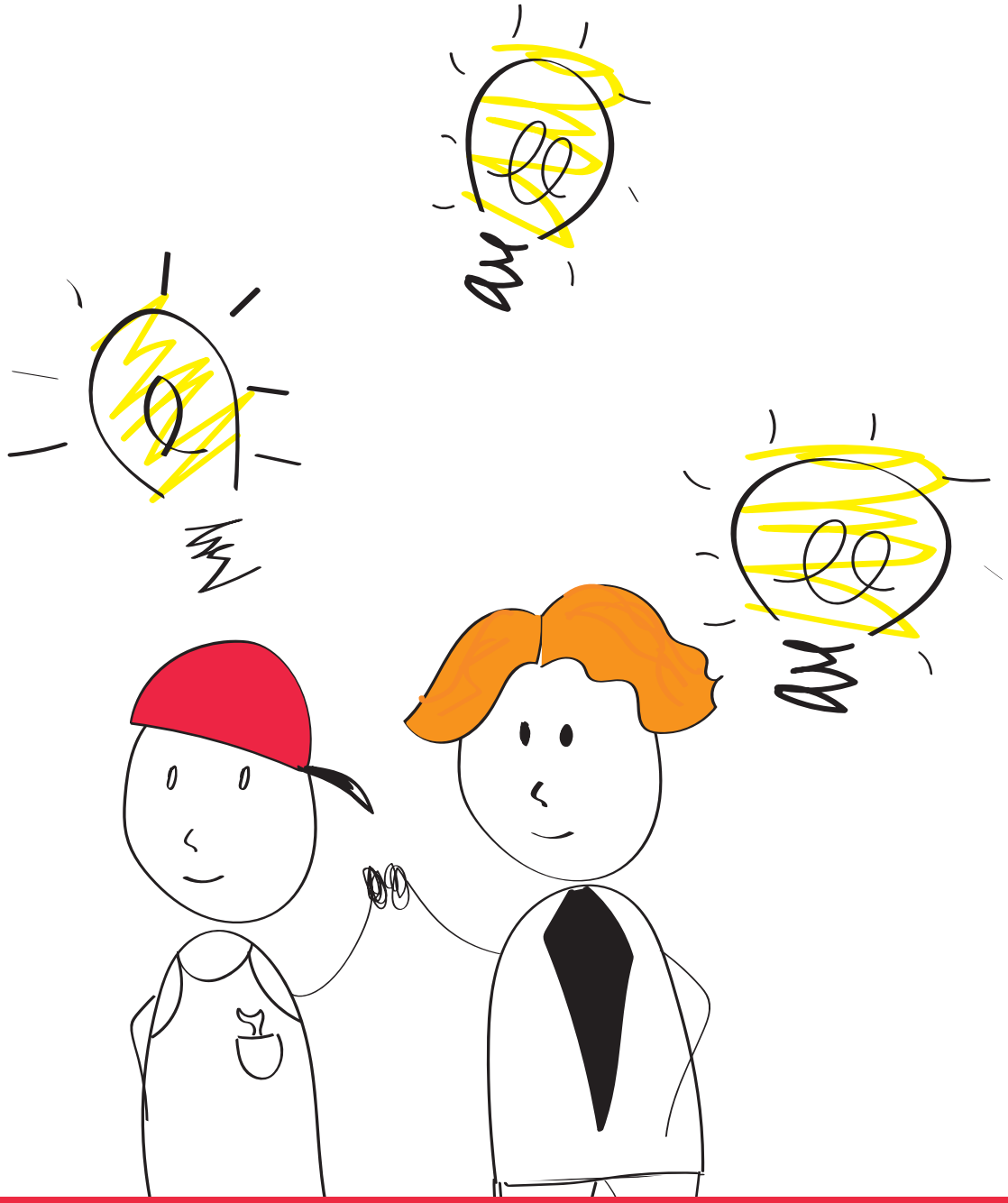

Design of a framework to co-create applications in a hangar environment

Master thesis

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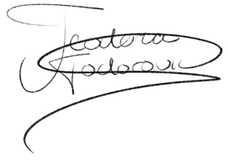

EXECUTIVE SUMMARY

New, innovative technologies are important. More and more companies are using digital technologies to their benefit. The act of leveraging such digital technologies to enable organisational improvements in a strategic way is called a digital transformation. In such transformations, the customer experience, operational processes and business models need to be reconfigured in order to get ahead of the forces for change in the digital age. If a company only focuses on technology, the transformation might fail, as also the daily work of people will change due to the digital transformation. Therefore, also human-centric challenges need to be tackled in a digital transformation strategy.

In order to create value with new digital technologies in a transformation program, it is important to understand needs of the people affected by the new digital technologies. The extent to which needs are met determines what value is attached to the digital artefact. Therefore, many strategies exist for uncovering user needs and involving users in the sense-making of the research topics for new product development. However, no strategies exist that tell how to combine such co-creation with software development to better meet user needs with features of digital artefacts.

This provides new opportunities for the development of a co-creation framework for software development. This thesis explores how to incorporate co-creation in agile software development. This is done for the department of a European-based airline. By involving their users in the creation of digital artefacts, the company will better know what users want and increase the value created with the artefacts of the digital transformation program.

Currently, this airline uses the Scrum framework to develop iPad applications. They find user needs but do not manage to translate those needs into the right product backlog items for the software development. Product backlog items are descriptions of user needs that explain to the development team what needs to be made in the application features. This thesis, therefore, answers the following research question:

How can co-creation be used to give support during the translation of user needs into product backlog items?

This research question is answered by following a double diamond design process, that includes both research activities and design experiments to create insights needed to answer the research question.

A detailed literature review is conducted the understand the current context of co-creation, value creation and software development. Moreover, two ethnographic studies are performed to understand the company's context and problem that is being faced. The research insights are translated in a co-creation framework outline. Based on this framework a co-creation process and several tools that together serve as a design solution are developed. This process and tools are designed based on several creative sessions and experiments that reveal what design principles do and do not work. Finally, a framework evaluation test is performed in the hangar environment, validating the principles of the design solution. Based on the evaluation insights, the design solution is extended, and recommendations for implementation and further research are given.

DESIGN OF A FRAMEWORK TO CO-CREATE APPLICATIONS IN A HANGAR ENVIRONMENT

GLOSSARY

Airline: term used to refer the company that this project initiated to guarantee anonymity of the company.

Check: a periodic inspection that needs to be done on all commercial and civil aircraft after a certain amount of time or usage. Such a check comes with standard tasks that need to be completed during the ground time of the airplen

Co-creation: collective activity that might occur in co-design and is about the exchange of ideas, experiences, and expertise. This activity can be creative when users are supported with the right tools to tell about their experiences and express their needs.

ETR: estimated time of redelivery of airplane. This term is used to describe the moment that an airplane needs to leave the hangar.

IT council: scheduled meetings that take place at the end of the day shift and beginning of an evening shift every other week. Representatives of each team go there and discuss problems related to IT and Innovation. The representative of a team is called a star point and is required to gather wishes, needs and problems of his team members with regards to it and innovations.

Pilots: official moment when a team uses only the iPad for the first time during a complete shift or complete check.

Product backlog item: feature that still needs to be developed into the application. This work is a description of the users' needs.

Prototype: artefact made in the co-creation framework that shows how user needs should be translated into screens.

Scrum: Agile software development framework that guides in an iterative and incremental way of working (Schwaber & Sutherland, 2017).

Team: group of technicians that always work together in shifts. Together they have all skills required to safely service an airplane.

Team lead: lead of a team of mechanics.

Technician: worker that services aircraft.

UX role: Role in software development team that is responsible for analysing user tasks and work domains, conducting interviews, making survey, taking part in discussions with users, analysing user needs,, usability testing, and finding problems and suggesting solutions for these problems (Da Silve et al., 2013).

DESIGN OF A FRAMEWORK TO CO-CREATE APPLICATIONS IN A HANGAR ENVIRONMENT

TABLE OF CONTENTS

1. INTRODUCTION

The first chapter briefly describes the research background of this thesis. This project is commissioned by a European Airline that is in the middle of their digital transformation. Specifically, this project is commissioned by the aircraft maintenance department of that company. This chapter gives insight into the assignment background, the project purpose, the assignment, research question and concludes with a description of the project approach.

1.1 Project context

The assignment is performed for a European-based airline. This airline flies millions of passengers a year to both European and intercontinental destinations. This company is customer-centric and has started several transformation programs to become more customer-centric. One of these programs is the digital transformation program, that focuses on 4 different themes (Figure 1).

The aircraft maintenance department provides the airline, and other airlines, with competitive aircraft, engine and component maintenance, and engineering support. Since the aircraft are the company's most expensive asset, they need to be kept in flight as much as possible by keeping their ground time as low as possible. This means that performed aircraft checks need to be as efficient as possible. To increase efficiency, the department uses Virtual Reality (VR) training for staff, predictive maintenance and even has transformed one of the hangars into an innovative and future-proof hangar. Besides, several innovative digitalisation projects, which are part of the digital transformation program of this airline, have been started to increase operational efficiency.

Within the digital transformation program, several tablet applications are being developed by different teams to increase the efficiency of the business operations. One of these applications is iTask[1] that has been designed to empower the technicians in servicing the aircraft as efficient as possible, keeping the turnaround time, which is the amount of time taken to complete aircraft checks, as low as possible. iTask is a digital app for the iPad that allows mechanics to break down the work packages of servicing the plane into tasks that can be assigned to team members by the team leads, picked up by team members, resolved and closed. The applications has 4 KPIs:

- iTask needs to increase productivity by 4%;
- iTask needs to ensure safety;
- iTask needs to increase employee engagement;
- iTask needs to decrease the turnaround time of an aircraft.

The goal is to make the technicians more mobile than desktop software does. For example, maintenance

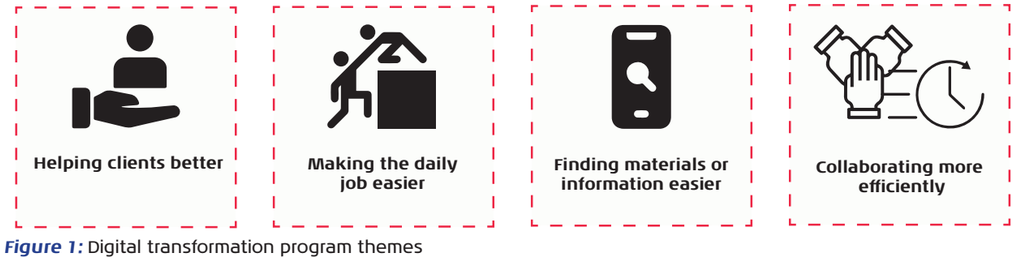

Figure 1: Digital transformation program themes

[1] iTask is a fictive name. The real name has been anonymised for this thesis.

manuals, that are needed to service an airplane, can now be viewed on the iPad while servicing the aircraft in the hangar environment because of iTask. In the past, technicians needed to go to a desktop in the office, log in to the desktop, look up a manual, send it to the printer, pick it up at the printer and then take it with them to the aircraft to perform a task. iTask will be discussed in more detail in Chapter 3.

However, applications developed in the digital transformation program of the airline are not finished yet. The applications are developed with the Scrum framework, which is explained in Section 2.4.1. Every two weeks new functionalities are released. The technicians that service the plane, therefore, consider the application not to be finished yet. As a result of this, they still use old software to do their job. Besides, the technicians argue that several technological artefacts have been designed and developed to help them do their job but none of those artefacts are helping . Why is it that the digitising team is trying hard to make an app wanted by the users, while users argue that the app is not helping them in their daily job?

First, the special environment of the hangars requires a seamless connection between the users and the digitising teams as the context is complex and as the check of an aircraft is influenced by many factors. Examples of such factors are: missing materials, safety and compliances, time pressure of the estimated time of redelivery (ETR) of an aircraft and work experience of the technicians. It is hard for the digitising teams to understand what the users need in a digital artefact translate due to the complexity of the work environment. Second, for digitising teams it is hard to involve technicians in innovation projects. The teams talk to users to uncover their needs but when they translate such needs into the iPad applications features, mechanics argue that they did not need such a feature. Last, the shift work of the mechanics makes it hard to work together, since it can take several weeks for a mechanic to be again scheduled during office hours, when the applications are being developed.

1.2 Project aim

The digital transformation of the maintenance department and the complex ecosystem of an aircraft maintenance check create the aim of this project.

Design a company-specific, time-efficient co-creation framework and basic tools which support the company's digital transformation in the hangar environment. The framework needs to include experiments that would help the digitising team establish metrics on how backlog items will positively affect the work of the mechanics both in terms of productivity and employee satisfaction. It must fit an agile way of working.

This aim is the assignment that is carried out in this work. The argument for this is that currently digitising teams collaborate with their application users, ask about their needs and still build features that are not used or wanted by the users. Therefore, the problem statement of this project is:

The methodology used by the application development teams does not allow to uncover the right user needs and translate them right into the applications.

A framework in this graduation assignment is considered to be a set of steps that can be followed to include co-creation in the Scrum software development process. To guide the users of the framework, the framework will be provided with tools that can be used in these steps. The framework that needs to be designed there is a basic structure underlying tools that can be followed when one wants to co-create in an environment where Scrum is used for software developed.

1.2.1 Research questions

To solve this challenge, the application iTask will be used as subject to set up experiments with and test design interventions for. To be able to complete this challenge the following research questions have been set up:

1. How can co-creation be used to give support during the translation of user needs into product backlog items?
2. How does a day in the life of an aircraft mechanic look with digital tools?
3. How does the digitising team develop applications at this moment?

The first research question is a translation of the design challenge into research questions to determine what needs to be researched by performing a literature study to understand the relevant themes and create a theoretical framework.

Research questions 2 and 3 show themes for the design research that needs to be performed to understand the complex hangar environment and workflows of digitising teams to be able to design a co-creation framework that will bridge the gap between the workflows of the technicians and digitising teams.

1.3 PROJECT SCOPE

There are several factors that influence this project. This project was performed in collaboration with an European-based airline. All the steps and tools are designed with the airline as context.

In this thesis product backlog items are examined from the users' perspective in order to support the translation of user needs into product application features. The process of finding new product backlog items is not explored in depth, however, it is explored how the understanding of what users need can be deepened by co-creation.

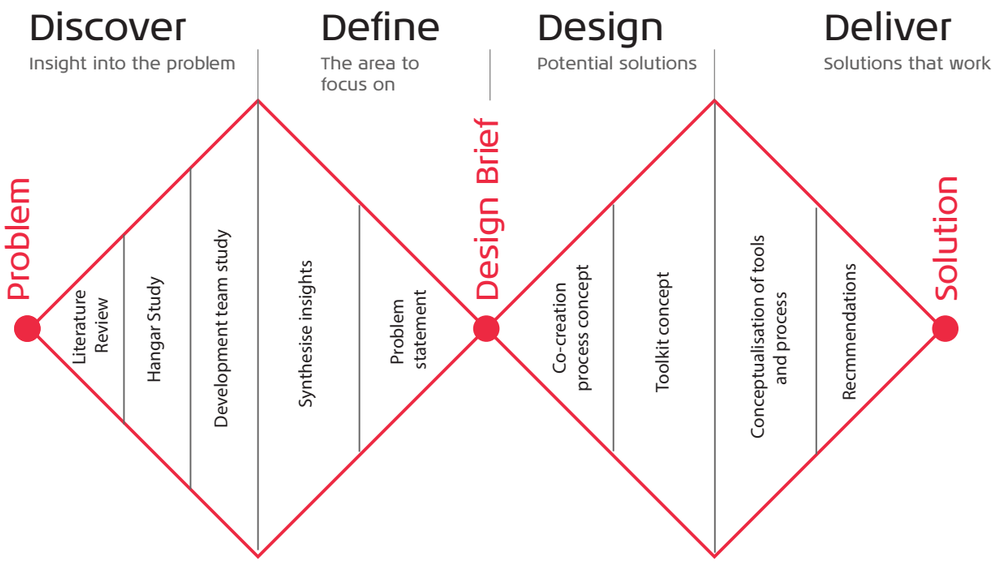

Figure 2: Double diamond project approach

1.4 PROJECT APPROACH

Since the project context is complex, it is important to understand the context well to be able to define what the actual problem is and to eventually design and deliver a solution to this problem. The double diamond (DesignCouncil, 2007) is used to structure this project. The Double Diamond has a generic shape (Figure 2) but allows to stretch the diamonds as needed to gather the right understanding and eventually solution (DesignCouncil, 2007).

Ethnographic research practices and research through design methodology are combined to gather different types of knowledge (Figure 3). Combining these activities will enabling moving from explicit, to observable, to tacit and to latent knowledge (Visser, Stappers, Van der Lugt & Sanders, 2005) and better-understanding challenges that the department is facing.

Together, the studies about the hangar and environment and development team studies provided all information required to define the design brief. The findings are used as a foundation for design interventions in the second diamond and eventually for the conceptualisation

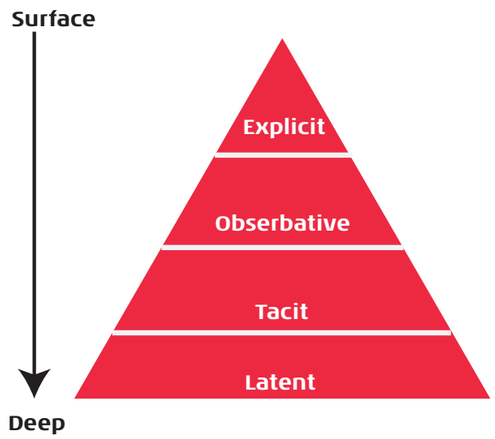

Figure 3: *Different layers of knowledge*

of a co-creation framework. Such interventions belong to the Research through Design methodology and can be used to generate knowledge (Stappers & Giaccardi, 2017). Therefore, the interventions created are based on existing scientific theory and designed to create change in a setting which can include new practices and theories (Hayes, 2014).

2. DISCOVER - LITERATURE

This chapter presents the current knowledge on topics relevant for answering the first research question:

How can co-creation be used to give support during the translation of user needs into product backlog items?

The first section is set up by introducing the theory around co-creation and value creation. In the second section, it is briefly explained what digital transformation means according to theory and what is needed for the combination of Scrum software development and user participation.

2.1 Co-creation

Co-creation is a term that is often used and misused. There are a lot of benefits to co-creation. Iin order to optimally benefit from co-creation this section, it is discussed what co-creation is and how to design for co-creation.

2.1.1 What is co-creation?

Co-creation is a broad term that is often confused. Even academic institutes use different terms to refer to the same activity. To be able to design a co-creation framework, an understanding and definition of co-creation are needed.

Often two terms are used: co-creation and co-design.

Calabretta and Gemser (2015) define co-creation as an approach to incorporate an end-user perspective throughout all stages of a strategic project to create value.

Mattelmäki and Visser (2011) define co-design as activities in the design process that by involving users aim at searching new potential directions for product development, producing design solutions, making sense of the topic that is researched or expressing experiences collaboratively.

At the faculty of industrial design engineering, Delft University of Technology, the term co-creation is used when users are stepping into the shoes of designers by being given tools to create new tools, while the process is facilitated by designers or researchers (Mattelmäki & Sleeswijk Visser, 2011). Thus, both co-design and co-creation are used to describe similar projects that include a large toolbox of creative methods as well as users' and stakeholders' involvement (Mattelmäki & Sleeswijk Visser, 2011).

Sanders and Stappers (2009) define co-creation as an act of collective creativity that is shared by two or more people. In the same paper, Sanders and Stappers (2009) define co-design as collective creativity as it is applied across the whole span of a design process and therefore consider co-design to be an instance of co-creation. This means that co-design is a specific instance of co-creation: in co-design collective creativity (thus co-creation) happens across the whole design span. This can happen in the four directions depicted in Figure 4 (Mattelmäki & Sleeswijk Visser, 2011).
From the literature above it can be concluded that co-design is a

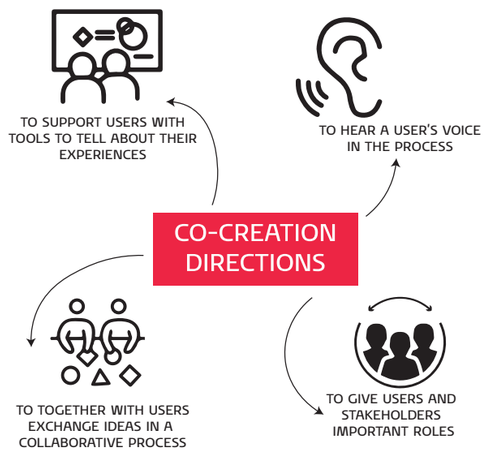

Figure 4: *Co-creation directions (Mattelmäki & Sleeswijk Visser, 2011)*

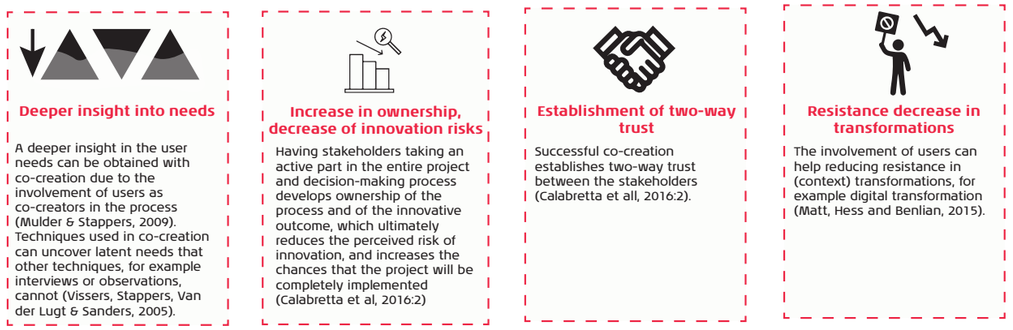

Figure 5: *Advantages of co-creation*

process and contains collaboration tools to give users and stakeholders a voice in the entire design process. Co-creation is a collective activity that might occur in co-design and is about the exchange of ideas, experiences, and expertise. This activity can be creative when users are supported with the right tools to step in the shoes of designers to tell about their experiences that can be used for design or can also be a moment where users are involved to hear their voice. However, to create real value the exchange of ideas and experiences, needs to happen throughout all decision-making moments (Calabretta & Gemser, 2015), thus: through the fuzzy front end, design phase, development phase and implementation phase of the project.

The involvement of users in the design process or design activities has several advantages (Figure 5). Due to its advantages, the term co-creation is used a lot within companies nowadays. In general design practices are moving from user-centred design, where the user is a subject of design, to co-creation, where the users is a partner in design (Sanders & Stappers, 2009). Yet deep involvement of users in product development is limited (Mulder & Stappers, 2009). Product- and concept-testing are becoming commonplace in the industry, butindustry but involving users in the fuzzy front end or idea generation phase is not often applied yet (Mulder & Stappers, 2009).

To keep co-creation effective, four aspects, visualised in Figure 6, need to be considered (Calabretta, Gemser and Karpen, 2016).

2.1.2 How to design for co-creation?

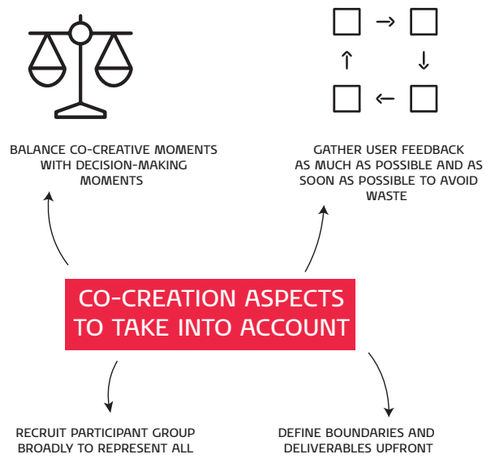

Figure 6: *Important co-creation aspects (Calabretta, Gemser & Karpen, 2016)*

Participatory design, which is defined by Sanders & Stappers (2009) as collective creativity in the design process, is connected to co-design and co-creation. Participatory design can be found in the literature for many years and origins from Scandinavia (Greenbaum & Kyng, 1991; Schuler & Namioka, 1993; Ehn 1988). The original goal of participatory design was to empower workers and foster democracy in the workplace (Spinuzzi, 2005). The main argument for participatory design is that end-users know better how to change practice than management or development teams (Holmlid, 2009). As a result of this, user involvement in participatory design is a well-developed technique. Participatory Design methods and techniques that can be used for a co-creation framework are: building prototypes (Sanders & Stappers, 2012), performing role-plays (Sanders & Stappers, 2012), designers and developers apprenticing with users to understand and empathise with their work (Sanders & Stappers, 2012), design probes (Mattelmäki, 2006; Gaver, Dunne & Pacenti, 1999) or design games (Brandt & Messeter, 2004).

