode starts best with a workshop to generate the roadmap with the creative team and to integrate new team members, see Figure 4. The workshop is functioned as the kick off for the development team. At least the team, product owner and agile coach write down all requirements and prepare the product backlog. From now on, the agile team, including suppliers, should be finally nominated to continue, see Figure 5.

In the planning event, the development team creates the iteration backlog out of the product backlog. The iteration backlog contains all the team activity for the upcoming sprint as well as the length of an iteration to reach the target. The length of each sprint is depending on the amount of work the team plans to deliver 100% (Sutherland and Schwaber, 2016). To keep the product backlog actualized - because this stage is agile and requirements may change - the grooming event takes place before every next planning event. The grooming event is conducted by the product owner and the agile coach, if necessary including an additional expert to write down new user stories. Additional suppliers can be added to the sprints at any time if the requirements have changed in the grooming. The whole agile delivery mode can be run cloud-based. This procedure iterates until the product backlog is 100% completed. There is no recommended period of time for the application of the Empagile process. All planning horizon must be tailored to the specific requirements of the project proposal.

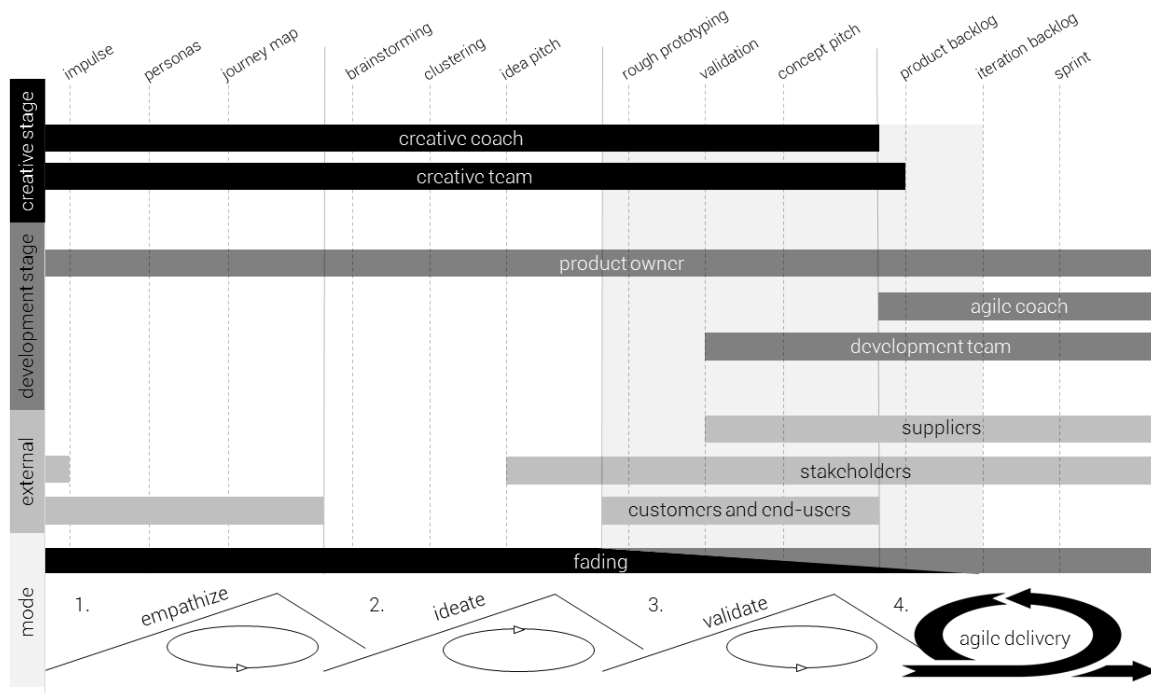


Figure 5. Team constellation in the Empagile process for agile product development including a selection of empathic methods (Grashiller, 2016)

4 EXAMPLE

The Empagile process was tested within an innovation project of a German car manufacturer. The task was to rethink the customer demands on seats, especially in the field of autonomous driving. The search field was committed to a maximum, what allowed radical ideas. The project runtime was agreed to eight months. To get the requested innovation capacity the creative stage was set to two months, followed by the development stage with six months. The creative stage was held with two six hour workshops per week within these first two months in which time Empagile process was implemented. The team consisted of five people (one person from engineering, sales, interior design, sustainability and IT) and the creative coach. In the validate mode there were at least four new concepts presented to the stakeholders. The final concept was a radical change to the current version that ended in a nomination of different suppliers, including manufacturers from the fashion industry. Fading in the validate mode included technical experts and suppliers, so statements about feasibility could be concluded at an early stage and every party was committed to the project right from the beginning of the development stage. This enabled a smooth transition from the creative stage to the agile development stage. The development team started with an engineer of the creative stage, the sales department became product owner. Two more developer and at least seven suppliers were added to the development team. The teams worked in two week sprints; it took six sprints to finish the 1:1 full functional pilot production of a completely new seating concept. One of the pain points was that the suppliers were widespread worldwide, so all agile events had to be planned online. Extra time for shipping of all parts to the workshop had to be considered. The development stage was finally managed with Google Hangouts, which brought transparency for all team members and confirmed the suitability of the Empagile process for cloud-based working.

A comparable project with the same target but using conventional development process stuck at the concept phase. The valid concept - a material substitution of the standard seat - was handed over from the design department to a project manager. Neither the project manager, nor the team were part of the creative phase. To accomplish the development, a conventional stage-gate process was installed. There was a huge workload for the project manager to get all suppliers to the process. Changing a supplier ended up in a delay to the upcoming steps. Changes to the concept because of new requirements were not possible without a step backwards and crashing the deadline.

5 CONCLUSION

Contemporary product development processes may reach their limits when it comes to innovation or agility requirements. Design Thinking is not only a process; it is a chance for cultural change: it can break through continued and hardened organizational structures. Therefore, the process is an enrichment of every corporate transaction.

Combinations of both creative and development stage in parallel brought no acceptable result. In the early creative stages the agile methods will restrict the design team from divergent thinking. Moreover the development team cannot be provided with all necessary information needed from the creative team for planning the development stage. The solution to combine the value of both approaches is called fading. Both stages are interleaved at the optimal timeslot; fading enables the symbiosis of creative and agile project management methods by running consecutively.

The creative team generates the desired outcome offline with all the team together in one area. This ideally modular area should also be used for the development stage, even if individual members are connected online. All agile methods used in this approach also operate cloud-based and virtual. The process is suitable if unimpeded ideation with lean implementation is desired as one single innovation process. Therefore, the process must be tailored to the project-specific targets in advance.

Whereas for continuously innovative research issues, the usual Design Thinking may be the process of choice, the Empagile process can bring innovative results in the application in hard- and software producing industries, especially for innovation issues within a limited period of time.

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