Participatory design has been researched for years, much longer than co-creation and co-design have. ThereforeTherefore, much literature can be found about the approach.

Three basic stages (Figure 7) are present in most participatory design projects (Spinuzzi, 2005):

1. Initial exploration of work: this is the phase in which the development team meet the users and immerses themselves in the ways of working of users;
2. Discovery processes: in this phase, a future workplace or future state is envisioned by the designers and users, which allows the users to clarify their goals;
3. Prototyping: last, the designers and users make and shape technological artefacts to fit those into the envisioned state of phase 2.

Several tools can be used in the stages in participatory design. In Table 1 commonly used methods and tools for each stage are summarised.

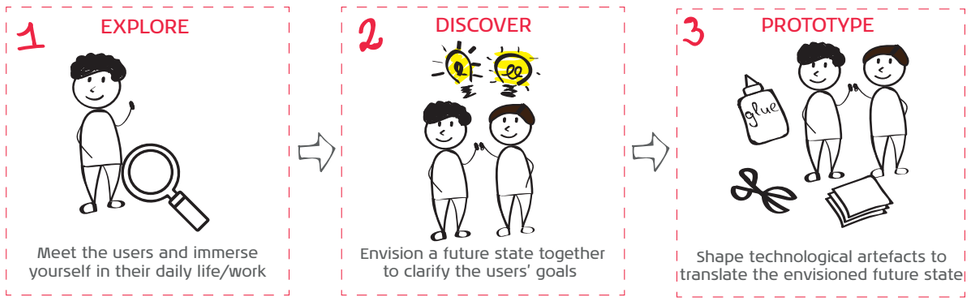

Figure 7: *The three stages of participatory design projects (Spinuzzi, 2005)*

Table 1: Participatory design process tools

Stage	Tools that can be used
Initial exploration	Observation; interviews; generative techniques (Sanders & Stappers, 2012)
Discovery	Role-playing games (Sanders & Stappers, 2012); Design games; (Brandt & Messeter, 2004); Make-tools both 2d and 3D (Sanders 2000; Sanders & Stappers, 2012; Stappers & Sanders, 2003); Design Probes (Mattelmäki, 2006; Gaver, Dunne & Pacenti, 1999) , Diaries (Stappers, Brandt, & Binder, 2010), cards to organise/categorise/ prioritise ideas (Stappers, Brandt, & Binder, 2010)
Prototype	Mockups (Mattelmäki, 2006; Gaver, Dunne & Pacenti, 1999); paper prototyping (Novick 2000), cooperartive prototyping (B0dker and Gr0nbaek 1991; Gr0nbaek and Mogensen 1994); Pictive (Muller 1991b, 1993),

However, as this table shows, there are no decision-making moments, as proposed by Calabretta and Gemser (2015).

2.1.3 Conclusion

Many different definitions exist for co-creation. This literature study concludes that co-creation is a collective activity that might occur in a process, when users and designers/ researchers come together. This activity gives voice to the users in the process.

To achieve the benefits of co-creation, an active role of the user is needed at all decision-making moments. This suggests that only a few co-creation sessions are not enough for solving the company's problem: involvement in the fuzzy front end, idea generation, and product testing are needed to cover the important decision-making moments. Participatory Design methods and tools can be used for a co-creation framework, as participatory design focuses on the change of the workplace. However, in addition to these tools and methods other methods, such as decision-making methods, need to be added to the framework as well.

2.2 Value creation

Since the goal of this airline is to create value for the employees, it is important to know what value creation is, how it relates to user needs and how to choose what value is going to be created.

2.2.1 Relation between value and user needs

Value creation has been recognised as a central concept in marketing for a long time (Woodruff, 1997) since it is a precursor to user satisfaction and loyalty (Woodall, 2003). Value creation is important since the extent to which user needs, wants, and preferences are met, underlie what value is attached to a product by users (Smith & Colgate, 2007). Therefore, customer or user value is related to user needs. A user need is a user problem that a product or service solves (Griffin, 2005) and therefore creates value. This is important in any product that is designed to solve user problems or improve the daily work as intended with the digital transformation program of this airline.

User needs can be on top of mind and easy to express, or deep and therefore hard to express (Vissers et al., 2005). Needs on the surface, called explicit needs, can be elicited with interview and observation techniques, while for latent needs generative sessions are needed (Vissers et al., 2005) (Figure 8). Latent needs uncover what people dream about for the future, but to uncover such needs users must be provided with the right tools to articulate their needs and users must be prepared to do so in advance (Sanders & Stappers, 2008). Such preparation of users to express their latent needs, is called sensitising. To sensitise users, designers and researches often ask users to think about a certain topic, answer questions about this topic and/or do some exercises about the topic before the session (Sanders & Stappers, 2008). These answers and exercises then are discussed in a session to uncover needs.

The path of expression (Figure 9) structures a process in which participants are sensitised and creates awareness (Sanders, 2001). The path of expression guides participants to a deeper understanding of their needs, wants and dreams and therefore

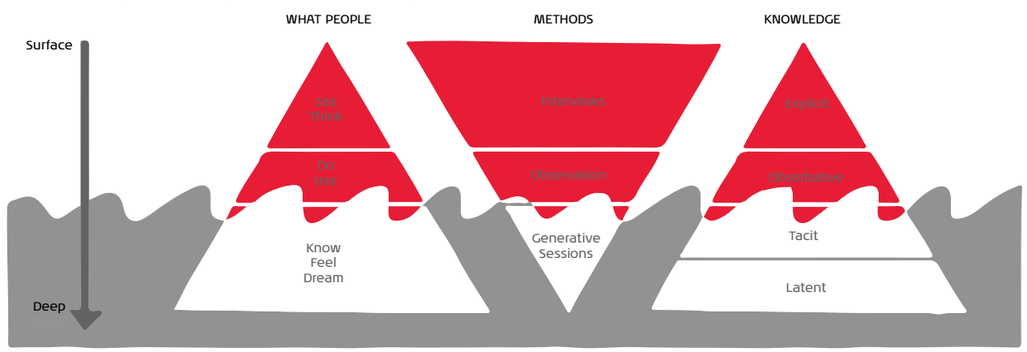

Figure 8: Different types of needs (Vissers et al, 2005)

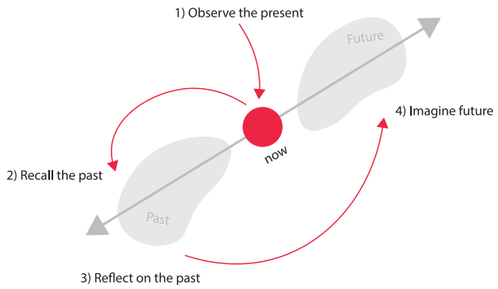

Figure 9: *Path of expression (Sanders, 2001)*

enables to find design opportunities (Sanders, 2001). First, the participants consider their current situation, then recall good and bad experiences related to that situation which then are reflected to find underlying values (Sanders & Stappers, 2008). Last, participants are guiding in thinking of what a wanted future situation would be.

However, user problems are complex and often user needs for these problems conflict (Griffin, 2005). Therefore, a good understanding of the users and their context is needed (Griffin, 2005). Users cannot easily tell what products to develop or what the future product should look like (Griffin, 2005; Sanders & Stappers 2008; Vissers et al., 2005), but by having good user-understanding development teams can help with making such a translation (Griffin, 2005; Sanders & Stappers, 2012). As this is an important decision-making moment, is it is important to do this in a co-creative manner to give users a voice in the process and create valuable products for them (Kautz, 2011).

Another reason why value creation is important, is the emotional bond that is being established between the user and producer of the product once a product is bought or used for the first time (Butz & Goodstein, 1996). This leads to users recommending the product to friends and colleagues (Butz & Goodstein, 1996). For this to happen the service provided needs to meet or exceed the customer's expectation of the product (Butz & Goodstein, 1996).

2.2.2 Conclusion

Understanding user needs is important to create value with (new) products and services. To create such understanding, users need to be enabled to express their user needs. For this several tools can be used, which can be found in Section 2.2.1. Only by understanding the user needs, the right product attributes can be designed and developed. Different techniques can be used to uncover different level of needs. When the goal is to uncover explicit needs, interviewing techniques are sufficient. However, for latent needs interview or observation techniques are not sufficient. Sessions that enable users to make artefacts that express their needs are necessary to uncover what users dream of for the future.

2.3 Digital transformation

The following section introduces some theory about the digital transformation. Before any form of digital transformation research can be discussed, three terms that are commonly present in digital transformation research are introduced in Figure 10 to ease reading the following section.

These terms are visualised from left to right in a logical way, based on impact and effort. Digitisation is the simplest way of transforming analogue information into digital information. Digitalisation goes a step further: underlying infrastructures are changed to go from analogue to digital. In a digital transformation, even more, is changed: current business processes are transformed to create more value for both business, employee and customer.

In this chapter, it is discussed why digital transformation is needed and how this effects the digital workplace to create understanding for the context for which the framework will be designed.

2.3.1 The need for a digital transformation

New, innovative technologies are important. The Internet is used anywhere, anyhow by anyone for different purposes. Companies can use such technologies to their benefit. The act of leveraging several digital technologies to enable business and organisational improvements in a strategic way is called a digital transformation (Matt, Hess and Benlian, 2015; Demirkan, Spohrer & Wesler, 2016). A digital transformation, that requires processes to be reconsidered and changed to new digital ways that bring more value, is more than digitisation, in which analogue information is encoded into a digital form (Tilson, Lyytinen & Sorenson, 2010) or digitalisation, in which new technological techniques are applied across industries and context in ways that affect and change current underlying infrastructures (Tilson, Lyytinen & Sorensen, 2010). Devices for mobile connectivity, such as tablets and mobile phones enable the transformation due to their form and characteristics. Besides they generate big amounts of data that

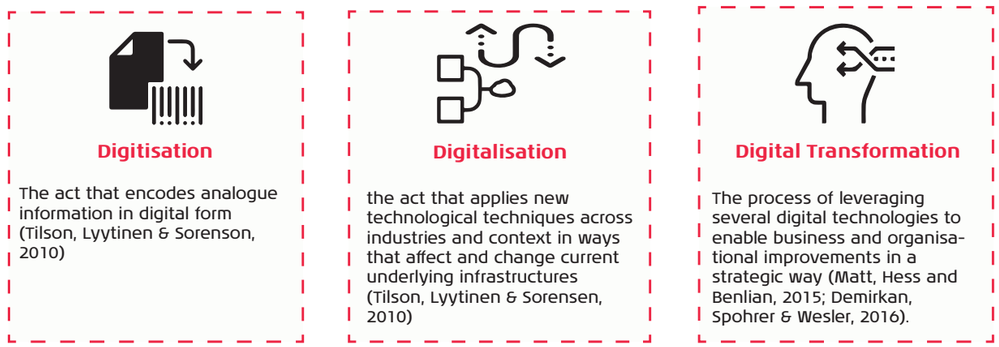

Figure 10: *Common digital transformation literature terms*

can be useful, however, in general strong business analytical skills are needed to interpret the data and take advantage of it in a business setting (Berman, 2012).

Transforming businesses and processes digitally can bring much to a company. The digital transformation enables organisations to address market or user needs quickly and enables higher levels of collaboration for sharing information faster due to access to knowledge and resources via new, advanced digital technologies (Demirkan, Spohrer & Wesler, 2016). Such a digital transformation program has three building blocks (Westerman, Calméjane, Bonnet, Ferraris, & McAfee, 2011). These building blocks are visualised in Figure 11. These blocks need to be reconfigured in the transformation to get ahead of the forces for change in the digital age of today (Berman, 2012). Therefore, a digital transformation program often affects large parts of the company, resulting in far-reaching consequences. Due to this, it is more than a technology challenge, it is a management and people challenge as well (Westerman et al, 2011; Kane, Palmer, Philips, Kiron, & Buckley, 2015). Many companies are failing because of focusing too much on technology instead of the entire strategy (Kane et al., 2011).

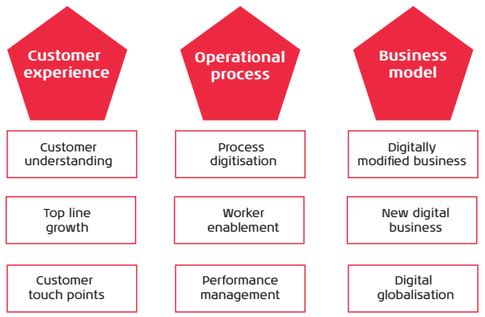

Figure 11: *Digital transformation blocks (Westerman et al. 2011)*

To overcome this, digital transformation strategies are designed and implemented. Digital transformation strategies are blueprints that support companies in guiding transformations that arise due to the integration of digital technologies and operations (Matt, Hess and Benlian, 2015).

2.3.2 The digital workplace

For a digital transformation to be successful, the right capabilities to implement changes and new styles of working are necessary (Berman, 2012; Dimension Data, 2012). This leads to required changes in traditional workplaces to become digital workplaces (Dimension Data, 2017). The strength of such capabilities and styles of working is determined by how well everything is integrated to transform the business and work (Kane et al., 2015).

Not only business-wise there is a need for such changes. Also, employees are asking why they cannot collaborate via digital tools with their colleagues in the way they can with friends (Westerman et al, 2011). For such new ways of working and workplaces, users have exponential increasing expectations of technology quality resulting in high change pressure for management (Westerman et al, 2011). A digital workplace includes all the technologies that employees use to get the work done in the workplace (Deloitte Canada, 2011). This means that workplaces need to be digitised and digitalised: some information needs to be encoded from offline to online, while for other technologies infrastructure changes are needed. Due to such changes, jobs change as well: some jobs might disappear due to complete automatisation, new jobs might be created for example for the support of new infrastructures. Such changes require flexibility and fluidity of companies (Schreyögg & Sydow, 2010). This means that companies must react flexible to changes in the organisation, that might occur in complex, changing contexts (Schreyögg & Sydow, 2010), for example, organisational environments that are in a digital transformation. In such environments, technology can assist humans in decision-making, reducing the complexity of the task (Shim et al., 2002).

Technological changes mostly influence the design of the work (Barley, 2015). First, the lines between personal life and work-life blur: due to mobile devices and cloud services employees are always connected to their workplace (Mazmanian, Orlikowski, & Yates, 2005; Mazmanian, 20 13). Also, teamwork changes: regular teamwork gets replaced by virtual teamwork (Gilson et al., 2015), resulting in changing ways for communication and knowledge-sharing via collaboration tools (Haas, Criscuolo & George, 2015). Many challenges of the digital transformation are not only technology-centric but are also human (Solis & Littleton, 2017; Westerman et al, 2011; Kane et al., 2015). Management and guidance are needed from the organisational perspective to change individual perspectives of employees (Sollis & Littleton, 2017).

2.3.3 Conclusion

To conclude, technologies are increasing in importance, resulting in digital transformation. Such transformation require processes to be reconsidered and changed to new digital ways that bring more value. In such transformation program the customer experience, operational processes and business models need to be reconfigured in order to get ahead of the forces for change in today's digital age. If a company only focuses on technology, the transformation might fail (Kane et al., 2011). Not only the business changes due to digital transformation programs, but also the daily work of people. This implies that next to technology challenges, also human-centric challenges need to be tackled in a digital transformation strategy by providing guidance to the employees. Hence, to bridge this challenges, a co-creation framework that enables employees to express their needs in the digital transformation could be of added value. The next section explores how co-creation can be used in the development of digital artefacts in a digital transformation program.

2.4 Software development and user involvement

This section investigates what Scrum software development means, since this is how the airline develops its applications, and investigates how to combine such development practices with co-creation.

2.4.1 Scrum software development

Scrum is an agile software development framework that guides in developing, delivering and sustaining complex adaptive problems, while productively and creatively delivering the products of the highest possible value since the early 1990s (Schwaber & Sutherland, 2017). In the Scrum Guide Schwaber and Sutherland (2017) define Scrum in terms of roles, events, artefacts, and rules that bound the former three. All components are essential to Scrum's success and usage.

2.4.2 Agile software development, UX roles, and participatory design

Companies increasingly adopt Scrum and other types of agile software development practices to work as efficiently as possible. Also, more and more companies that adopt agile development practices want to design products with involvement of users (Bruun, Larusdottir, Nielsen, Nielsen, & Persson, 2018; Da Silva, Silveira, Melo, & Parzianello, 2013). Despite the growing interest in designing software with the user in mind, still, not many organisations report that a UX role is needed for employing successful agile development (Sohaib & Khan, 2010) or about user participation in a Scrum process.

According to Cajander et al. (2013) to understand and manage user perspectives in agile software development the UX role is crucial. Responsibilities of such a role include research, understanding users and data gathering (Cajander et al., 2013; Da Silva et al, 2013). Corresponding tasks of this role are visualised in Figure 12 (Da Silva et al, 2013). Other studies report on integrating user studies, personas, prototypes, and usability tests into the process to integrate the UX role into agile software development (Hussain et al.,2009; Haikara, 2007) and create user understanding.

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However, in such processes, the user is still not involved in the creation of the product but is mainly interviewed

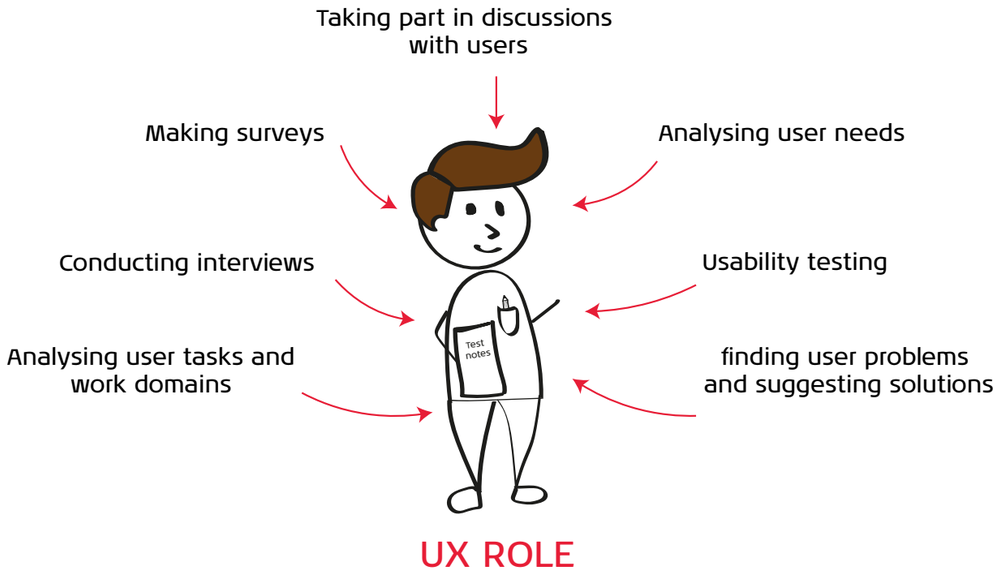

Figure 12: *UX role with corresponding role tasks (Da Silva et al, 2013)*

about user needs or used for usability testing. This contrasts with earlier found literature, that suggests that:

- needs expressed by words are explicit needs that are on the surface;
- that users cannot easily express their deep needs with words, but by making artefacts and explaining the reasoning behind artefacts they are enabled to express latent needs;
- involving the user in decision-making activities helps in decreasing the risk of innovation.

Other studies report about combining participatory design and agile software development. By integrating participatory design, the project progress and flexibility can better be balanced, resulting in successful projects that enable users to carry out their work to their satisfaction (Kautz, 2011). According to Kautz (2011), the participative roles of users are useful in requirements prioritisation, during feedback meetings and software presentations, and in preparation and performance of acceptance tests. It does miss an important factor, namely that co-creation is about exchanging ideas and experiences in a creative way (Mulder & Stappers, 2009). Also, in this study, no design tools were provided to the users to empower them in design activities. Mainly conversations, interviews, observations, and testing were used to create a participative role. A quote from the research is:

> *"It's not easy to find out from the WaterWorks people what they want; when I say 'do you want it this way', they say 'yes', and when I ask 'do you rather want it*

that way', they also say yes". "[. . .] and they say 'we have this and this problem', but to design an interface out of this information is our problem". - Kautz.

This quote exactly shows what Vissers et al. argued (2005): users need tools to express their needs and need to participate in the design process. Kautz used two more roles to incorporate the user perspective in the process: an informative role to enable the user to provide information about the daily work and a consultative role to comment on present design solutions.

User participation in agile software development enables people to develop realistic expectations and therefore reduce resistance to change (Kautz, 2011) and increases the workplace democracy by giving employees a voice in decision-making moments that will influence their daily work (Kautz, 2011). However, a different role is needed to give users a real voice and enable them to express their deep needs. Also, such co-creation moments where the voice of the users is being heard, need to be balanced with decision-making moments (Calabretta & Gemser, 2015).

2.4.3 Conclusion

Participative design in agile software development has added value since it develops realistic expectations about the end product and reduces resistance to change. Besides, it increases workplace democracy by giving employees a voice in decision-making moments. However, literature does not focus on Scrum and co-creation, but on a broader term: agile software development in combination with a UX role or participatory design. The goal of including a UX role is mainly to research the use context, user needs and to propose solutions to user problems. Important to notice is the passive roles of users in such studies: users are the object studied but do not participate in the design activities.

In the literature found about participatory design and agile software development, users participated in prioritising sessions, software presentations, and usability testing. More often, the users had an informative role or consultative role. Although user participation was used in the process or although the process included UX design, the users were not provided with the right tools to utilise their new role. Participatory design was not used to its full potential in the found literature since a participatory role is much more than informative or consultative.

2.5 Conclusion

This chapter has provided an overview of what co-creation, value creation and digital transformations are. Additionally it has discussed how co-creation and creation of applications can be combined. It was found that co-creation is a collective creative activity that is about the exchange of ideas and experiences. This activity can also occur in a collaborative process that has several tools that give users a voice in the entire design process to express their needs . This is important, since the extent to which user needs, wants, and preferences are met, underlie what value users attach to the product. However, to co-create with users, tools are needed to enable users to express their needs and step in the shoes of a designer.

Unfortunately, not much theory exist about combining agile software development with co-creation, where users are treated as active partners in the process. Most literature provides insight about how to combine agile software development with user research. Nevertheless, it has been demonstrated in research about participatory design that end-users of products that change the daily work know better how to change the daily work than management or development teams know (Holmid, 2009). Unfortunately, the literature study did not provide an answer yet how to use co-creation in agile software development to support the translation of user needs into items that can be developed by the development teams.

3. DISCOVER - COMPANY ANALYSIS

To understand the context in which the co-creation framework will be used, several explorations methods were used. Methods used are department analysis, observations and semi-structured interviews. These exploration methods were used to gather insights about how the daily life of a technician looks like and how digital applications that technicians are supposed to use, are built now. Section 3.1 describes the department analysis, Section 3.2 the ethnographic study performed to understaind the daily work of technicians and Section 3.3 describes the ethnographic study performed to understand how digital applications are being developed now. The chapter concludes with a comparison of the literature and the exploration findings in Section 3.4

3.1 Department analysis

The department analysis was mainly done by reading future vision documents of the department, analysing product roadmaps of current applications oand holding informal conversations with the digital transformation lead of the department. The goal of this analysis was:

- Understanding the vision for the department's transformation
- Understanding how the current products contribute to this vision

The digital transformation at the engineering department has started in 2015, with the development of the product iTask. To make this more concrete, a vision for 2030 (Confidential Appendix A) has been developed by the Management Team with help of the visual thinking consultancy[2], visualising the strategic goals of the department.

To realise this vision, midway through this project, a roadmap (Confidential Appendix B) has been developed for the transformation envisioned within the department.

As the future vision shows, a lot is to be changed in the following years, e.g. work processes to create a connected aircraft, connected materials & equipment, and a connected technician. The workplace will change in terms of processes, but also job tasks of technicians. As the literature study showed (Section 2.1.1, 2.1.2 and 2.2.1), it is important to investigate the user needs in this transformation to create value. Also, the literature study showed that it is important to involve the technicians in this transformation using co-creation to uncover their needs and decrease risks of innovation

iTask was the starting point of this transformation in the maintenance department of this company and is supposed to increase efficiency in the operation. iTask is making the operations more efficient by having visual progress information of the check and a digital plan board and by offering assistance in task assignment and management. To achieve the KPIs, iTask has been, and still is designed with 6 digital themes in mind (Figure 13) (Swaanenburg et al., 2015)[3].

Only the themes material and equipment readily available have not been developed yet, nor is it possible to see in the application the status of materials or equipment. The screens belonging to the 6 digital themes are included in confidential Appendix C.

Currently, the teams responsible for the development of technologies have their office in the hangars to be close to the users and enable a better collaboration. All other application development teams sit in a new-built office far from their users. However, the current methodology used to uncover and translate user needs

[2] The name of the consultancy has been anonymised to guarantee the anonymity of the airline.

is not working, which results in user needs being translated wrong into iPad application features, despite the digitising teams sitting so close to their application users.

3.1.1 Conclusion

More applications are to come that will contribute to the realisation of the future vision. Co-creation of the path towards the future will help to uncover insight into deep user needs (Mulder & Stappers, 2009; Vissers et al., 2005), to discover how needs should be translated into application features (Muller, 1991), to develop ownership of the innovation outcomes and therefore decrease innovation risks (Calabretta et al., 2016:2) and will help reducing resistance towards the big transformation of the workplace that is ahead (Matt et al., 2015). For these challenges, the framework that will be delivered can be used.

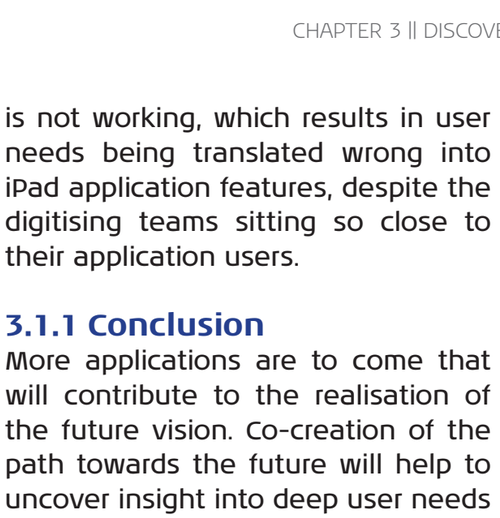

Figure 13: *Digital themes iTask*

[3] Source derived from the intranet (not publicly available) of the company.

3.2 Ethnographic study: The hangars

To understand the complex practice of servicing an aircraft, technicians were observed doing their job, joined in their shifts and many informal conversations were held with the technicians.

The goal of the ethnographic study was:

- Understanding what servicing an airplane is
- Understanding what the artefacts developed in the Digital Transformation program mean for the technicians
- Understanding how servicing an airplane and using technological artefacts come together in the daily work of technicians
- Identifying how co-creation can help the technicians in expressing their needs for future applications better

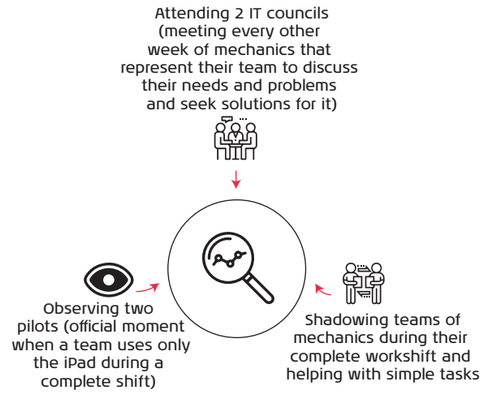

Figure 14: *Data gathering methods used*

Figure 14 shows how all information was gathered and Figure 15 how all findings were analysed.

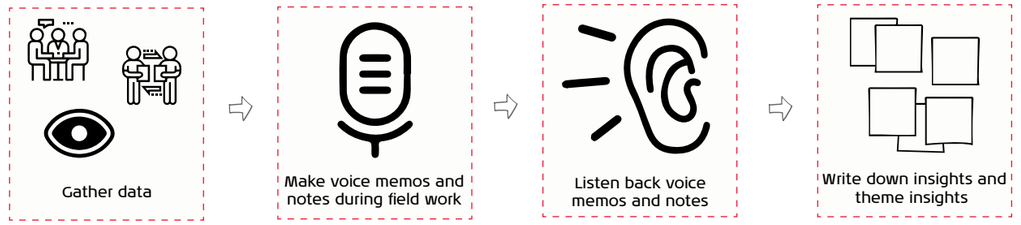

Figure 15: *Data analysis approach*

3.2.1 Servicing aircraft and using the iPad

An aircraft maintenance check is a periodic inspection that needs to be done on all commercial and civil aircraft after a certain amount of time or usage. Such a check comes with standard tasks that need to be completed which are considered to be routines. Together these tasks are grouped into a work package that needs to be completed during that specific check.

A check, as it is scheduled (Figure 16), is an ideal situation. Only in an ideal situation an inspection happens before other team members start working on a plane or only scheduled tasks are performed. In practice, a check never is performed like that. To decrease the turnaround time some technicians therefore already start working on tasks while other technicians do an inspection. This inspection can result in extra tasks that need to be performed to guarantee that the aircraft leave the hangar in a safe way.

iTask has been designed to support all checks completely (Figure 17). However, the usage of iTask in all these stages by the same technician was not seen during the shifts observed. Technicians use the application for parts of their shift, but not for their entire shift.

To show why the technicians do not prefer iTask over legacy system they set up an experiment to measure the time needed to sign off a task was both in iTask and legacy systems. Completing the tasks on the desktop in Maintenix, which is the forerunner of iTask, took a little bit longer than 15 seconds. In iTask, it took more than a minute to complete the tasks. This slow speed was demonstrated through multiple examples, showing why the technicians do not prefer iTask over the old software on the desktop. The only moments an entire team was seen to use iTask during their entire shift, without using legacy software, was during pilots, thus when the mechanics were forced to use the application.

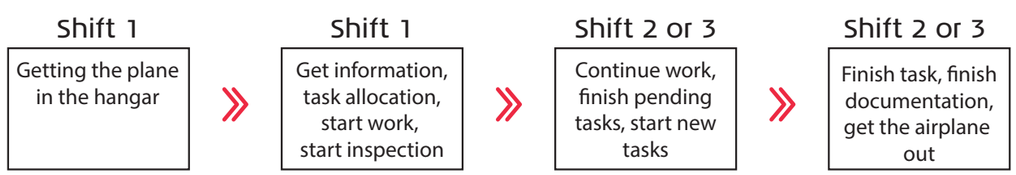

Figure 16: *The sequence of job tasks during a check*

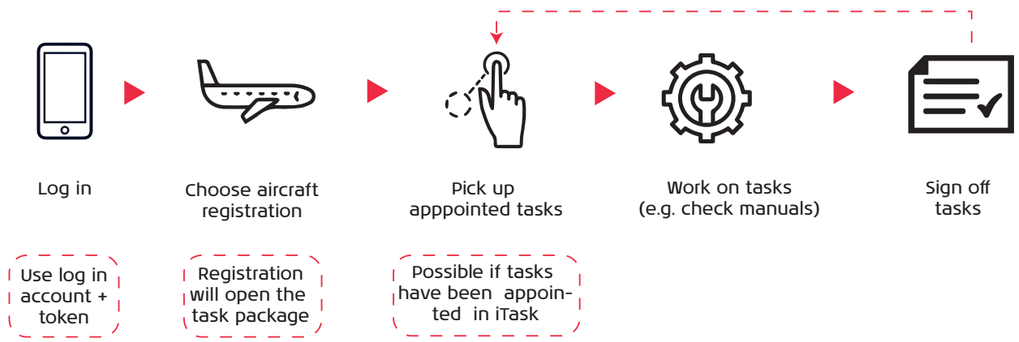

Figure 17: *Usage scenario of iTask from the technicians' point of view*

why the technicians do not prefer iTask over the old software on the desktop. The only moments an entire team was seen to use iTask during their entire shift, without using legacy software, was during pilots, thus when the mechanics were forced to use the application.

"I do not want to use an app that is less efficient than other systems." - Technician, hangar 12

"To be honest, I don't believe that iTask is going to succeed at all. They wanted to implement it earlier, and they told us they would fix the problems iTask has soon, like the speed or the errors. That should have been done in the summer of 2017, and now and nothing has happened. It would be so stupid, to start using iTask just to let it succeed but to delay every aircraft we service." - Team lead, hangar 14

"Let's count together how long it takes to open the manuals, how many times the WIFI drops, or how many times I need to go back the office and use the desktops because iTask is not sufficient." - Technician, hangar 14

"The administration takes much longer. Therefore, I don't really see the point." - Team lead, hangar 12

iTask also has a manual section, that enables technicians to see all required steps that need to be undertaken to safely complete a task. These manuals are supposed to be online and to enable technicians to immediately see the manuals corresponding to their tasks, rather than first having to print them in the office. The manuals are being updated by Boeing and Airbus often, and therefore technicians need to make sure that their manuals on the iPad are up to date as well. Since the WiFi in the hangars is too slow to enable regular updating of the manuals in the hangar, technicians need to download the manuals offline at home.

Also, the check progress that iTask is supposed to show, is not good enough according to the mechanics. They have a paper plan board (Figure 18), that, according to them, tells more about the check progress than iTask does. The application page for check overview, that is supposed to replace the paper plan board, does not provide the right information, yet they do tell that the digitising team asked them about what they need on such a page.

Figure 18: *Paper plan board*

"I need to update 1 hour at home every 3 days, and that is outside of working hours. Because when I do it here, I can start working 4 hours after I started my shift and we don't have time for that. If we all would do that, we would never meet the estimated time of redelivery." - Cabin technician, hangar 12

"When I work on a new plane that I do not know that well, the digital plan board does not tell me if I am on schedule to meet the estimated time of redelivery. For old planes that I already know, I do not need the app to tell me whether I am on schedule or not. I just know that" - Team lead, hangar 12

3.2.2 Performing a task with iTask

To understand better how the digital artefacts in the daily job of the technician are used, multiple mechanics were shadowed during two shifts. Observations were then mapped in a behaviour map (Figure 19). Table 2 explains all the actions that were performed by the technician with numbers that correspond to the arrows in the behavioural map.

The map (Figure 19) shows the path a technician often follows to resolve a problem and complete a task.

Servicing a plane is a physical heavy job. It requires a lot of walking, carrying around materials and tooling, and replacing material - which often requires non-ergonomical positions (Figure 20). Besides, the iPad is often left near the boxes with tooling (Figure 21) and is not used during the actual maintenance of the aircraft.

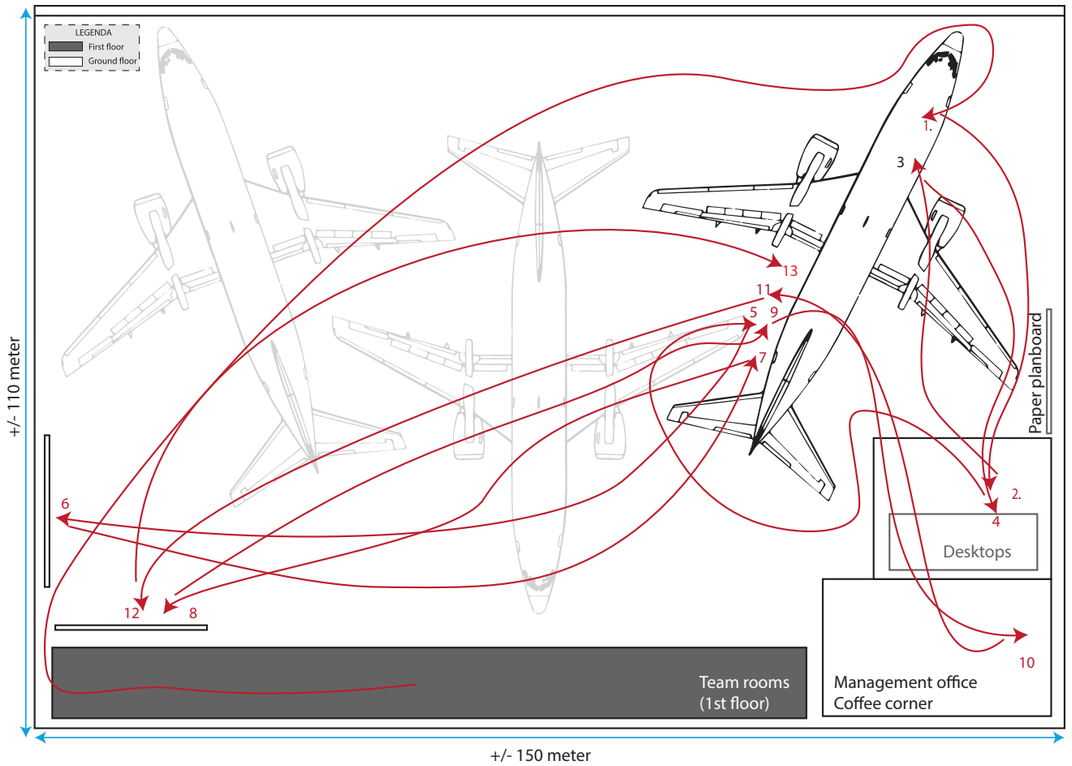

Figure 19: *Behavioural mapping*

Table 2: Actions mapped in behavioural map

Action	Description
1	Starts shift in team room, goes to aircraft. Cabin for inspection (he finds out that only half of a part needs to be replaced while CabinApp tells him that the part completely needs to be replaced)
2	2Unscrews the part that needs replacement - Goes to the team lead that is doing administration on a desktop. Team lead checks material availability in Maintenix on the desktop and reserves it.
3	Team lead asks him to bring a similar part as well - Level 0 goes back to the aircraft
4	Unscrews part - brings part to team lead
5	Starts new task, while waiting for the ordered material, by going to the aircraft Gets required material
6	Gets required material
7	Goes back to the aircraft with material
8	Gets required tooling
9	Bring tooling to the aircraft
10	Goes to the office for coffee
11	Returns to aircraft
12	Starts working on the task - finds out that tooling is missing - goes back to tooling department for required material
13	Returns to aircraft to work on task, finishes tasks and signs off task in iTask

Figure 20: Body positions during aircraft maintenance

Figure 21: iPad left on tooling box

To show what servicing a plane means and how the iPad is used for the daily job, a user journey was made, showed in Figure 22. This journey is based on all observations and shadow sessions done. The journey shows a work shift of mechanic that is part of an IT council. The IT council has been founded to give mechanics the opportunity to gather their own wishes and try to solve fulfil their wishes. The IT council focuses on problems related to the iPad or other innovation projects of the department. Members of the IT council are supposed to perform extra tasks related to the IT council next to his regular job tasks, without getting time scheduled to perform these tasks.

The figure shows that the technician is facing erros while using iTask, that the application is slow and that it does not show the required information. This problem can be solved by the digitising teams, but to do so they need the understand the wishes and desires of the technicians.

Second, the user journey shows that the iPad is not the problem of low usage of the iPad applications. The problem can be found in the applications themselves. Some apps like CabinApp[4] are used, but the technicians prefer other software when it comes to task management and support. The difference between iTask and CabinApp is that iTask's core functionality is the administration of a check, while CabinApp has the unique functionality to help to perform tasks in a visual way and, therefore is perceived to be better than older tools. As found in a department research earlier in 2019, for a new app to be accepted by the technicians it at least needs to be as good and fast, but preferable better and faster, than old software available (Enache, Scholten & Aris, 2019).

Lastly, the user journey shows that there is room for improvement left in the organisation of the IT councils. In hangar 12, the IT council is often cancelled, or the technicians did not gather the needs and wishes of colleagues due to missing tools or time.

"Why would I put the effort into the IT council. The only thing we managed to fix in the last 1.5 years is a printer. That's not enough to do such things in my free time, so if I prolong my work shift to attend an IT council, I go home earlier during an evening shift." - Starpoint IT council, hangar 12

"Well, I used to go there, because they invite you for value pokering , so I thought that it was going to be a fun game. Turns out that value pokering is an endless discussion about priorities and not a game." Starpoint IT council, hangar 12

"You know why, when the digitising teams come to the IT council they use terms like API that we don't know, only to tell us that the application is still slow. Why not say that it is slow, rather than explaining in technical terms how the low speed is caused?" Starpoint IT council, hangar 12

[4] This is an application that has not been developed internally but bought by the airline.
[5] Source derived from the intranet (not publicly available) of the company
[6] Value pokering is a method used at the department to prioritise iPad application features

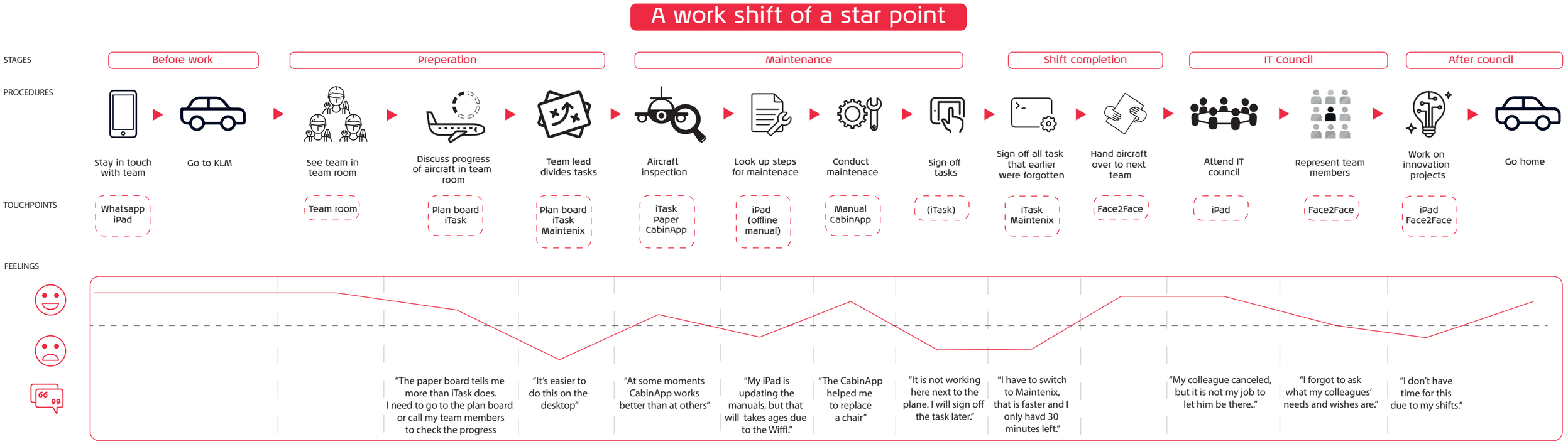

Figure 22: *User journey of a star point*

3.2.3 Study conlusion

This study provided insights about what an aircraft check is and how performing a check works. To capture all the quotes, feeling and behaviour observed and hear during this study, an empathy map was made. This map can be found in Figure 23.

As became clear from this ethnographic study, and as the empathy map shows, an aircraft check is complex. A new software tool, iTask, has been designed by the airline itself to support technicians in their daily work. However, as argued by the technicians, the software does not help them. Several reasons were given for this, e.g. the slow speed of the application, slow WiFi in the hangar, or screens that are designed to solve user problems but still do not fulfil user needs. Besides, the technicians feel that they are not adding much to the digital transformation program, while they are supposed to do so with the IT council. A co-creation framework could help the mechanics to let them hear their voice about what they really need and help them reach more with the IT council.

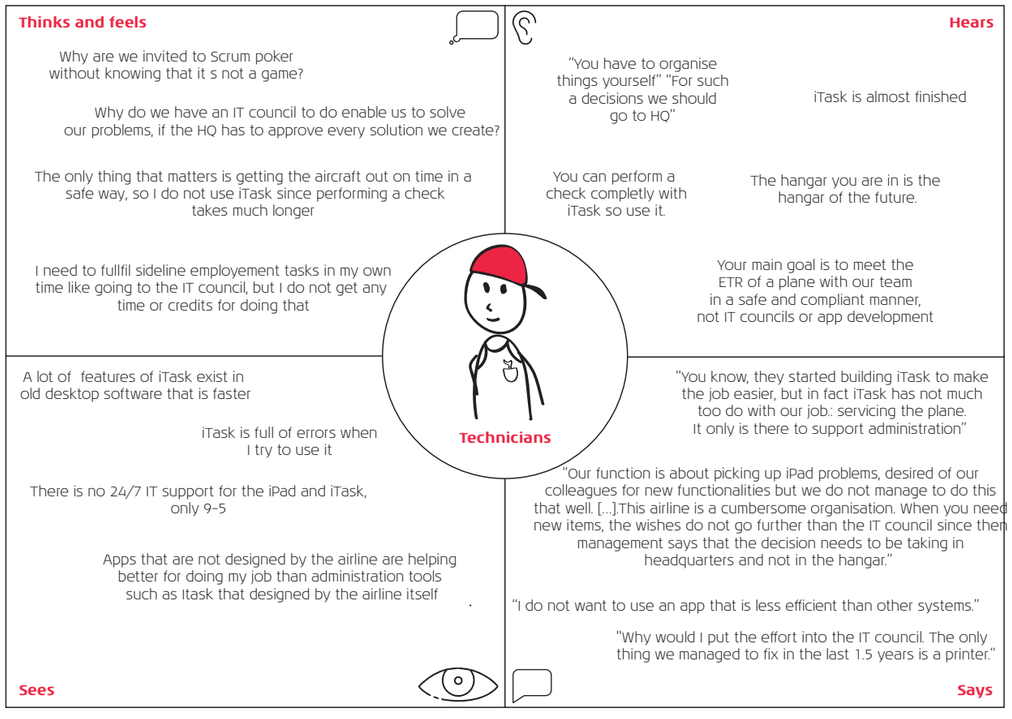

***Figure 23:** Empathy map technician*

3.3 Ethnographic study: The digitising department

To understand how the digital artefacts are created for the digital transformation program, a second ethnographic study was performed, focused on the digitising teams and their development process.
The goal of the ethnographic study was:

- Understanding how applications for the digital transformation program are developed
- Understanding how user needs for the applications are gathered
- Identifying how co-creation can be applied in the development process of the applications

For the data gathering of how the applications are developed observations were used. Besides, the author of this thesis worked with the team four days a week, which resulted in deeper insights about how the applications are developed and user needs gathered. These insights are described in Section 3.3.1. To explore the development process deeper and way of gathering user needs, semi-structured interviews were held. The approach and results of the interviews are described in Section 3.3.2. Last, the study conclusion is described in Section 3.3.5

3.3.1 Appdevelopment process and development team

For the development of the applications within the airline, the Scrum framework is used. The framework consists of scrum teams and their roles, events, artefacts, and rules that all have their specific purpose that is essential to the success of the framework (Schwaber & Sutherland, 2017). This process is visuliased in Figure 24.

The digitising teams that work on the development of application consist out of a few different roles (Figure 25).

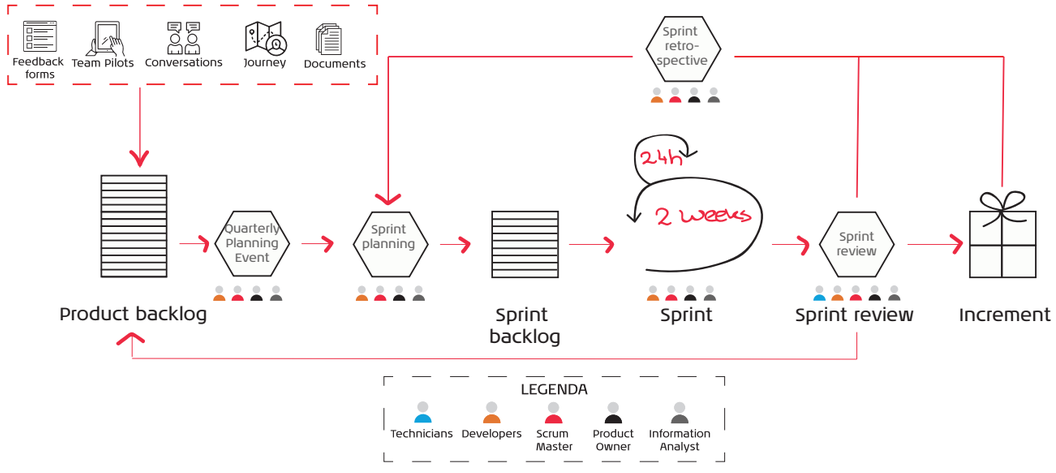

***Figure 24:** Development process*

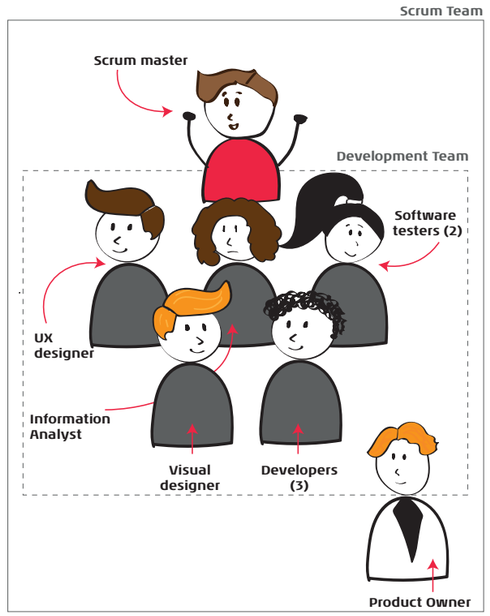

Figure 25: *Team roles*

The Scrum master orchestrates the development team to deliver product increments The product owner is responsible for maximising the value created with the development of the product, therefore he is responsible for providing the teams with items on the product backlog that need to be developed. These items are called user stories and represent user needs. Figure 26 shows examples of user stories. The development team exactly develops what is stated in the user stories of the product backlog items.

As Figure 24 shows, user needs are gathered through:

- Conversations with users;
- Team Pilots: these are moments when teams of mechanics use the application for the first; time through the entire shift. After the pilots the mechanics provide feedback;
- The feedback in the application;
- Business documents (e.g. updated rules and regulations that require changes in the application);
- Employee journey.

The employee journey is a document that shows the day in the life of a mechanic that uses the application. This document is created before an application development process starts and shows important digital themes. To create such a document at the beginning of the development of a new application, the airline works together with a design consultancy that performs user research and co-creates a day in the life.

For the gathering of user needs, the information analyst and designers of the development team help the product owner. Therefore, their roles are discussed in more detail.

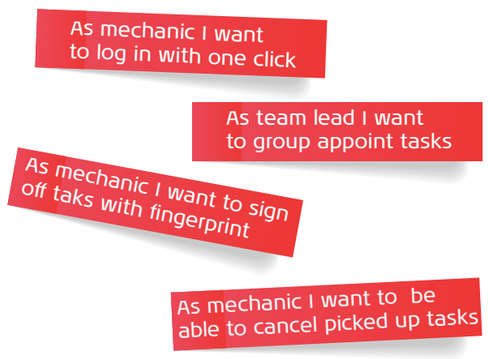

Figure 26: *User story examples*

<u>THE PRODUCT OWNER</u>

Observations done and informal conversation held are synthesised this into an empathy map (Figure 27).

As can be seen in Figure 27, the product owner is mainly busy with maximising the value of iTask. The application is mature enough to support during a complete check, yet most technicians perform complete checks without iTask. Therefore, he is trying to involve users more and uncover what they need in iTask. He tries to talk to users every week, but also tries to increase the number of users that show up during official feedback moments or moments when new features are released. The features that users request are being developed, but afterward are not used by the technicians, as said by him "We digitised the paper plan board and still they tell me that the paper plan board has more information than iTask while we display the same information".

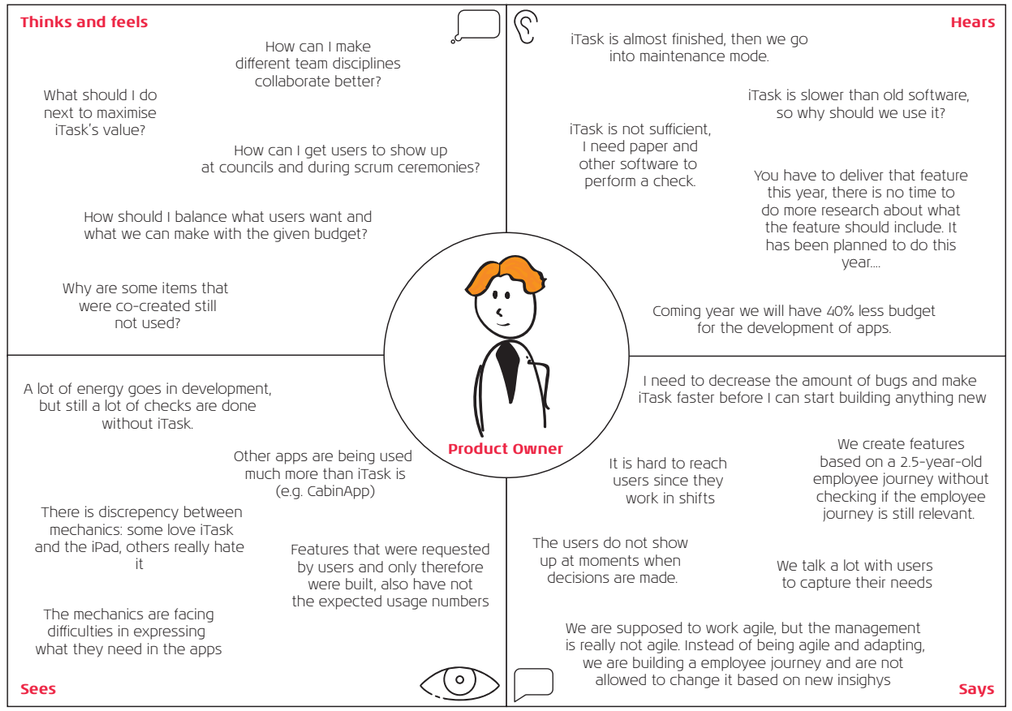

Figure 27: *Empathy map product owner*

THE INFORMATION ANALYST

Observations done and informal conversation held with the information analyst are synthesised this into an empathy map (Figure 28).

Officially the task of the Information Analyst is to guarantee the feasibility of the product, but the information analyst in the digitising teams is a lot in touch with the users to gather product feedback. She translates this feedback into user stories, that go to the product backlog and get assesses on value and planned to develop. However, in the translation, there is room for improvement since technicians often complain that they did not ask for the features built, while the team built exactly what the users told they need.

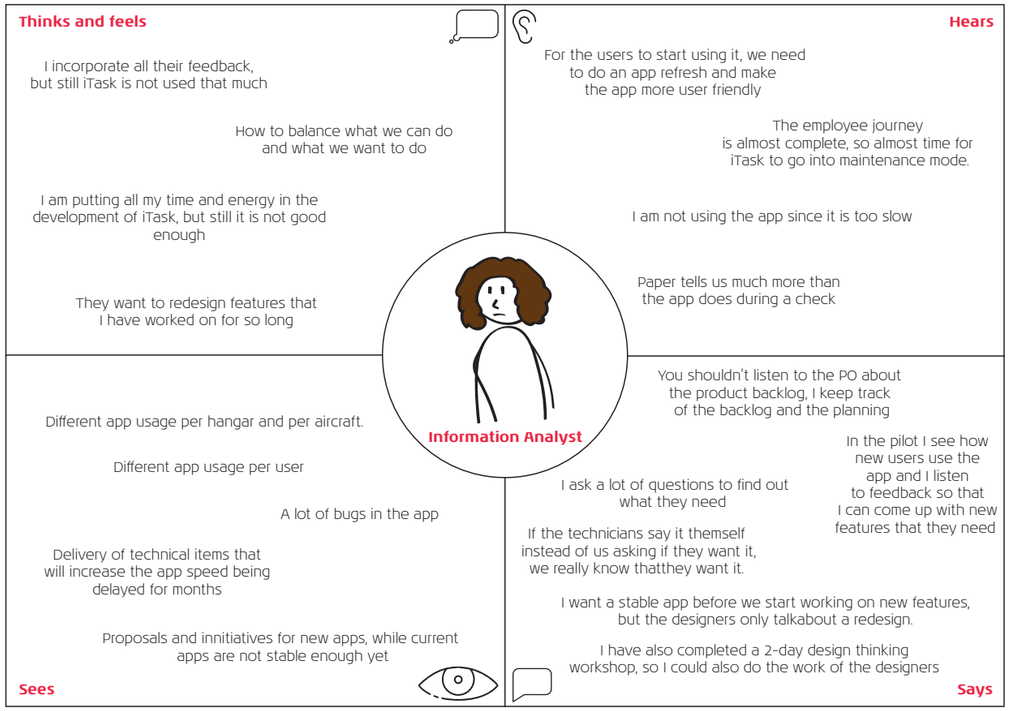

Figure 28: Empathy map information analyst

DESIGNERS

The team also has two designers. These designers are responsible for conducting user tests, designing product interactions and designing the screens. Insights about their role are visualised in Figure 29.

The designers are mainly struggling with how to incorporate the user perspective in the development process, as they experienced that user testing is not enough to build the right applications. However, there is a contradiction in what they say: they say that a more user-centered approach is needed, yet they say that they did not have time to do user research themselves ever since they started at the department 7 months ago.

They mention that the team treats application errors as mistakes in how users use the application. Besides, they see other team members fulfilling their job tasks: user tesing. The reason for this that the team does not believe the results of the user tests conducted by the designers. Due to how the current development process is structured, the designers get tasks they need to perform, for example: "Design a new menu button". There is not much room for them to perform the tasks belonging to their role (as described in Section 2.4.2).

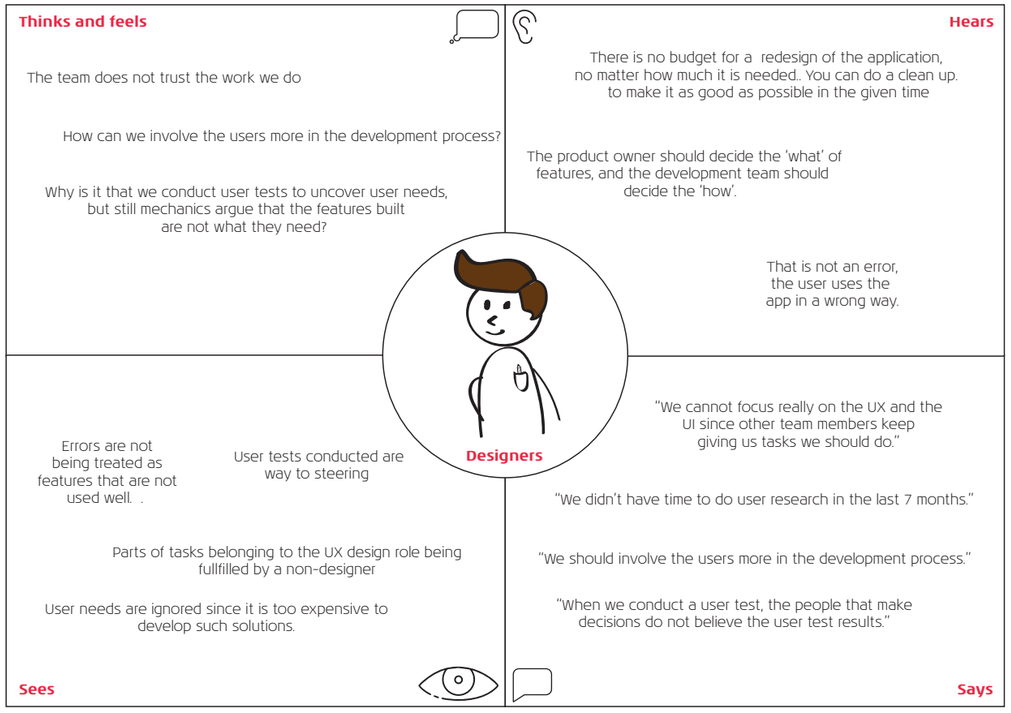

Figure 29: Empathy map designers

3.3.2 Other observations about the development process

During the exploration of the current development process and process of gathering user needs, some interesting insights were found, which are described in this section. These insights were found by observing the current way of working of the digitising teams.

ASSUMPTION-BASED DEVELOPMENT

The team has a lot of assumptions or feedback coming from just one user or coming from what the team thinks that technicians need. These assumptions or such feedback are not validated but processed into new user stories and prioritised. This results in the development of features based on assumptions. Two examples of such assumptions are:

- There is an error in the application occurring when technicians log in to iTask, do task management and then keep the app untouched for several hours. The team assumed this is not an error, but just a wrong way of using the applications.
- The designers assumed that the application is not being used as much as expected due to the navigation and proposed a redesign of the navigation flow based on assumptions (the assumption existing: the flow is not like you would expect it to be on an iOS app and therefore users do not use it).

VERY STRICT ALLOCATION OF TEAM ROLES AND FRICTION BETWEEN TEAM MEMBERS

The roles of the product owner, information analyst and designer are

overlapping, as all focus on gathering the right user needs in order to create value. However, the different team members are very strict in their roles, and therefore sometimes ignore each other's advice. An example of such behaviour is described Figure 30. This figure shows a representation of a conflict that happened at the beginning of this graduation assignment.

SELECTIVE USER TESTING

The digitising team is trying hard to involve users more and test solutions better to deliver as much value as possible. However, selective user testing takes place. Different aircraft checks exist, that require different skillsets and therefore also require different information available in the applications, but user tests are not conducted with a representative user group. Often only one hangar is chosen to participate in the test, and most often this is hangar 12. However, differences are big between the hangars.

PILOTS LEAVE ROOM FOR IMPROVEMENT

Pilots are organised to gather feedback from teams that did not yet use the iPad during a work shift or aircraft check. However, during such pilots, feedback is not always welcomed well. Dig members try to come up with a workaround for the technicians so that no changes need to be made into iTask. The second reason for organising such pilots is to assist the technicians during their shift in case they do not know how to use a feature of iTask. However, during pilots, the teams also plan other meetings and are not available for assistance or sit far away from the technicians – making it harder for

Figure 30: *Conflict scenario due to behaviour of different team roles*

technicians to approach Team Alfa.

At the end of a pilot, the team tries to collect feedback, however, this is done unstructured. Most of the time the team meets the technicians in a room and simply asks "What do you think of iTask?"

ITASK IS TREATED AS AN ALMOST-FINISHED APPLICATION

The employee journey has almost completely been developed in the application. Therefore, team members consider iTask to be almost done and talk about going into maintenance mode, rather than finding out what the reason is that technicians complain about iTask not being enough for them to do their work. As Figure 31 shows, not all feedback that comes in is incorporated.

NO USER RESEARCH AND CO-CREATION ON FEATURE-LEVEL

The employee journey is being digitised, without researching how the digital themes shown in the journey should look on feature-level, as the team considers the employee journey to be the rules to follow, while the employee journey is, in fact, is general and not specific about what should be made. When theI asked him about it, the product owner answered that "The employee journey shows what we should do, that journey was co-created", however, no co-creation happens on feature-level.

NO DIGITAL TRANSFORMATION

Figure 31: *Behaviour towards requests for new features*

ROADMAP[7]

For the development of iTask, the employee journey is used as a roadmap. The employee journey, as the name implies, shows what a day in the life of a technician will look like with iTask. According to Simonse and Whelton (2018) a roadmap is a visual map that enables organisations and designers to devise creative responses to future strategic challenges plotted on a timeline. It is supposed to offer a tactical plan on design innovations to turn a future vision into a reality (Simonse & Whelton, 2018). For iTask, the employee journey is used to define features that need to be developed, rather than looking at the future vision of iTask that needs to be realised.

NO PERSONAS

As became clear from the first ethnographic study (Section 3.2), the hangar environment is complex, and an aircraft check is even more

[7] This changed after the midterm of this graduation project, and a first roadmap was made, which is included in Section 3.1

complex. To perform an aircraft check, several disciplines need to be present in a team. Technicians need to be skilled, trained and certified to be allowed to perform certain tasks. This means that different technicians types have different needs for an application to make their work more efficient. However, the iTask team has no overview of the differences in technician types or personas that represent the different technicians. When they need user input, they just approach technicians available instead of approaching the right type of technician (e.g. team lead vs. regular mechanic).

3.3.3 Semi-structured interviews

Apart from informal conversations and observations with the digitising team, also formal interviews were conducted. For this, semi-structured interviews were set up, see appendix B for the interview guide and transcripts of interviews.

The interviews were conducted with the product owner, scrum master, designers, and information analyst. The goal of the interviews was to find out who the team was, what iTask is supposed to be and to get insights into the development process of iTask. In addition to finding relationships between insights, all interviews were transcribed and Atlas. TI was used to code all interviews. To find relationships between codes, the grounded theory method (Urquhart, 2012) was used. Initial codes were made first to label insights, then all codes were compared, and if needed codes were grouped. After this, all codes were grouped into categories and examined relationships between the codes using semantic relationships (Urquhart, 2012).

This resulted in the integrative diagram showed in Figure 32, discussed in the results section. All codes and categories are included in Appendix D.

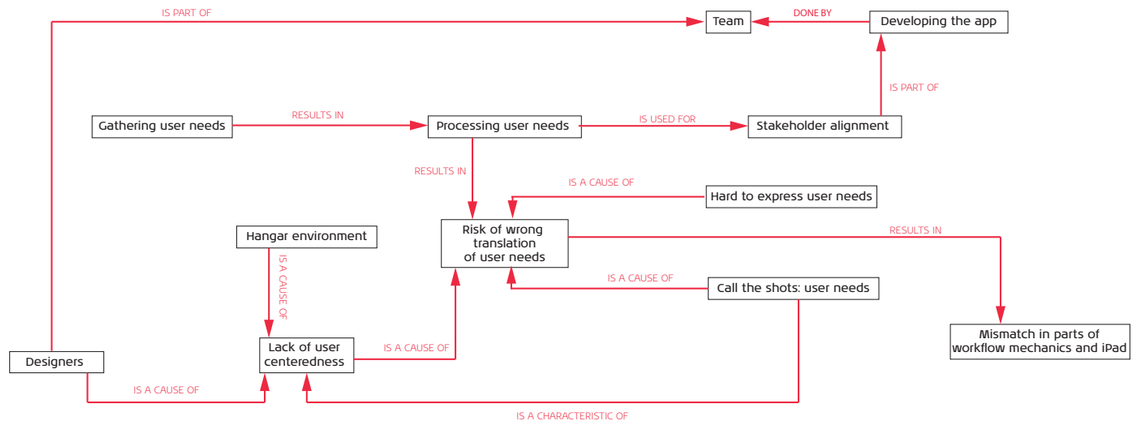

Figure 32: *Integrative diagram interview results*

RESULTS

The results of the interviews will be discussed per theme found. A lot of the information gathered with interviews was seen during the observations done. However, by analysing the interviews, coding them and seeking relationships between them, new insights were found.

Gathering and processing user needs

User needs are gathered in several ways by different team members. For this observation techniques and talking is used. In contrast to what the literature suggest, mainly the product owner and information analyst are responsible for the gathering of user needs.

"We gather a lot of feedback during the pilots we run" - Interviewee 1

"Seeing how they use the iPad gives also feedback for the application" - Interviewee 3

"As soon as you have an idea you need to talk again with the users" - Interviewee 3

"I ask always further to understand what they need. In this, I do not face any problems". - Interviewee 3

P1: "I always start an informal talk, like hey how are you doing, how is the performance of iTask, do you like iTask, are there features you miss in iTask." - Interviewee 1

"The product owner and information analyst connect multiple times with the actual users. So they are going to end-users, discussing with them what they need to find out requirements. Then they come to the team to make stories for the product." - Interviewee 4

As user insights are not immediately usable for the Scrum process, these need to be processed. Processing user needs means writing down all the insights, organising insights on the intranet and linking them to items used by the development teams and writing the user stories that the development team needs. However, some mentioned the user stories to be incomplete. The creation of user stories is done by the information analyst and product owner and is done for the sprint so that everyone knows what the users do.

"Yeah the user stories, those are poor, I'm sorry to say that. The people that write those are a lot in meetings, talk about user stories, make decisions and then bring the stories to us as a team. However, a lot of information is missing and no research has been conducted. [...] Yeah to some extent there was research of course, but no user research, and without such information, we are supposed to develop solutions to the stories" - Interviewee 2

"In the sprint planning sessions is decided what is going to be developed in the next sprint. In the sprint defining the product owner and business analyst define a story. They explain to the team what they want and the corresponding requirements. The team can ask questions for clarification." - Interviewee 3

Development process and stakeholder alignment

To align all stakeholders several practices exist. Scrum poker is used to together determine the value and effort of items, and prioritise work based on this score.

"We poker with representatives of the hangar, which are members of the it council, the continuous improvement leader, plant leader (or their delegates) and the business analyst. For the poker session, I find feasibility important, and I look at what the risks are of a proposal. In the end, we want features that we actually can make. This is input for the WSJF score and based on the WSJF score we prioritise the backlog so that a sprint planning can be made and the teams can work on realising the value." - Interviewee 1

To develop the app Scrum is used, which means that the team has two-week goals that they work on. The role of the team is also to poker the effort of the items. In these sprints also refinements are done, to make stories more concrete. Before any item can be developed, design work is done by two team members specialised in design.

"Two times a week, on Tuesday and Thursday we do refinement sessions together. The team looks at the items and tries to refine them". - Interviewee 3

"Before we start any development work, we need the designers first. Once they have a design, they discuss it with the product owner after which they can hand it over to the developers."- Interviewee 3

To deliver the value promised, the team works closely together, improve their work and change scrum processes where needed. However, still, there seems to be a hierarchy of team members in the team and lacking involvement of other team members.

"There is one person in the team, and actually nobody is supposed to ask her permission, but still everyone does. Because, if she is not positive about the item, we as a team do not pick up that item". - Interviewee 2

"I strongly urged the team to not edit any of the items. [...] Normally I try to be ahead, and exactly know what needs to happen before we have a session in which we discuss that, just to know". - Interviewee 3

Designers lack of user centeredness and the consequence: risk of wrong translated user needs

Some of the above-mentioned team problems (e.g. team hierarchy) resulted in a strange atmosphere within the team. This was felt during the interviews as well, but became more clear later when the project continued. The designers consider themselves to be not part of the team, but are also considered to be expensive by the team and therefore their skills are not used optimally.

"As mentioned, we are part of the team, but also are not due to the fact that we are external. [...] Actually, there is no room for UX research. As soon as they hear a technician say 'this would be nice' they start working on that item [...] we just get the user stories to do what is in there." - Interviewee 2.

"We have two designers available that work part-time on the project but they are expensive to hire for work" - Interviewee 1.

"We have a UX designer but he did not conduct any UX research yet."- Interviewee 4.

Thus, no UX research let alone co-creation is applied.

The reasons for this can be found in the complex hangar environment. People work in the operations and do not have time scheduled for innovation projects, which makes co-creation hard. But also the rules and regulations that are applicable do not help. As a result of this a gap is being developed between the product being made and the product that is wanted by technicians.

"The hangar environment is a complicated one. Safety in aviation is really important. This sometimes is an impediment to the technicians. iTask is a process tool that regulates processes more precisely compared to how it used to be. This means that unqualified mechanics cannot get assigned to tasks that require a specific qualification. They don't like that but we cannot forget about safety. " - Interviewee 1.

"We often talk to users, develop features based on what they say and still they do not use it [...]The users needed an overview screen like they have now. You have seen their paper board downstairs, right? The paperboard provides them with an overview of the check progress and it is key in their progress. So we made an aircraft overview screen in the application. It shows how much task cards are open for 'langs' and 'dwars' and even shows how much time is needed to complete all task cards." - Interviewee 1.

"It was not possible to do what they wanted. They wanted a real aircraft in the app, showing at which zones tasks are open. But we weren't able to do that with aircraft, for that we would need 3D models of every type of aircraft and we would need to code a screen for every aircraft type. So now we have a grid with circles on it that represent the work [...] Probably somewhere in the process we lost sight of the core need..." - Interviewee 2

Hard to express user needs and calling the shots

Parts of the problem that the team is facing, is caused by users, according to the team. They mention that the users find it hard to express needs and are not very eager to express what they need. Therefore the team tries to define themselves what users need. For this the information analyst and product owner have because of interactions with the users is used, and vision documents. The result of this is a mismatch of the workflows technicians have and the workflow the iPad has. The interviews did not go deep into that, however, some quotes were mentioned that just show that the iPad does not work as technicians work, some differences caused by safety and regulations, other not. However, the team is aware of that:

"But they never come up with new things they need, they mainly talk about performance and slowness." - Interviewee 1.

"We do not need any feedback, we do not need new items for the backlog due to time. [...] Sometimes you see that you get feedback that is not needed [...] as soon as we finish the performance issues a lot of the feedback will disappear I think" - Interviewee 1.

"It is often quite clear from what the users say so we can make user stories from that input" - Interviewee 1.

"They describe the things we make as not useful." - Interviewee 1.

INTERVIEW CONCLUSIONS

Similar to what the observations showed, was mentioned in the interviews as well. Pilots with users, business documents and conversations with users are used to gather user needs. These user needs are processed by a team member to keep an overview and to be able to translate the user needs into user stories for the application.

Since users find it hard to express their needs, and since the team calls the shots about user needs by mentioning multiple times that they know their users and know what users need, there is a risk that user needs might be translated wrong into features. Partly this is caused by a lack of user centeredness: team members mention that there is no need for UX research, that they have no time for UX research or that user tests happen

with few people that are not selected based on their representativeness.

3.3.4 Study conclusion

The ethnographic study showed the digitising team is aware of the importance of gathering user needs. They try to find out what users want by organising pilots, talking to users and by applying observation techniques. However, this does not always enable them to translate the user needs in the right user stories, and therefore application features. Furthermore, it was found that the methods applied to gather user needs of product backlog items do not allow to find latent needs (Sanders & Stappers, 2008). To develop applications that users dream of this should change.
An important insight to consider is the role allocation of the digitising team. Tasks related to understanding user needs' and suggesting solutions belong to the UX role (Da Silva et al, 2013), but are executed in the digitising team by somebody else than the UX designer.

Lastly, it was found that co-creation at this moment is not used for the development of the applications. Co-creation was only used at the beginning of the project to create an employee journey. Considering that co-creation is a good way to hear what the user need (Mattelmäki & Sleeswijk Visser, 2011; Sanders & Stappers, 2008) an opportunity arises for the co-creation framework to investigate product backlog items better before user stories can be written.

3.4 Conclusion

To conclude this chapter, the findings of the company analysis and ethnographic studies are compared to what was found in the literature study.

CO-CREATION IS MISSING IN THE CURRENT DEVELOPMENT PROCESS

The literature review showed that there is a lot of discussion about what co-creation is, but all agree about at least one thing: co-creation focuses on user involvement in the design process to understand user needs. For effective co-creation, the user is involved in all important decision-making problems.

A way to apply co-creation is by following the participatory design methodology, that identifies three stages in which co-creation needs to happen to empower workers in changing the workplace (Figure 33).

At the beginning of the development of iTask stage 1 and 2 took place). Before the development started, an external design consultancy was hired to find out what users need (stage 1) and co-create an employee journey with the technicians to envision the future state (stage 2). Once this was completed, co-creation stopped and the digitising team started developing the employee journey. To incorporate the user's perspective they do talk with users and conduct tests, but the actual co-creation disappeared.

USER NEEDS ON THE SURFACE ARE COLLECTED

In the literature, it was found that user needs underlay the value perception of a product. User needs can be classified in certain categories, based on what the needs uncover: explicit knowledge or latent knowledge. The development team is using conversations and observations as a method of gathering user needs. This means that only needs on the surface are collected. Features and functionalities that technicians dream about are at this moment not collected. Technicians are not provided with the right tools to be able to express such needs.

ROLE OF THE UX DESIGNER

In the literature review, it was found that the UX role is crucial in agile software development to enable user research, understanding of the user and gather the right data. The UX role does exist now in the development team. However, the corresponding activities that should be performed by the UX designers are not performed by the team's UX designer. A reason for this could be the informal task allocation that exists in the team, but also the friction that is present between the designers and the rest of the team.

ROLE OF THE USERS

The company department has a vision about how the department should look in 2030. This is completely different than it is now. The transformation program to reach this vision has started with iTask. However, as the ethnographic studies showed: the digitising teams are trying hard to make applications that users want, but they do not succeed in the finding of real user needs and the corresponding translation of needs in application features. For the transformation to succeed and to reach the envisioned feature of 2030 it is essential to understand what they users need for this vision to be successful, understand their jobs to be done and together find solutions. If this is not done, the gap between the operation and the apps developed to support the operation in working efficiently and making the job easier will only become bigger. The participative role that was found in the literature could help to avoid this but does not exist yet in the company.

Figure 33: *Integrative diagram interview results*

4. DEFINE

For an efficient start of the design phase, a design challenge based on the assignment stated in the project brief is formulated in this chapter. This challenge will be used in the following chapters to design and deliver the framework and tools.

Section 4.1 introduces the opportunities that are based on insights from the internal analysis. Section 4.2 describes the design challenge with design objectives, that have been formed based on the insights of Section 4.2.

4.1 Framework opportunities

The research resulted in too many findings and directions to include in the design challenge. As incorporating co-creation in the current way of developing applications will impact the department in terms of resources needed and extra time needed to prepare co-creative sessions, a opportunity mapping session was organised with the lead of the digital transformation program. The goal was to decide what findings are relevant for the design challenge.

In the session all observations done and the outcomes of the interviews were discussed and compared against literature and categorised. The approach to the session is visualised in Figure 34. In Appendix E an elaborate session approach and analysis of the session outcome is included. The result of this is communicated in Figure 35

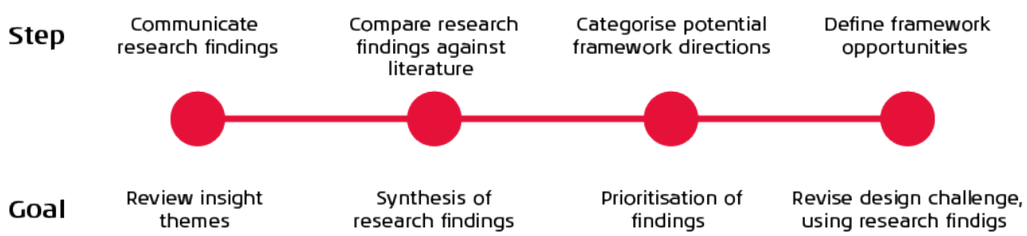

Figure 34: *Opportunity framing approach*

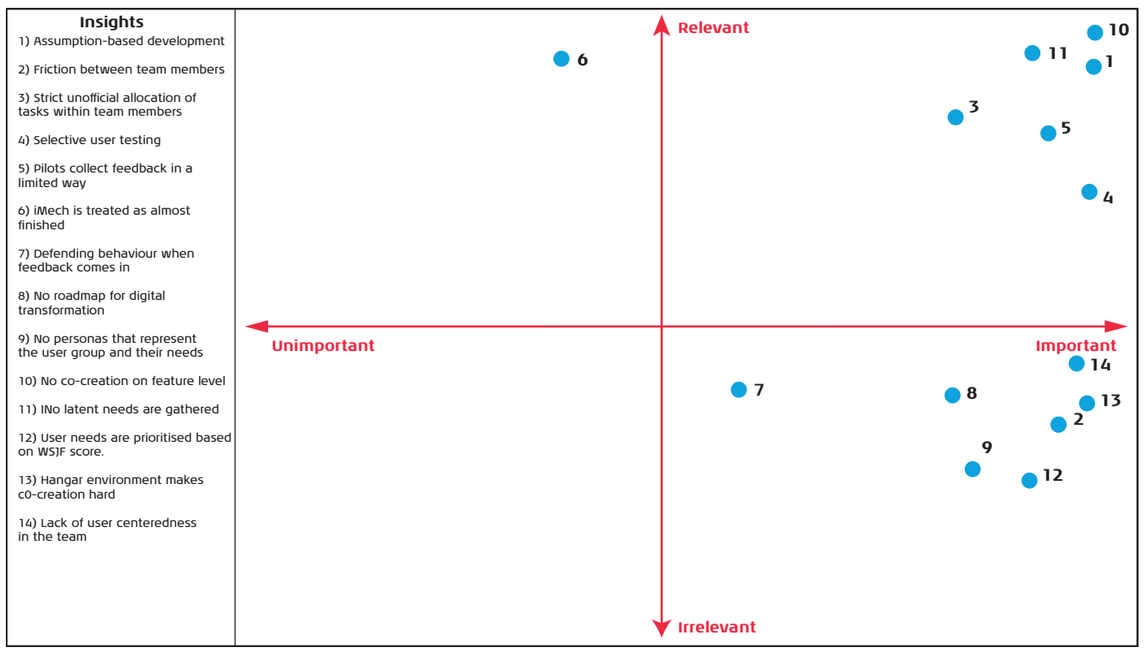

Figure 35: *Opportunity matrix*

4.2 Design challenge

The first chapters showed what co-creation, value creation and software development in literature mean, how this is applied within the company's context and what servicing planes in a hangar means. These insights were mapped into an opportunity matrix, that can be used to deepen the design challenge, based on research findings:

Design a framework that guides the digitising teams in changing their development process in a co-creative process with technicians to create iPad application features that are used and increase the productivity of technicians.

Do so by providing tools for testing assumptions and uncovering deep user needs. Provide guidance for the ideating and prototyping phases with the co-creation framework to avoid wrong translation of user needs in user stories and to help the teams apply co-creation during the development of features.

The underlined sentences in the design challenge are explained in more detail in point 1, 2,3 and 4.

1. Guide for a co-creation process with the digitising teams and technicians: To help digitising teams involve users more in the process and in different ways the final solution should guide them in such a way of working. A co-creative way of working has the goal to uncover deep user needs, create ownership of solutions, decrease the risk of innovation and decrease resistance towards transformation, but should be flexible allowing the teams to decide themselves if a specific step for a specific story is needed.

2. Help to create features that are used and increase the productivity of technicians: The goal is to give technicians a way and/or tools to express what they need in the iPad applications so that the digitising teams can co-translate these needs with users into the right iPad application features and avoid wrong translations of ideas into features.

3. Testing assumptions and uncovering deep user needs: Part of the framework should be tools that help in taking away assumptions and finding (deep) user needs.

4. Guidance in the ideating and prototyping phase: The solution should help the digitising teams to together with users go from insights and/or user needs to ideas and/or prototypes user needs in terms of user stories and/or low-fidelity screen.

4.3 Design criteria

To fulfil, the challenge design criteria have been set up. These are a result of the literature review and both ethnographic studies. All criteria have been linked to the paragraphs that resulted in the criteria. The criteria have been divided into three categories

1. Framework

1. The design needs to incorporate the user perspective at the fuzzy front end, and design phase (p.15);
    a. By either hearing the users or providing tools to the users to become a designer and exchange ideas with the development team (p.15);

2. To structure the process, the design needs to have deliverables or formats that need to be filled in (p.16);

3. The design balances co-creation and decision-making activities (p.16);

4. The framework enables to early test assumptions/ideas and to early co-create to avoid waste (p.16);

5. The design has at least two stages that enable the teams to envision a future state that clarifies goals and to prototype technological artefacts to fit that vision (p.17).

6. The design enables co-creation with users that work in 24/7 shifts due to the operation (p.36);

7. The design provides a clear allocation of roles in the stages and activities (p.50);

8. The design shows when and how different co-creation activities can be performed by which role (p.50);

9. The design can be performed in all stages of a project (when a project still needs to be set up, during the minimum viable product creation or during the development of features);

10. The design can be used in parallel to a Scrum software development process (p.45).

2. Tools

1. The designs uncover needs that are both on the surface and deep levels (p19);

2. The designs help to go from need to artefact that fulfills the need (p.17);
   a. The designs incorporate rules and regulations in this process to guarantee feasibility (p.47) ;

3. The designs enable the teams to use more techniques than interviewing and observation to uncover user needs (p.45);

3. General criteria

1. The framework and tools provide a way to broadly recruit participants, rather than selective (p.16, p.51);

2. Users need to be available to co-create (p.42);

3. The framework and tools need to be designed in such a way that the teams can use it, meaning that the tools have to be self-explanatory;

4. The framework and tools need to be designed in such a way that this thesis does not have to be read before one understands how the tools need to be used.

5.

In the design phase, it will be investigated what tools need to be used in which format in the co-creation framework.

5. DESIGN

This chapter describes the steps followed to ideate a the future state for the co-creation framework in steps that need to be followed for a good co-creation process and tools that need to support these steps. The discover phase (chapter 2 and 3) resulted in design criteria for the framework (chapter 4). In section 5.1, a future state for co-creation within the department is ideated for steps that need to be followed in the framework. In Section 5.2 principles for tools to guide the co-creation process are tested.

5.1 Ideation of the co-creation framework steps

To design a co-creation framework, the future state of co-creation is envisioned together with the digitising teams. The decision to use co-creation was made to decrease risk of innovation (Calabretta & Gemser, 2016), decrease resistance towards the transformation of the current way of working (Matt et al., 2015) and to uncover the deeper needs and motivations of Department XYZ employees (Sanders, 2001) but also to show the department the added value of co-creation.

Also, in this phase, a creative session with TU Delft design students was organised to see how students that have an user-centered design background, and that are not influenced by company practices, would envision a co-creation framework to.

To start this phase, the author held a personal brainstorm individually on what tools could be useful for the framework (Figure 36). The outcome of this brainstorm served as a thinking tool for what methods to include in the co-creation with the digitising teams .

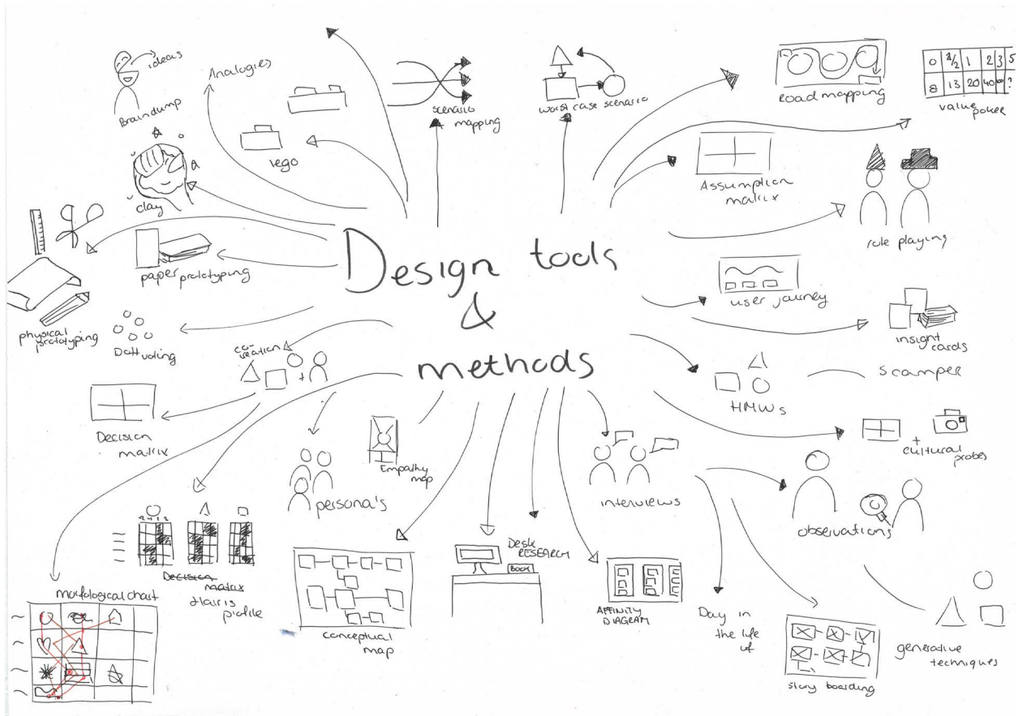

Figure 36: *Design tools and methods brainstorm outcome*

5.1.1 Co-creation with the digitsing teams

This section describes the approach applied to co-create a future state of working with the department's digitiing teams. The next sections elaborate on the co-creation approach, goals of the co-creation and insights of the co-creation

APPROACH AND GOALS

As starting point of this session, a meeting with the lead of the digital transformation, the technical manager of the department and the product owners was organised to discuss whom to invite to the co-creations.

The product owner and UX designer are very important for the co-creations as they will be the ones mainly using the framework due to their roles related to value creation and user research. In theory, the information analyst has a role focused on the technical aspect of iPad application features and not to gathering user needs, which is contradicting to what was found in the discover phase. The information analyst is responsible for the refinement of user stories to make those feasible, and therefore needs to be invited to some co-creations guarantee that the technical part will not be forgotten due to the co-creation framework. The tasks she performs about uncovering user needs need to be taken over by the UX designer.

The first aim of the co-creation session was to discover how employees within the department envision the future state of applying co-creation. The goal was to have defined in the future state:

- Activities per framework stage;
- Team roles for the activities;
- Formats of sessions (e.g.: creative sessions, user testing, etc.);
- Relation of activities and Scrum process.

The second aim of the co-creation was to uncover deep(er) user needs of the involved employees by providing them with tools to express their needs for the process covered with the framework (Sanders & Stappers, 2012). Therefore, the underlying reasons for decisions during the co-creation are important. Besides, this approach helped to understand the employees and emphasise with them (Sanders & Stappers, 2012) by listening to them and giving them a voice in the development of the framework through co-creation.

To ideate an ideal co-creation framework, a case was set up for the employees. In the case the employees were asked to design a co-creation framework for a company called "The Airport of Delft" – a very young and innovative airport that wanted to start a digital transformation program and was looking for a framework to apply both co-creation and Scrum practices to their digitalising efforts. This was done to encourage out-of-the-box-thinking.

The co-creative session, facilitated by me, took one hours and consisted

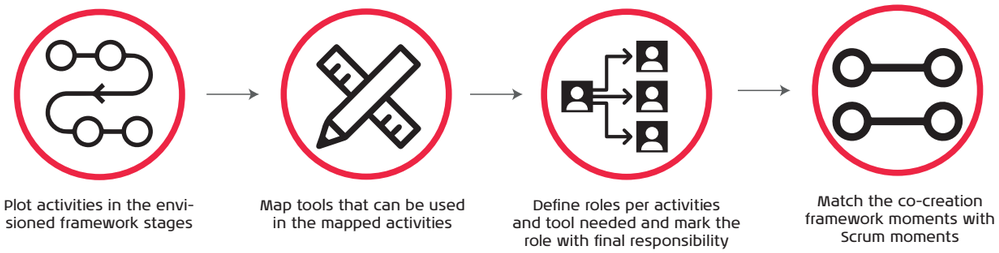

Figure 37: *Co-creation approach*

out of a set of cards (Appendix F) that needed to be organised in the right order under the stages. Additional guidance was provided in PowerPoint slides (Appendix G).

The group was split into two, balancing different backgrounds as much as possible and followed the process described in Figure 37. For every step visualised in Figure 37, a card set was provided to the participants.

In the design criteria it is defined that the framework needs to support the discover stage and prototype stage only. However, as the explore stage is a pre-requisite to be able to co-create, this stage was included in the brainstorm.

After the completion of all steps, the teams were asked to present their created framework and explain their reasoning behind the framework. This explanation was audio-taped to analyse.

INSIGHTS

The co-creation (Figure 38) helped to define two co-creation processes (Figure 39 and Figure 40) and helped to uncover needs of the employees. The insights are discussed per team. , since the group of stakeholders that attended the co-creation was split in two teams.

Insights team 1

The first team, see Figure 41 for a visualisation of their co-creation output, divided the framework into four stages, adding the Scrum phase to the framework. Also, they changed the name of the second change into Ideate as the found "explore and discover" to not be different enough.

In the first stage they find it important to start with finding user needs and matching those needs to business goals and the business vision. In order to know how the needs differ from the current situation they placed 'current process analysis' in this stage as well. After the first stage, they placed the discover phase which should get a new name: ideation. This phase starts with idea generation, however, the team thinks that application users should not be involved there due to lacking skills, yet they want to use generative techniques as idea generation tool to uncover user needs. In the same session rules and regulations need to be introduced as converging method, to make clear that solutions are developed that are feasible and viable. However, the rules and regulations should be introduced

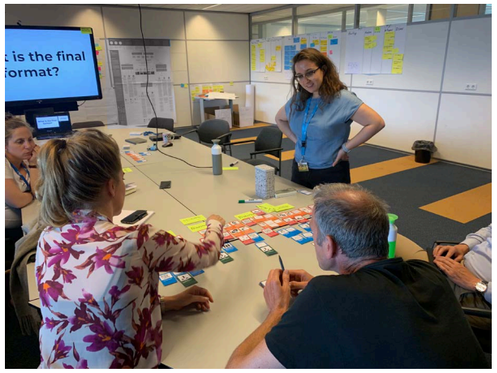

Figure 38: *The explenation of the co-creation artefacts*

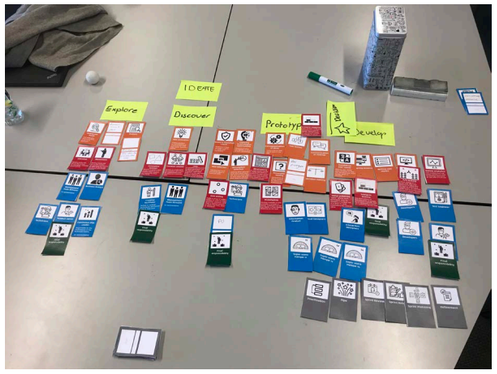

Figure 39: *Co-creation results group 1*

Figure 40: *Co-creation results group 2*

The team also choose to give an important role to the creative facilitator in the ideation phase but mentioned that a UX designer also could do the job and therefore decided to give the UX designer a role in such activities.

> *"We do not need technicians or super users in the idea generation, they often don't know how to express what they need"* - Team 1

> *"We need also a dream big activity before we start thinking about feasibility and viability, so first a creative session and then session in which we can roast all generated sessions"* - Team 1

In the prototype stage the team did decide to not have users participate in two crucial activities: testing assumptions through scenarios and wireframing and in the user testing also no users were placed but also no comments were made about this decision. It could be that the team considered users to automatically be involved in user testing due to the name of the activity. However, in the creative activity of that stage, conceptualise ideas, the team did find it crucial to have super users involved. Super users are a group of selected users that provide feedback to the applications developed in the digital transformation program.

Translating user needs was put to be part of the Scrum process that comes after the stages of the co-creation framework. When asked why then the team told me that only then the development teams need to know what users need, not earlier. However, users should not be involved in this activity according to the envisioned approach.

> *"We need users to conceptualise screens together, to make sure we are making the right decisions, and super users know more than normal users".* - Team 1

> *"The users should be part of the decisions that affect them".* - Team 1

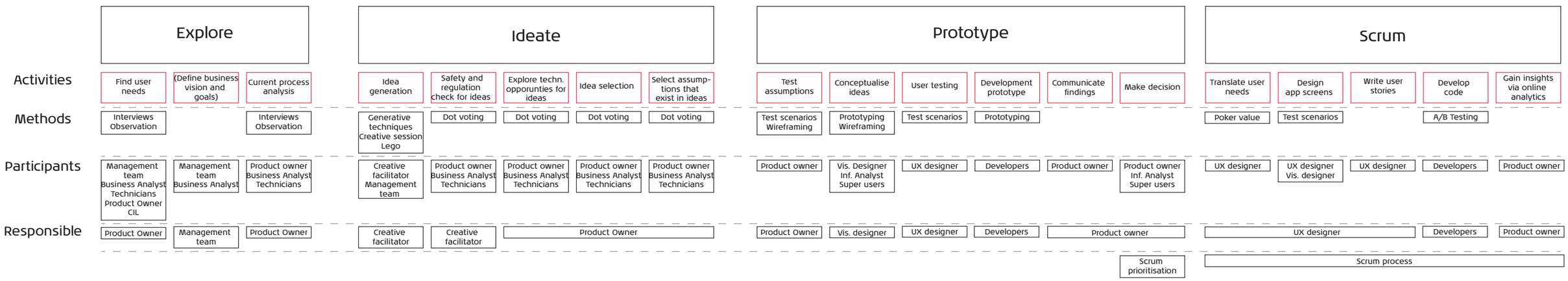

Figure 41: *Visualised co-creation results group 1*

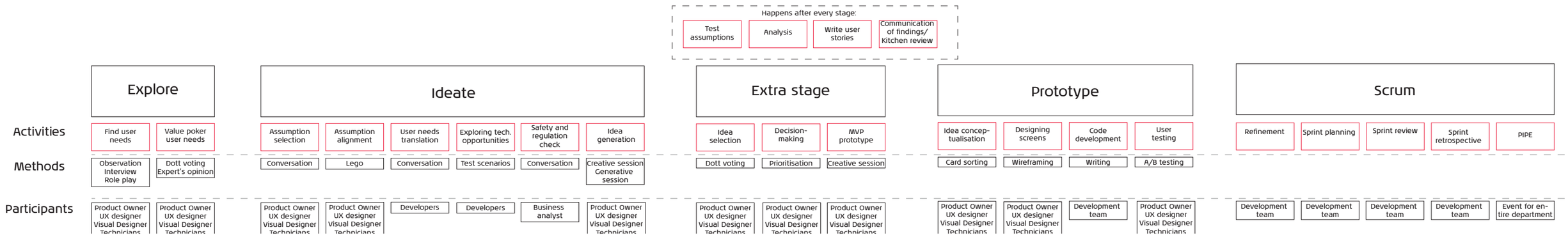

Figure 42: *Visualised co-creation results group 2*

Team 2

The co-creation output of team 2 is depicted in Figure 42. In contrast to team 1, team 2 decided to have a short exploration phase in which only user needs should be found and value pokered. Before a co-creation process could be started they want to know the department's vision.

Also immediately the team picked four activities that should happen during every stage or at the end of every stage: testing assumptions to avoid waste, analysis, writing user stories according to the find-ings to keep this iterative, and communication of findings to keep all stakeholders up to date. All users are considered to be important in the these activities and should, therefore, be involved in the those activities. This team wants to let go of super users and give all users an opportunity to contribute to innovation projects.

> *"Let us first remove them from the process, they should have a vision and communicate this clearly to the development teams, but should not be involved in the co-creation of the applica-tion itself. That is going to create hierarchies of power so let's try to avoid that."*- Team 2

> *"Let's start working with all users rather than a selective group of so-called super users.WeI want all members of the digitising teams to be involved and let's try to make the whole team responsible instead of only one."* - Team 2.

After the exploration stage, the discover stage is placed, which they also decided to name Ideate. This stage should start with taking away all assumptions, translating user needs into user stories, checking all rules and regulations, and technological opportunities. Only after completing all these steps, a cre-ate session to generate ideas should take place. In the idea generation, the visual designer gets the final responsibility since the team thinks he/she should know what would work best in the application, and as they think that a creative facilitator will not work in the company context. However, this deci-sion does show that the employees are in need of somebody who knows how to organise creative sessions to generate ideas.

> *"I think that a creative facilitator is not doable, this airline has no budget for it anyway"* - Team 2

The team decided that an extra stage is needed to define what ideas would work and make decisions. In these sessions, technicians should have a big role according to the team. A discussion arose about the role of the UX designer, where one considered

the UX designer to just have a design role and the other one, a UX designer himself, considered the role to be more important and have responsibilities in both uncovering of user needs and translating user needs to product or application features. There-fore, the team decided to have the UX designer present in almost all activities to act as a bridge. As user testing the group chose A/B testing.

> *"Let's use A/B testing, then we can see if a new feature is making a differ-ence and worth the investment or not."* - Team 2

During the session it was found that the employees have underlying concerns of the team about co-creation. The assignment was to think about another company, but everyone was aware that the overall objective of this session was to find out what employees would like to have in a company-specific co-creation framework.

> *"We need to be able to stretch the framework and enable teams to have multiple iteration loops if needed for success. However, the management team would then need to give us a budget for such a way of working."*- Team 2 .

CO-CREATION CONCLUSION

An important insight is that the envisioned workflows users should be involved more compared to the current situation. However, still at some important moments (Idea generation, testing assumptions, translating user needs) users were not placed as participants by both teams, resulting in room for tools that will enable the digitising teams to involve users in such activities as well.

The session showed some unmet needs of the employees, as the employees mentioned that users should not be invited to sessions since they are not able to express what they need. However, as the literature study showed, users can do so if helped and provided with the right tools, but the employ-ees are not aware of the existence of such tools. Also, an important takeaway is the need for some-thing similar to Lego to create screen proposals in the co-creation framework is an important takeaway that can be solved with tools.

Between the teams there was a difference in approach, one team was using a diverging/converging approach to ideate and put desirability first, while the other team was not planning on diverging in their workflow. They put also viability and feasibility first and only after that there was room for idea-tion.

Last, there was doubt whether a creative facilitator was needed in both teams as the teams thought that a UX designer could fulfil such job tasks as well. This is an important factor to investigate for suc-cessful implementation.

5.1.2 Creative session with students

To see how user-centered designers would envision a co-creation framework, a creative session with three designers was organised at the TU Delft. Two designers were graduate students, following the master's in strategic product design, and one student was a last-year bachelor student. The mixed group of students was chosen to complement each other's skills. A first-year master student in design for interaction, who was supposed to give a more user-centered view, unfortunately, cancelled 2 hours before the session. Therefore the group was not as mixed as intended, but a suitable replacement could not be found at that time.

APPROACH AND GOALS

The students got the same set of cards as the company's employees and were asked to frame a co-creation process for the digitalisation work. They were provided with information the three stages of a basic co-creation process: explore, discover and prototype and told to place activities under the stages that were shown on the cards, but that they were not required to use all cards. If they were missing cards they could make new cards by using blank cards. Figure 45 shows the approach for the session.

The goal was similar to the goal of the co-creation with the company department, namely to have defined in the future state:

- Activities per framework stage;
- Team roles for the activities;
- Formats of sessions (e.g.: creative sessions, user testing, etc.);

In contrast to what was asked in the co-creation with the company department, the students were not asked to map Scrum process activities in their approach, as the Scrum activities of the company are quite specific and as their expertise laid in design processes, not software development processes.

For every card placed the participants were asked to think out loud. The session was audio-recorded to capture their reasoning.

Figure 43: *Creative session approach*

INSIGHTS

The designers immediately (Figure 44 for picture of results, Figure 45 for session output) started recalling how they normally approach projects and mentioned that important activities were missing. According to the students, some important activities were missing for the exploration stage: situation analysis to emphasise with the users and project brief creation for stakeholder alignment.

> *"You need a situation analysis, otherwise you cannot empathise with the users."* - Student IDE.

> *"Why is there no project brief creation activity? This is crucial for stakeholder alignment and to know what you need to do in the next steps."* - Student IDE.

Tthe discover phase, the designer did not find in necessary to change the name, needs to be iterative. A discussion arose about the sequence of idea generation and exploring technological opportunities, but the designers agreed to place idea generation before exploring technological opportunities

> *"There is no such thing as a linear ideation process."* - Student IDE.

> *"We first need to know what is desired, before thinking about whether it is possible."* - Student IDE.

The sequence that comes after those

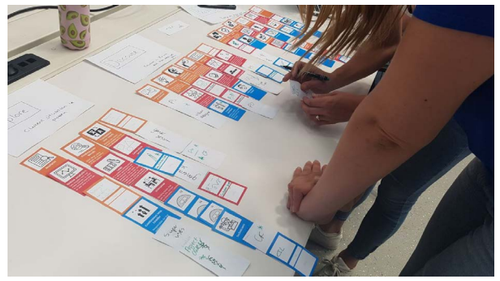

Figure 44: *Creative session with students*

two steps is a little bit messy, as the team decided to select assumptions, write user stories, make decisions and only then select an idea. However, no comments were made about the decision-making here. First, ideas are selected and then it is checked whether ideas are compliant with rules and regulations of the aviation industry. A reason for such a decision could be missing knowledge about the complex aviation industry and associated rules and regulations that are steering in decision-making.

However, what does become clear from this creative session is that the users are involved in the ideation activities, but also translation moments like writing user stories. However, in the conceptualisation of the ideas users are not involved:

> *"We do not need users here. If you co-created an idea, you do not need users in the conceptualisation step when you think about how to make it work in terms of feasibility and viability."* - Student IDE.

The team concluded with a decision-making moment, since, according to them, you need to decide whether

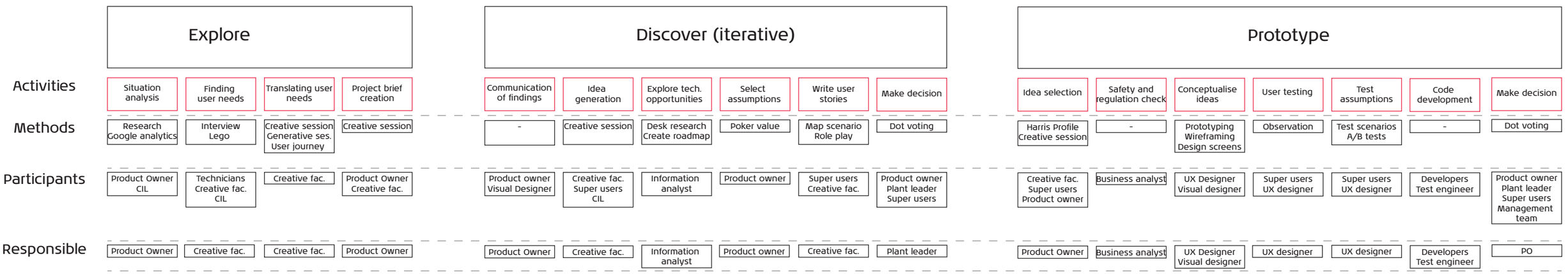

Figure 45: *Output creative session*

the conceptualised idea is going to deliver value as described in the project brief or that a new co-creation loop is needed.

Another insight of this session is the involvement of the plant leader. The team put him/her to be involved in decision-making moments as he/she should know best how a certain decision will impact the hangars and their workflows.

The creative facilitator has an important role in the envisioned framework. Multiple times the designers were discussing whether the creative facilitator needed to be responsible or product owner. Eventually decided to give the creative facilitator the responsible role in all creative activities to guide the participants and in translation moments as well.

> *"A good creative facilitator knows a lot about tools and should know how to guide a group of people in defining problems, generating ideas or selecting ideas with different techniques. Such a facilitator is also objective and I think that is good when formulating user needs or generating ideas, to avoid a steering session."* - Student IDE.

CONCLUSION

The most interesting insights from this session are the prominent role of the creative facilitator, the start of a project with a situational analysis to emphatise, the addition of project brief creation before an ideation phase is started, and the diverging/converging approach that is used in every stage.

The session with the designers provided a lot of input on how to arrange research and design activities in the co-creation framework, with thoughts about why users need to be involved at certain activities, starting with a research activity to empathise (situation analysis) and an activity to decide what the project or feature objective is. It also provided good feedback about activities that were not in the card set, yet needed for a structured design process (e.g.: project brief creation and situational analysis as activity) or tools that can be used (e.g. user journey creation, desk research, and road mapping). Also, they had a clear view of what type of person is needed to facilitate a co-creative way of working. As Chapter 3.3 showed, the digitising teams of the department mostly use interviewing and observations to uncover user needs and then write down what they think users need – this could be avoided with a role like the creative facilitator, as creative facilitator knows how to apply different creativity techniques that uncover user needs. This session showed clearly that idea generation needs to be put first, to contribute to the desirability of an idea, and only then viability and feasibility need to be taken into account.

5.1.3 Proposed concept solution

This paragraph introduces the steps needed in a co-creation framework to currently existing problems as defined in the design challenge (Section 4.2).

The co-creation framework steps are visualised in Figure 48, together with suggestions for what tools to use and who to invite to the activities.
The process shows activities that can be performed in a certain order to uncover latent needs, avoid assumption-based development and to involve users at relevant moments for the creation of the product.

The exploration stage is out of scope for the formulated design challenge. It is important that research activities such as situation analysis are performed well, but this does not need to be supported by the co-creation framework.

The co-creation framework provides guidance with activities that enable to uncover deep user needs with ideation tools for the future state, and prototype tools that enable users to create artefacts that fulfil their needs and explain why this is the case. Both are the principles of generative techniques (Vissers et al., 2005).

This co-creation process needs tools to communicate findings of stages in terms of what problem needs to be solved or what process needs to be changed and how the solution solves the problems. Second, tools are needed for the ideation stage to enable technicians together with digitising teams to imagine a future state and define what is possible in terms of rules and regulations and technology opportunities, as are tools needed to select ideas and to take away assumptions. Last, for the prototype stage tools are needed to translate ideas into screen options so enable the translation from future state to technological artefact.

EXPLORE
In the explore stage the goal is to research the current situation that needs to change by introducing new applications (features), find the first

user needs or problems and decide what needs to be investigated and created in the following stages.

IDEATE
This step is referred to as 'discover' in the literature (Section 2.2), as its goal is to discover what a future state for a situation or future solution to a problem could be for users. However, the decision has been made, based on the co-creations, to give this stage a different name. This name was the result of the co-creation.

This stage starts with diverging by idea generation and concludes with converging activities: checking if ideas are feasible in terms and rules and regulations. Concluding this step, the project brief is updated in terms of user story writing and selecting and testing assumptions, to make sure that all crucial knowledge for the conceptualisation of ideas exists.

PROTOTYPE
The last step of the stage focuses on translating ideas about the future state of working into technological artefacts. This is done by conceptualising ideas into screens and testing if such prototypes will meet what has been agreed upon in the project brief.

This stage starts with a concrete translation of user needs into technological artefacts, summarising what has been found in the ideation generation and making this more tangible by shaping solutions. Tools need to support technicians and employees to together build concept screens.

A big part of this session is user testing if the prototyped screens do what was envisioned, however, user testing will not be supported by the tools as this already happens in the Scrum framework – but was placed earlier in the process now.

ROLES
The current roles within the Department XYZ will change by implementing the co-creative way of working. As described earlier, the strict unofficial allocation of team

	Explore					Ideate								Prototype				
Activities	Situation analysis	Find user needs	Prioritise user needs	Write project brief (first user story)	Communicate findings and decisions	Idea generation	Safety and regulation check	Explore tech. opportunities	Select idea	Write user stories	Select assumptions	Test assumptions	Update user stories	Translate user needs	MVP prototype	Conceptualise idea	User testing	Update user stories
Methods	Research Google analytics	Interview Observation Generative tech. Creative sessions	Dot voting	Creative session Map scenario	Conversation User stories User journey	Creative session	Conversation	Desk research Roadmapping	Dot voting	Creative session	Poker value	Test scenarios	Creative session Map scenario	Creative session	Creative session	Design screens Prototype Wireframe	A/B test Test scenarios	Creative session Map scenario
Participants	Product Owner UX designer Technicians CIL Creative. fac	UX designer Technicians CIL Creative. fac	Product Owner UX designer Technicians CIL Creative. fac	Product Owner UX designer Technicians CIL Creative. fac	Product owner	Product Owner UX designer Visual Designer Technicians CIL Creative. fac	Product Owner Technicians Business analyst	Product Owner Technicians Information analyst	Product Owner Technicians IA & BA Designers CIL Creative fac.	Product Owner UX designer Technicians CIL Creative. fac	Product Owner UX designer Technicians	UX designer Technicians	Product Owner UX designer Technicians CIL Creative. fac	Product Owner UX designer Technicians CIL Creative. fac	UX designer Technicians Product Owner	UX designer Technicians Visual designer IA	UX designer Technicians	Product Owner UX designer Technicians CIL Creative. fac
Responsible	Product owner	UX designer	Product owner	Creative fac.	Product owner	Creative fac.	Business analyst	IA	Product Owner	Creative fac.	Product owner	UX designer	Creative fac.	Product owner	UX designer	Designers + IA	UX designe	Creative fac.

Figure 46: Proposed design concept for framework steps

tasks becomes official with this design solution.

This means that the UX designer gets a more prominent role in the stages before actual development happens, as was found in the literature (paragraph 2.4.1) to be a good choice. The UX designer has responsibilities when it comes to finding user needs, translating needs into solutions together with users and user testing. The information analyst, therefore, will be less involved in the gathering of user needs and translation of user needs into ideas and technological artefacts. However, she will be involved in activities related to her job: ensuring that solutions are feasible.

The product owner is responsible for maximising the value that the product will create and is therefore involved in a lot of steps to be able to do that and know what is going on. However, in some steps (e.g. user testing, the conceptualisation of screens) the product owner is not needed since it should be clear what needs to be conceptualised and tested due to the process and other roles have skills required to execute such activities.

Currently, all hangars have a continuous improvement leader (CIL), a role that is responsible to lead new ways of working and improve the hangar's performance by engaging workers more and increasing the workers' productivity. As the digital transformation program was started to improve the performance and increase productivity, the continuous improvement leader is crucial in the creation of digital artefacts to make sure that those artefacts will help to reach this ambition. Often, organisations think that technology in itself will help and lose focus of what the technology is supposed to do (Surak, 2017). The role of a CIL can help avoid this if invited to co-creation activities.

The Change Manager role is also new in the application development process. The department already has a change manager, that is responsible for researching what users need to ease the change. These insights are valuable for the situation analysis as input for setting up a user needs research activity in the next step.

Last, a role that is new to the department is introduced: a creative facilitator. Both employees and design students envisioned a co-creative way of working that includes creative session and creative facilitators. A creative facilitator is somebody who is trained in solving problems in teams by applying creative techniques (Buijs & van der Meer, 2014). The person who wants to solve a problem or change a situation is called a problem owner. In the airline's situation, this would be the product owner. A creative facilitator facilitates a session to help the problem owner solve a problem. Such a facilitator is used to an uncertain process of not knowing what the end solution will look like while being able to still facilitate the right process to solve a problem (Buijs & van der Meer, 2014).

A facilitator, problem owner and a resource group, which is a selected group of employees that will come together to ideate a problem solution, are needed for a (co)-creative process a (Buijs & van der Meer, 2014). For a creative session, it is not required that a resource group consists of only solution users. However, for a co-creative session, it is required to have solution owners participate in the session, and therefore the resource group in the hangars should also include technicians. Also, other people can be part of the resource group, e.g. UX designers or CILs.
There are several reasons why a product owner, that is the problem owner, should not be the facilitator of a creative session (Heijne, van der Meer, Goncalves, Goodwill, & Fraaije, 2019):

- A product owner or problem owner already has many tasks to fulfil;
- A product owner or problem owner often is steering the resource group;
- The resource group may feel limited if the problem owner is facilitating the problem-solving session.

5.2 Ideation of framework tools

Based on the future state of the co-creative way of working, tools are needed to support such activities. The literature review already showed what tools are often in the different stages of a co-creation process (table 1). However, these tools are not tested for the development of iPad application features. Therefore this chapter focuses on investigating how several tools can be used in the digital transformation program of this airline.

Based on the design challenge, defined design requirements and findings of Section 5.1, tools are needed to:

- Uncover and test assumptions (Explored in Section 5.2.1)
- Tools to communicate findings (Explored in Section 5.2.1)
- Uncover (latent) user needs for screens (Explored in Section 5.2.1 and 5.2.2)
  - Both for new screens, to make the framework future-proof, and for existing screens that are not used now as technicians argue that some screens do not help them
- Translate ideas into technological artefacts (Explored in Section 5.2.3)

5.2.1 Exploring the current situation by scenario testing

One of the challenges to be solved with tools is how to uncover user needs for application features. According to the Spinuzzi (2005) this is done by first understanding the current situation or problem. To do so, interviews and observations can be used (Sanders & Stappers, 2012), but for latent knowledge, generative techniques are needed (Sanders & Stappers, 2012) that elicit dreams and fears of users. This can be used the explore the current situation as well.

APPROACH AND GOALS

In generative techniques, it is aimed to create context awareness by eliciting emotional responses from participants (Vissers et al., 2005). This is needed to elicit not only knowledge about current and past experiences but also about future experiences (Vissers et al., 2005). Generative techniques enable this by eliciting emotions in terms of dreams and fears (Vissers et al., 2005). The downside of generative techniques is that often sensitising of participants in their own time is needed (Heath, 2013) and that sessions need to be organised to discuss the filled in sensitising packages and uncover the user needs, which is not time-efficient for a hangar environment.

The first ethnographic study of this research project showed that technicians do not have any time scheduled for innovation projects and are asked to do such things in their free time. The customer journey

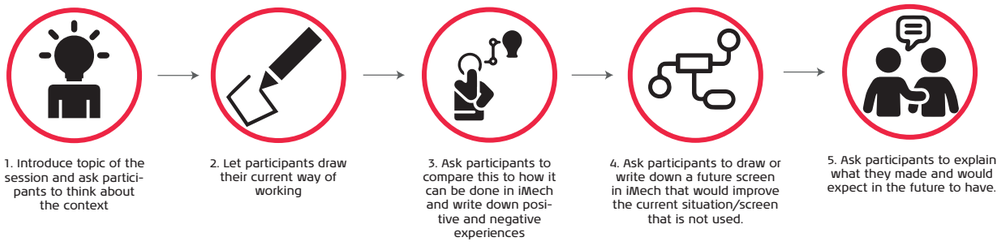

Figure 47: *Session approach*

(page 40, Figure 22) showed emotions of technicians about this: those were negative. Therefore the decision was made to try to uncover (deeper) user needs without sensitising kits.

The approach to testing if (deep) latent knowledge can be explored without sensitising packages is visualised in Figure 47.

The assumption is that by setting up a fictional case in terms of a scenario, users become aware of their context and, therefore, dreams and fears can be elicited.

In addition, this experiment tests if an adapted experiment dashboard (Klitsie, 2017), works to structure experiments and communicate findings. Figure 48 shows the preperation of the experiment. The experiment dashboard (Figure 49) was changed by adding a new box for Google Analytics data since Department XYZ started using Google Analytics this year to make decisions earlier this year.

The product owner decided what the acceptance criteria of the experiment would be. With acceptance criteria, it is meant what findings were needed according to him to pick up the users' needs.

For the experiment, a test iPad with a stable test version of the application was used, in which a task package for a Boeing 737-800 check was available. Due to this, technicians would be able to perform the scenario and interact with the fictional case.

INSIGHTS

One facilitator guided the technicians through the scenario, while the other facilitator made notes. On the iPad, a screen recording and audio recording were made simultaneously to capture all data.

In total 7 technicians explored the fictional case. Immediately 3 out of 7 technicians mentioned that they do not like the application and therefore do not have feedback, but

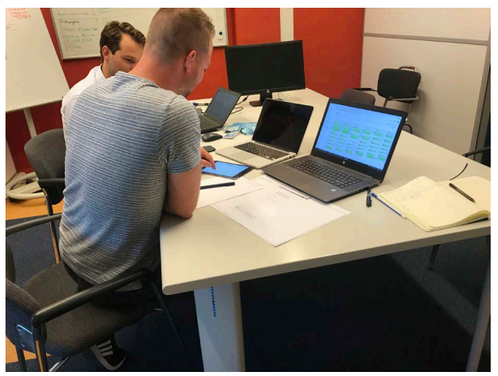

Figure 48: *Session preperation*

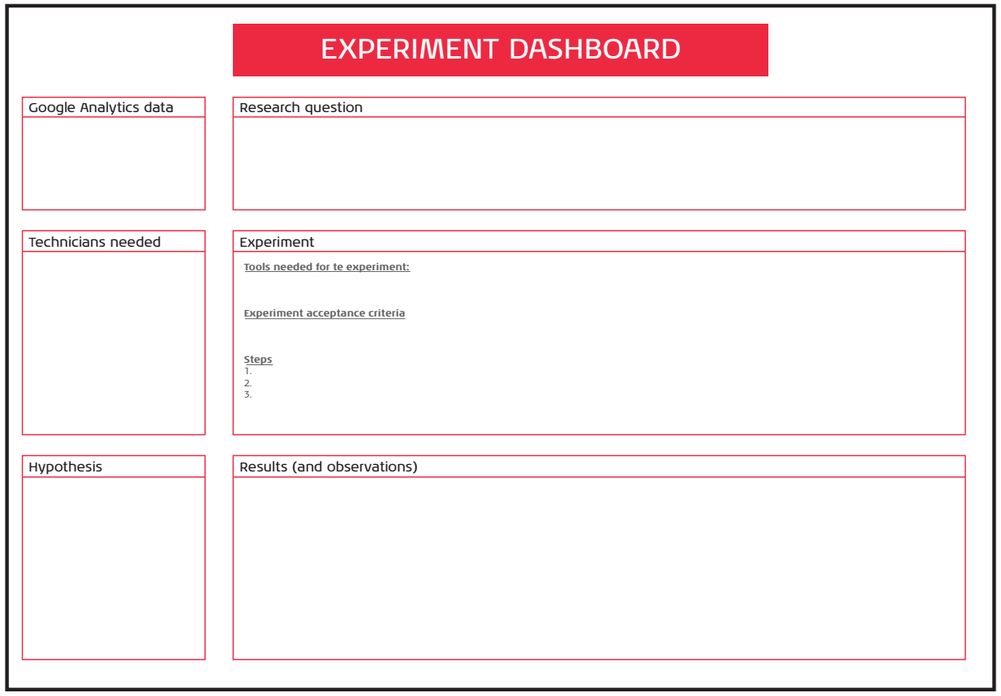

Figure 49: Experiment dashboard

by following the scenario all talked about what they would need in the future.

The analysis was done inspecting the field notes, listening and watching the recorded media and simultaneously writing down insight. The insights were clustered into three themes for the development team and communicated through the updated experiment dashboard (Figure 50).

The experiment showed that almost nobody was using a screen that was built to give an overview of the workload to the technicians, as this was, according to the Digital Transformation lead, the most requested feature at that time.
During the session, in the reflection moment, technicians were asked how they kept overview and different answers were given (Figure 51).

Due to the reflection moments, a few times technicians mentioned to change the appearance of the overview screen to something more familiar to them (e.g. Paper plan board was mentioned several times), examples of quotes mentioned are visualised in Figure 52.

CONCLUSION

The scenario helped technicians to reflect on their daily work, as it included tasks they have to do daily, and let us explore their current situation – as is needed in the first framework stage. Due to the sce-nario, they were able to imagine future wishes, for example

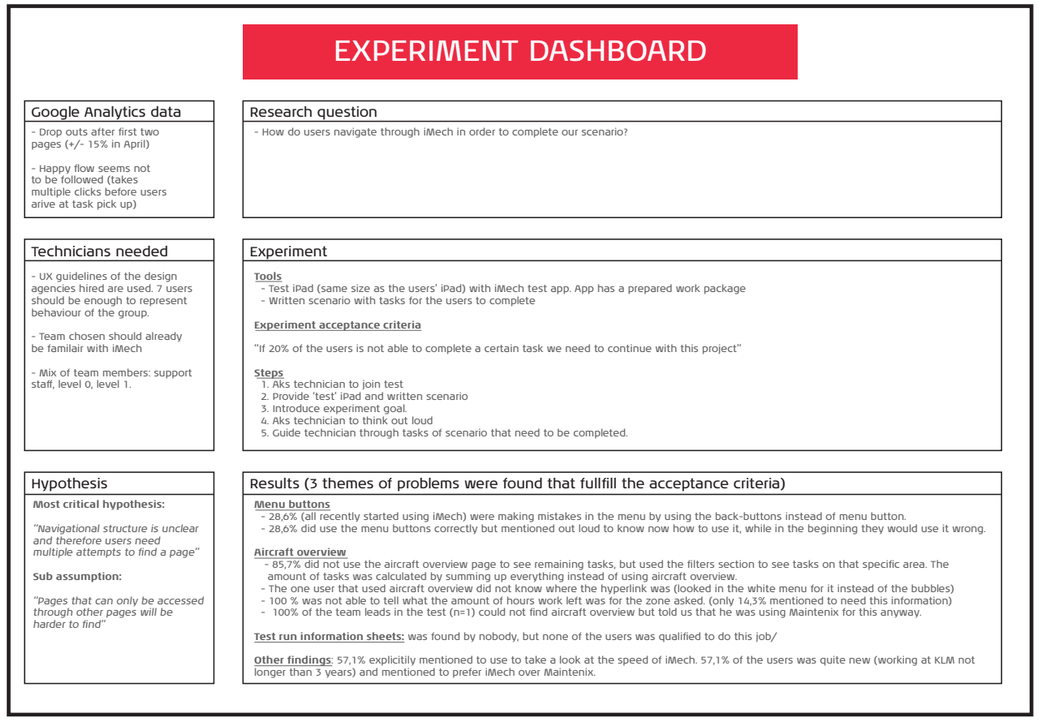

Figure 50: Experiment dashboard with results filled in

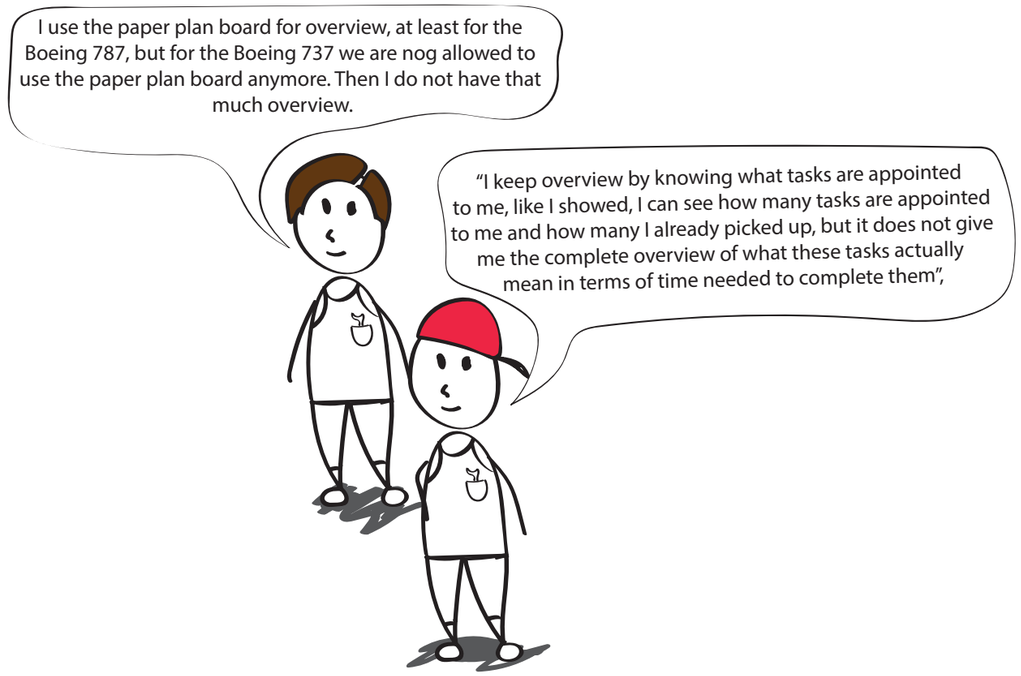

Figure 51: Experiment quotes about overview

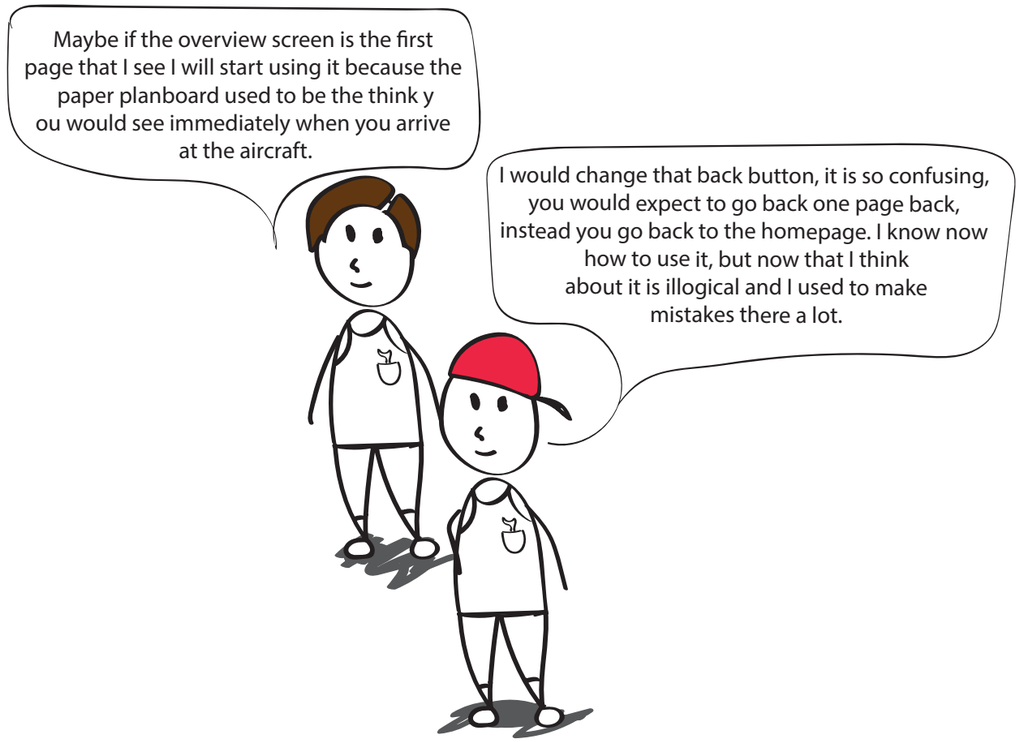

Figure 52: *Experiment quotes about screen designs*

changing the flow in the application or changing the appearance of the overview screen to give the overview they need. However, it did re-main vague what actual overview means to them, which can be explored further in the next frame-work stage.

Sensitising toolkits were not needed for this experiment, as the experiment in itself was designed to trigger participants to think and reflect on their work context. However, the needs found stayed vague, and some need to be researched further to know what to build in iTask.

The used experiment dashboard helped to structure an experiment that would generate the knowledge needed and turn assumptions into knowledge. The format turned out to be effective in the communications of findings, as everyone understood what was done to generate insights.

A point of attention is that this experiment worked to explore a situation that already is available in the application, but that this approach would not work for situations that have not been digitalised. This approach could be used to test screen proposals and see what technicians think about those.

5.2.2 Ideating new screen opportunities

One of the tools is supposed to help digitising teams to ideate a future state that fulfils user needs. This experiment will test what principles work or do not work.

APPROACH AND GOAL

The Aircraft Overview screen is used as the subject for this experiment. This screen was requested a lot, but now not used. The goal is to imagine a future state of the aircraft overview screen and to sketch this idea on the handout.

Before the session handouts (Figure 53) were designed, following the path of expression (Figure 9). The first handout focused on observing the current situation and reflecting on the past. The second handout asks to think about both positive and negative experiences, to be able to create opportunities for a new screen.

As this session was about a redesign, an extra step was placed in the path of expression: comparing the screens the technicians use now with the intended screen (aircraft overview), to elicit why the current screen is not useful.

The assumption was that these three stages would provide enough reflection on experiences to be able to imagine a future state. For the session supporting slides were designed to

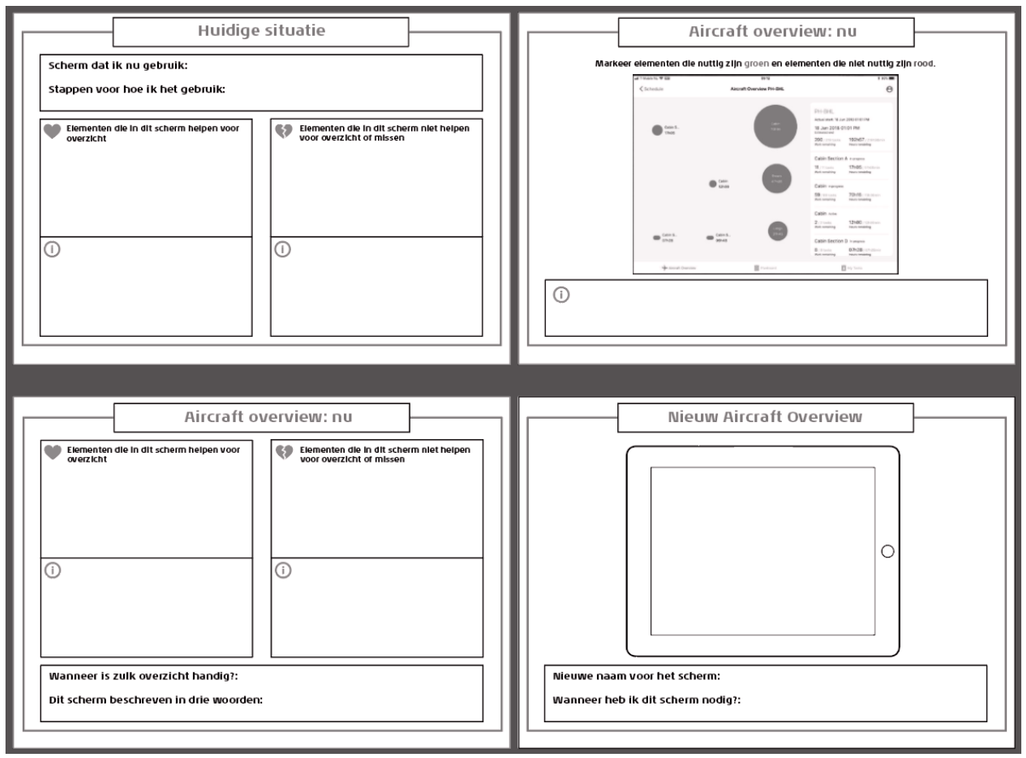

Figure 53: *Session hand outs*

guide the technicians through the co-creation. The slides can be found in Appendix H.

In this experiment the following assumption is tested: . By letting users follow the path of expression, they are enabled to express their needs and ideate a new screen design.

Figure 54: *Co-creation room*

INSIGHTS

The co-creation took place with 6 technicians. The session was audio-recorded to be able to analyse it after the session and the session was scheduled to last one hour.

Due to the operations and the rules of the hangar, it was not possible to choose the participants for the session, but technicians available on the scheduled day were asked by their team lead to attend the session. Also, it was not possible to do a co-creation on the hangar floor, therefore it was organised in one of the team rooms of the technicians (Figure 54).

Handouts were designed for the session, yet some technicians often mentioned things that they did not write down on the handouts. Therefore, a lot of notes were made to capture all insights. Some technicians drew a few elements on the paper, but none redesigned the complete screen.

A very important finding during the session was that no rules were introduced for how to behave during a creative session. As a result of this, the product owner sometimes started shooting at ideas due to safety and regulations. This should not happen in the future.

Relevant insights for the redesign of the page were found. Some quotes, to show their richness, have been visualised inFigure 55.

One pair of technicians brainstormed about how to show if a certain amount of tasks was feasible to finish in time. They came up with an idea to show the aircraft sections prioritised on time criticality and to give colours to the section, for example, a bubble that is coloured red if the section contains time-critical tasks.

The insights were communicated to all stakeholders in a meeting by using a PowerPoint without visuals that had all insights and quotes on the slides. Sometimes design opportunities were treated as threats or opportunities were evaluated based on feasibility or viability, without giving a thought on how something desired by the user still could be made. A reason for such behaviour could be that the insights were not communicated clearly enough, leaving room to discuss

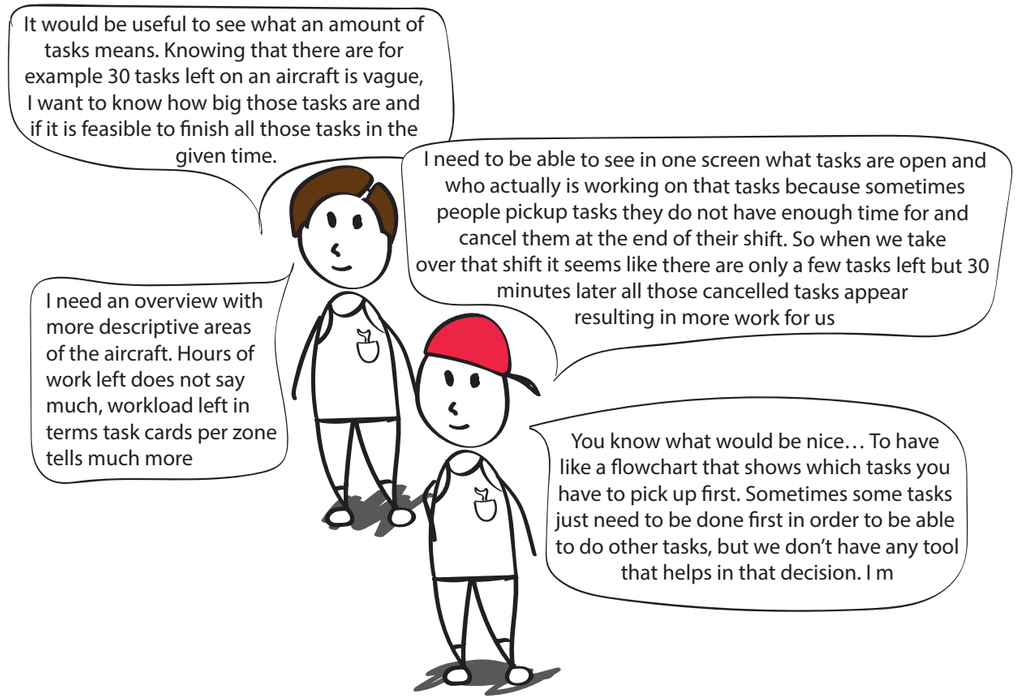

Figure 55: *Co-creation quotes*

the reasons for finding, rather than discussing what needs to happen to solve the found problems.

CONCLUSION

The session enabled technicians to imagine what a future Aircraft overview screen could look like. In the beginning, they all started off complaining about why it is useless but were all able to talk about what they need in the end. This is proof for the first part of the assumption tested.

However, the tools were not sufficient to go from need to screen design, but also not enough time was scheduled for this to happen. The full hour was used to uncover what the underlying need was in 'having overview'. Even if the tools were designed in such a way to create low-fidelity prototypes, there would not have been enough time to prototype a screen that fulfils the need.

The co-creative session set up required improvisation: sometimes we had to further question and ask why to understand what users meant and improvise what would work and what would not work to get the session going. This means that the hypothesis is not proven by this experiment and that tools need to be more guiding to enable participants to design a new screen, but that the handouts did work to uncover needs. Another point of attention is that the session enabled participants to dream big and diverge, but there was no converging phase to consider safety and regulations and shape ideas to still be legal.

A new experiment needs to be run, following to discover what tools will enable technicians to build low fidelity prototypes. Such a session needs to take longer than 1 hour.

For future co-creations in the ideate stage, a set of guidelines for during the sessions needs to be designed (what if things go differently than planned?) and rules and regulations need to be researched and provided to technicians. The session needs to have a part where solutions are redesigned and/or shaped to meet the rules and regulations.

Another action point of this experiment is to design a new way of presenting findings during the report out to steer the discussion more towards what design opportunities were found rather than defending why choices were made in the past.
Lastly, this co-creation tested if the path of expression works in the operational context of this airline and the context of digital innovation. It worked, as the technicians indeed ideated a future. However, this future was based on a screen that already existed, and therefore this tool will not work for ideating how new features in an application need to look.

5.2.3 Translating needs into technological artefacts

Since now user needs often are translated wrong into application features, the digitising teams need to be guided in this step by the co-creation framework and tools. Already some experiments were run with the aircraft overview screen, showing that this screen currently does not fulfil user needs. Therefore for this experiment, the aircraft overview screen is used again, to translate needs into a technological artefact.

APPROACH AND GOAL

The co-creation with the airline's employees and creative session with TU Delft students showed that for this activity Lego could be a good tool, as this is normally used to build solutions that solve problems. In this experiment the same principle will be used, but rather than Lego building blocks, webpage elements will be used.

A 2-hour session is scheduled for this experiment. Following the PICTIVE method (found in Table 1) technicians will be asked to express with design elements how a new Aircraft Overview screen needs to look. PICTIVE was proven to be successful for co-creating this literature (Muller, 1991; Muller, 1993; Hughes, 2012) due to the use of low-tech design components that empower users to fully participate in the design of artefacts that impact their job (Muller, 1991) and to improve knowledge from users about what is needed in the new artefact (Muller, 1991). In a session where the PICTIVE method is used participants are asked to create prototypes that address their user needs (Muller 1991; Hugh, 2012). Often participants are asked to think about a scenario that will solve their user needs upfront (Muller, 1991) but this can be also done during the session (Hugh, 2012). PICTIVE prototypes are constructed with design components, that are made upfront by the designers, and office supplies such as paper, pens, pencils, post-its, etc.

Figure 56 depicts the session approach

For the creation of design components for the PICTIVEVE session, the results of the experiment described in Section 5.2.2 were analysed and inspiration was sought in elements often used for paper prototypes. This resulted in the design elements (Figure 57) that were provided to the users. Besides, paper, post-its, markers, and pens were provided to users (Figure 58)

In the session the following assumption was tested:
By providing participants with a scenario and design components, participants can uncover their own needs and translate those into low-fidelity screens.

To guide the technicians through the prototype experiment, PowerPoint slides were designed (Appendix I).

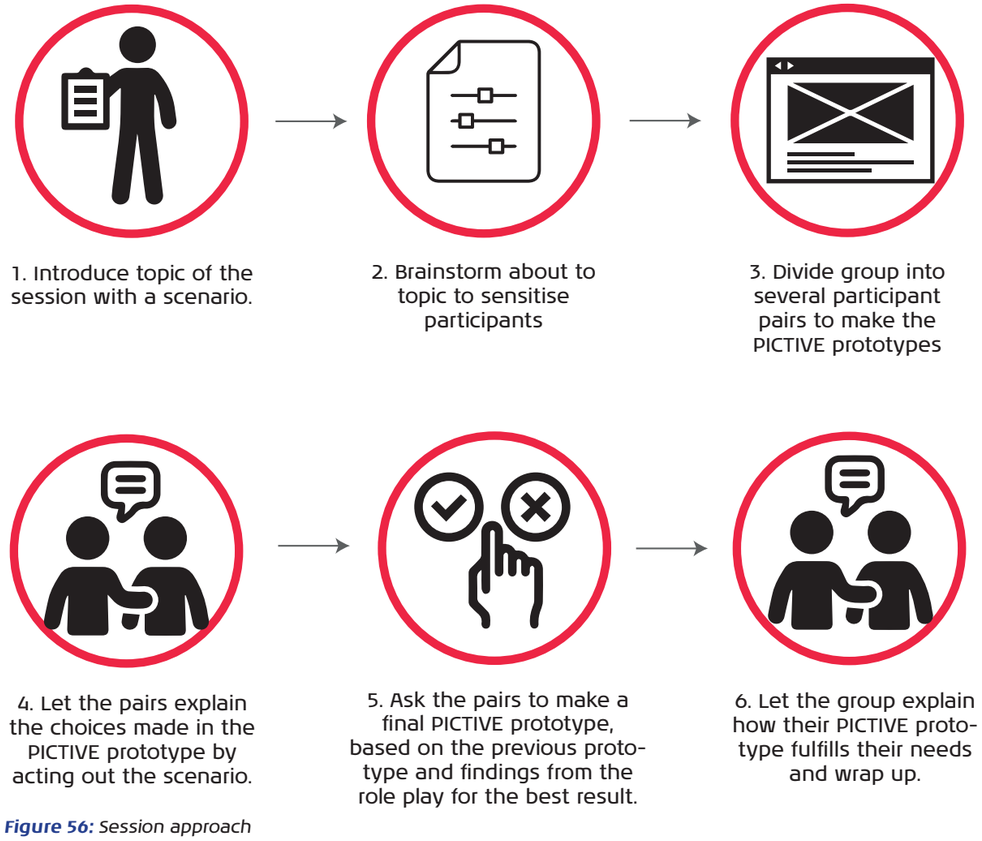

Figure 56: *Session approach*

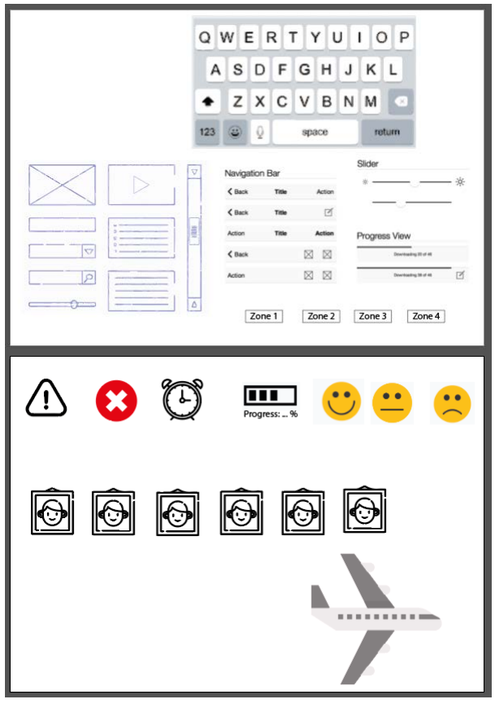

Figure 57: *PICTIVE components*

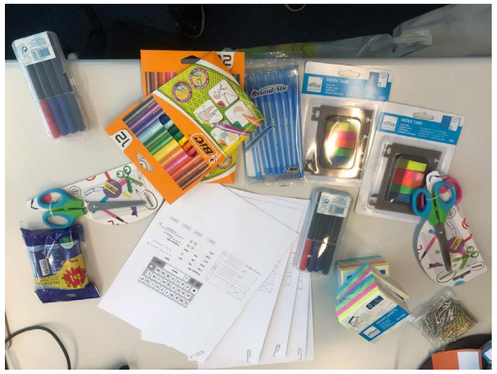

Figure 58: *PICTIVE office supplies*

INSIGHTS

The session was audiotaped and explanations of the screen were video recorded. For the analysis, I listened to the audio and transcribed interesting quotes from the screen design presentations.

Before the session, it was promised that 5 technicians would join the session, but eventually, 9 technicians joined the session since they thought the session sounded fun. The group was split in three and the technicians started brainstorming about how to visualise overview. The result of the three groups is included as Figure 59.

In the beginning, some technicians found it hard to start shaping new screens, therefore they needed to be probed: "Maybe you can make multiple sketches first on the post its or paper before starting to shape a new screen" which seemed to help. After about 40 minutes, all teams finished their screens and presented those to each other. The prototypes (Figure 59) and explanations showed that the technicians were enabled to express why current application features are not sufficient and what they dream of for the future. Appendix J describes the explenations in detail.

The fourth step, which was about designing a screen with the entire group, did not work out as planned. The technicians started thinking and decided that they wanted to have the screen presented by group 1, and that once you click on the section names in the page header you get redirected to the screen of group 2.

> *best solution, as the first screen gives overview in one page, and then the second screen is more detailed, showing the work that needs to be done in the next shifts".* - Technician, hangar 12

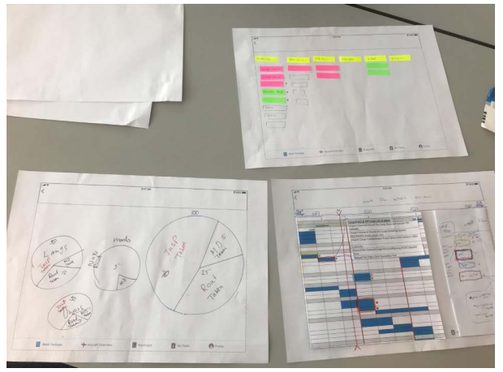

Figure 59: *PICTIVE co-creation output*

The results of the sessions and the explanations given by the teams are proof of the hypothesis. In the brainstorm session at the beginning, most technicians were quiet, but their behaviour completely changed once they got the tools to design low-fidelity tools. At the end of the session, I asked them about things they liked in the session and things they did not like. One of the answers given was:

> *"Well, at first, during the group brainstorm I found it hard, as I cannot easily express what I need, but the creative part was great fun. I think this is the way we should work right because we are the technicians and the teams should listen to our wishes. By creating the artefact I was able to tell you what I need."* - Technician, hangar 12.

Most of the design components were not even used by the technicians, but the office supplies were used and provided enough clues to start with.

CONCLUSION

This experiment demonstrated that a slightly changed PICTIVE approach works to translate user needs into low-fidelity screens. All groups were enabled to build a scenario through a screen and express why they build it like that, thus: what they need.

However, starting the build-part was experienced as hard in the beginning. A possible reason for this could be that a quick brainstorm is not enough to start the assignment, and more time needs to be spent on the ice-breaker. This need to be balanced due to the time-criticality of the hangers.

Lastly, this session did not take into account rules and regulations that can change the entire screen's designs. When applying such a co-creation to an actual product backlog item that needs to be built and delivered, rules and regulations need to be introduced in the session at some point to guarantee feasible and viable screen designs.

5.3 Conclusion

The first part of this chapter focused on finding a solution to the challenge in terms of what activities and tools are needed in the framework. The presented design will guide the digitising teams in changing their development process in a co-creative process with technicians to create iPad application features that fulfil actual user needs and therefore such features are more likely to be used.

By arranging activities in a specific way a process is formed that enables one to uncover needs or research a situation, imagine a future state and shape the imagined future state into technological artefacts. To enable digitising teams to follow this process activities need to be planned, of which some need to be supported by tools. For this work process, one new role in the digitising teams is needed; the role of a creative facilitator. Besides two roles that already exist in the hangars need to start collaborating more with the digitising teams: the CIL and the change manager, to ease the change and create relevant technological artefacts. Even more important is the involvement of technicians that will increase a lot once this way of working is implemented: time is needed to contribute to innovation.

In Section 5.2 several experiments have been set up to test how screens can be ideated, how low-fidelity screens can be built to ease the translation from a need to technological artefacts. It was found that using the path of expression to uncover why a certain screen is not used and how it needs to be improved through canvases works. However, this principle needs to be extended to ideating new screens that do not exist yet.

Ideas that fulfil user needs can be made more concrete by prototyping ideas with PICTIVE principles. Technicians experienced this as a fun and good experience since it enabled them to express their needs. These findings need to be conceptualised in tools for the framework in Chapter 6.

6. DELIVER

The discover phase provided a lot of insights, which were defined in a design challenge and design criteria in the define chapter. In Chapter 5, ideas for the co-creation process and tools were created and tested. This chapter introduces the final concept, based on the experiments of Chapter 5, that forms a solution to the design challenge.

6.1 The co-creation framework

The solution to this thesis' design challenge is a co-creation framework (Figure 60). The framework is a toolset for the digitising teams to understand the needs of their application users in different stages by together ideating future goals of users and shaping these goals with technological artefacts. The tools help the users to express their needs and help the digitising teams to translate needs into product backlog items.

Exploration is a pre-requisite for co-creation. As Spinuzzi (2005) found, one must first research the context and immerse oneself in the life of their users in order to be able to set up co-creative sessions and together change the workplace, as intended in the Digital Transformation Program of the airline.

To enable the digitising teams somehow to explore the context before co-creation can be applied, a suggestion on how to fill in the explore stage is done. However, the explore stage is a pre-requisite to co-create and therefore out of scope for the framework. After exploration a future state that clarify users' goal can be co-created. Lastly, the future state can be prototyped into iPad application screens.

The framework consists of a series of canvases and maps that need to be filled with the gathered information, and three sets of principles that can be used to ideate future states for new screens, ideate future states for screens that need to be improved and to prototype how future states will look in the applications. The insights gathered by using the framework are used to deepen the understanding of product backlog items in terms of users' goals and shapes of technological artefacts.

The framework includes tools that can be used to communicate the findings of the stages. The ideation stage has session principles that can be used to ideate future states for both new screens and already existing screens. The prototype stage has principles for a session to translate the future state into technological artefacts.

The framework guidelines (Section 6.8) explain to the teams how to make the attributes needed for this sessions and how to use the .

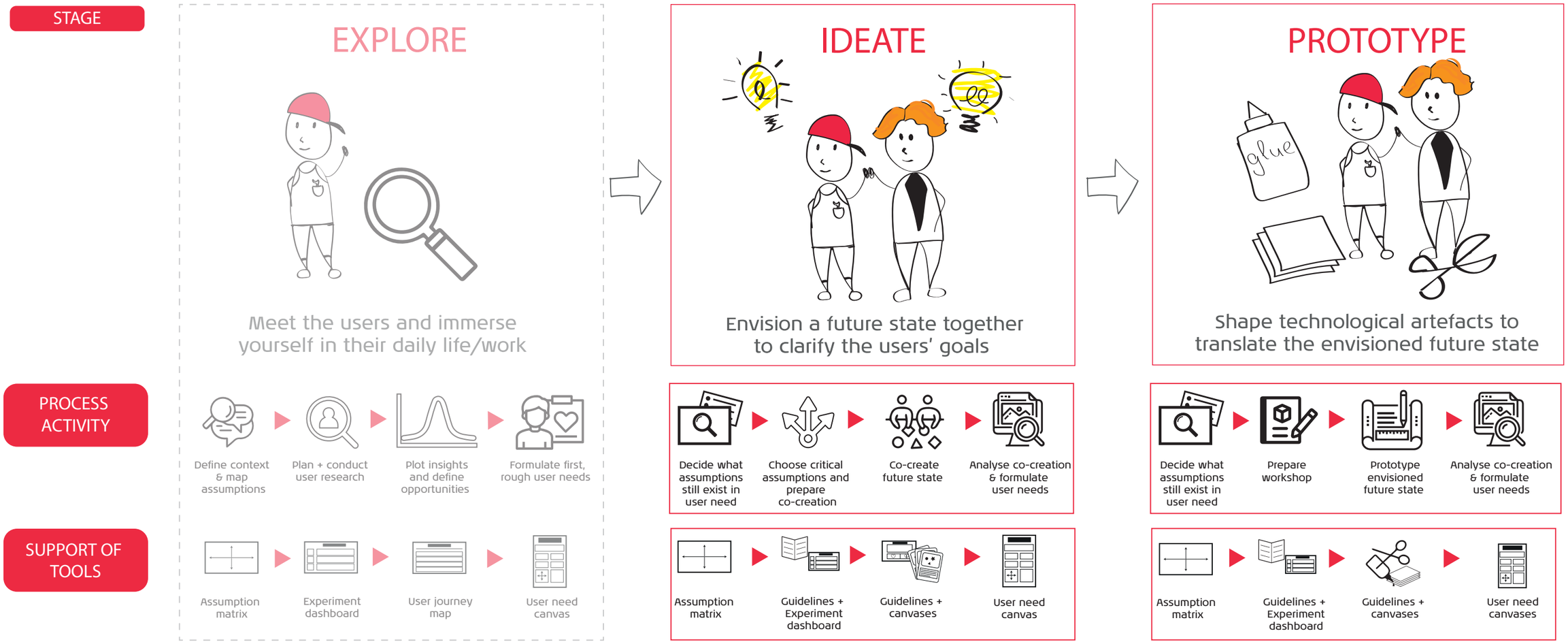

Figure 60: *Final co-creation framework*

6.2 Principles for ideating

For ideating a future state two different workshops have been designed. One workshop focuses on screens or digital themes that already exist and need to be improved and aids to uncover why and how the screens need to be uncovered.

6.2.1 Future states for already existing screens

Principles for a session to co-create future states for already existing screens have been designed based on the experiment in Section 5.2.2. The principles of such a session are visualised in Figure 61.

To enable the digitising teams to follow this workshop format, template canvases have been designed (Figure 62). .

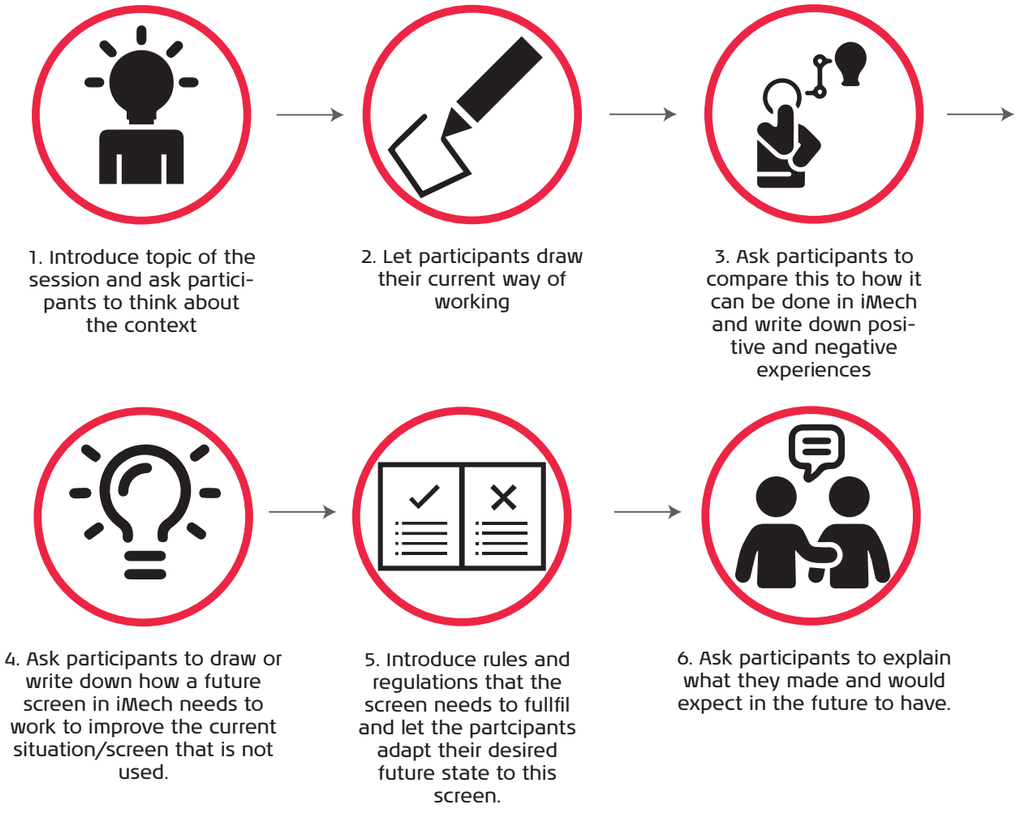

Figure 61: Approach for redesigning screens

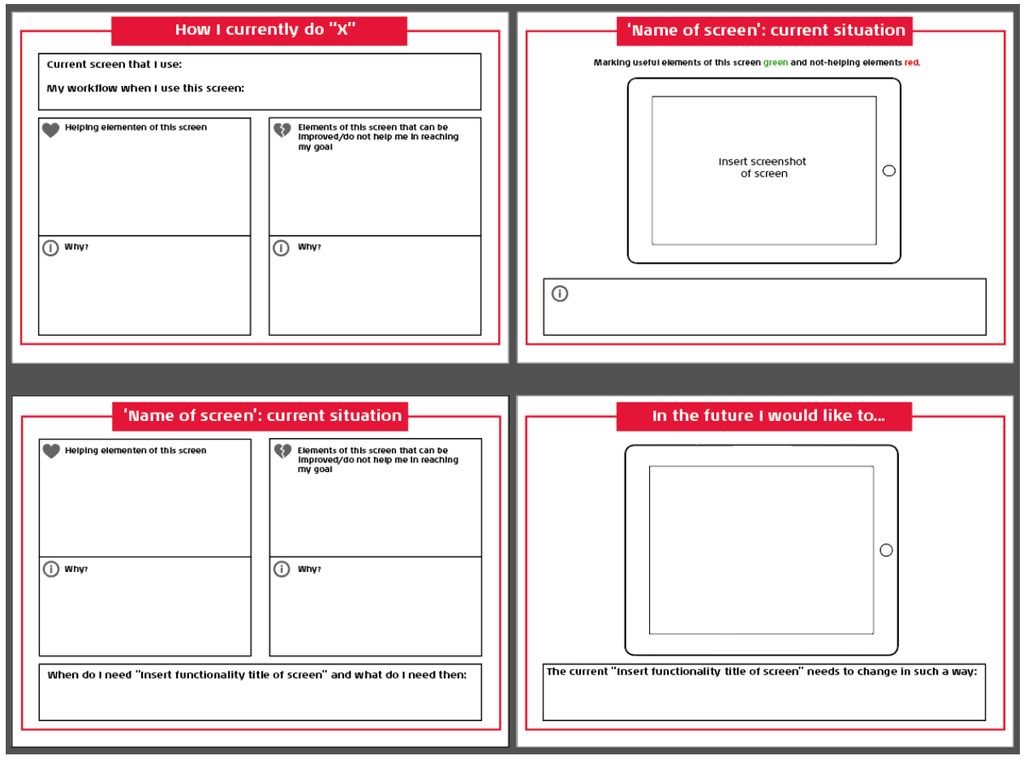

Figure 62: Canvases for redesigning screens

6.2.2 Future states for new screens

The set of principles for co-creative sessions (Figure 63) focuses on screens or digital themes that do not exist yet but are needed. This set was designed after the design intervention in Section 5.2.2, which concluded that an extra tool was needed for creating future states for new screens. Principles of the path of expression are used, but the workshop includes a card set to let technicians map their current situation, marking elements to reflect on the current situation and cards to plot ideal new workflows and change workflows to make them compliant to rules in the aviation industry. By working with flows rather than screens, technicians are enabled to think about steps required in their daily job to create future states instead of problem solutions.

The framework guidelines explain to the teams how to make the attributes needed for this session.

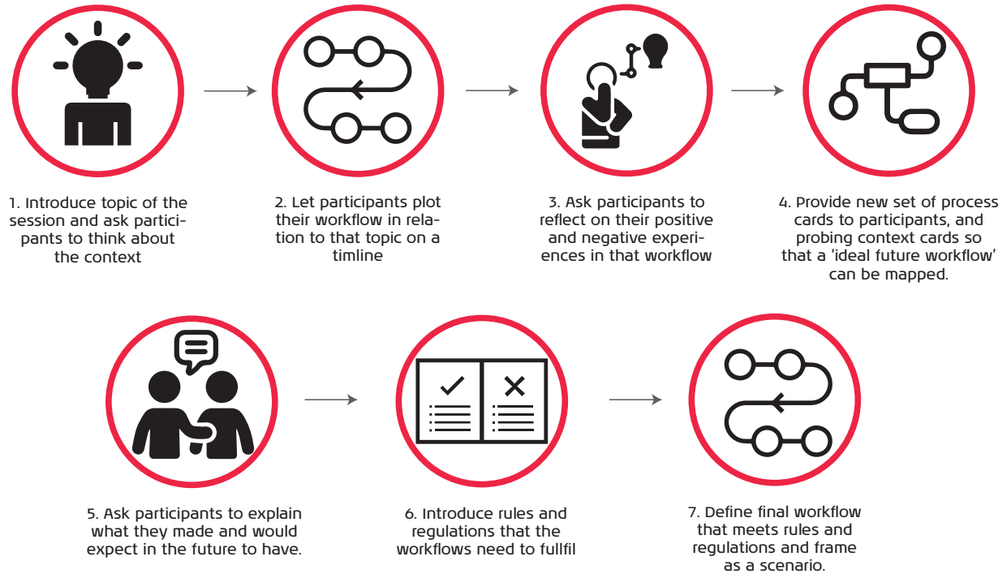

Figure 63: *Approach for ideating screens*

6.3 Principles for prototyping

The last stage is the prototype stage, in which technological artefacts are created by following the the steps in . This was tested in paragraph 5.2.3 and turned out to work. Therefore the workshop format has not changed (Figure 64).

By following the step, technicians are enabled to express in forms of technological artefacts what they need on application pages/features. The guidelines explain how to set up such a session.

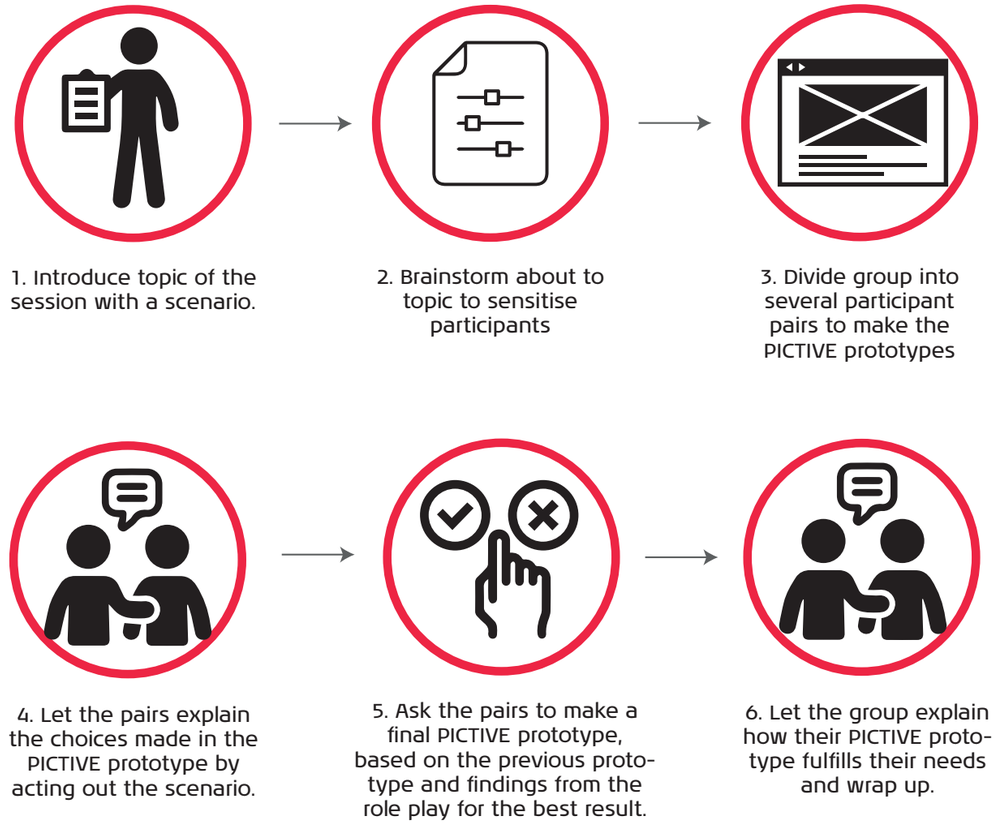

Figure 64: *Approach for prototyping screens*

6.4 Framework canvases

This paragraph introduces all canvases and maps that belong to the co-creation frameworks. The canvases and maps are briefly described in the following sections. The framework guidelines elaborate more on how to use the canvases.

6.4.1 Assumption matrix

The assumption matrix (Figure 65) has been designed with two purposes in mind:

- A tool that functions as a thinking and decision-making tool at the beginning of a co-creation loop, enabling the digitising teams to choose a relevant topic to explore with the co-creation framework;
- A tool that functions as a communication tool in the 'user need canvas' to show what steps still need to be taken before a feature will be ready to be developed following a scrum process.

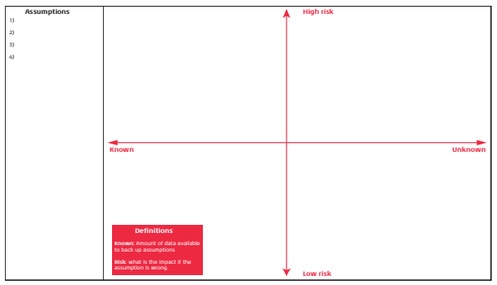

Figure 65: *Assumption matrix*

6.4.2 Experiment dashboard

To help digitising teams go from assumption to knowledge, the experiment dashboard (Figure 66) has been designed. The experiment dashboard helps in structuring experiments to gather the required information needed. The canvas has boxes that fit the digitising department of the airline (Google Analytics, as the goal of the department, is to start using Google analytics more), and boxes helping the teams to better choose experiment subjects (hypothesis, research questions) and technicians needed. The canvas can be used as a communication tool, as it enables digitising teams to briefly describe experiment purposes, experiment set-ups, and results.

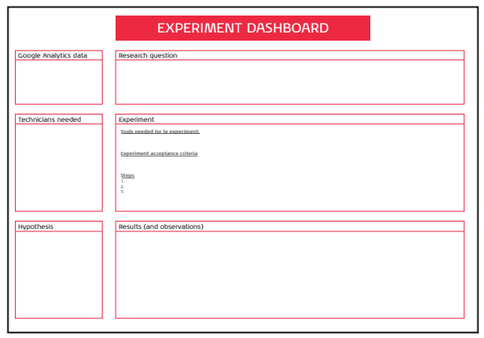

Figure 66: *Experiment dashboard*

6.4.3 User journey map

To enable the airline's employees somehow to explore the context before applying co-creation an adapted user journey canvas will be designed (Figure 69). This journey includes stages and activities to fill in, emotions and touchpoints that employees currently have. Lastly, the canvas has a box to formulate opportunities for further investigation with co-creation. A similar format has been used during the project to communicate the findings of the exploration phase of this project (Chapters 2 and 3). The creative session about co-creation with TU Delft design students suggested customer journeys to communicate research findings (Figure 24). The tool should function as a communication canvas. As the scope of this project is co-creation tools, no user research tools have been designed to gather the information required for this canvas. However, the digitising teams do include UX designer who, according to literature, could conduct user research in software development and gather the required information.

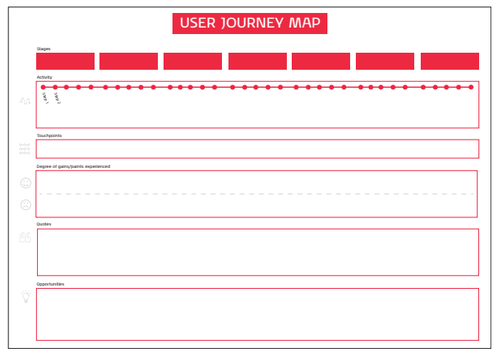

Figure 67: *User journey map*

6.4.4 User need canvas

The user need template (Figure 68) has been designed to aid the digitising team to think more from the user's perspective and referencing to the gathered user insights.

The canvas includes boxes to think about the value to be created and effort estimation, items that belong to the applied Scrum framework of the digitising teams.

Lastly, it includes the assumption matrix to enable the teams to plan the next steps required.

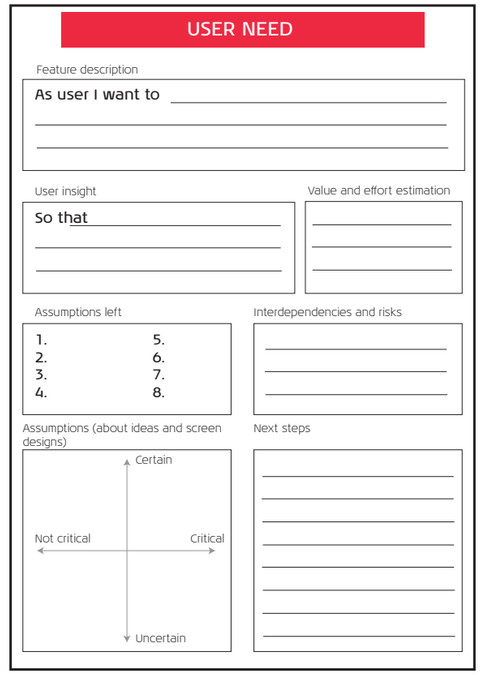

Figure 68: *User screen*

6.5 Framework evaluation test

To evaluate the value created with the co-creation framework, one last co-creative session has been set up to test the ideate and prototype stage by ideating a new screen (since this principle had not been tested in Chapter 5 yet). The same session is used to translate the future state into a technological artefact. The approach, analysis of results and elaborate conclusions of this session can be found in Appendix K.

6.5.1 Approach

To test the co-creation framework, the session had the goal to test both the ideation and prototype stage. Therefore the steps about assumption making and selection in the Prototype stage was left out of the test set up. The test was conducted in the team room of the sheet metal workers, which is on the hangar floor itself.

For this session the exploration phase was left out, since the case was fictional. Therefore also the Assumption matrix has not been used, as the test was only set up to test the co-creation principles of the framework. All stakeholders were invited:

- Users from hangar 11 (which was out of scope for this project, but is affected by the Digital transformation program as well);
- Users from hangar 14, both technicians that work on the narrow body and wide body;
- Users from hangar 12;
- The CILs of the hangars ;
- A safety and regulations manager (not a stakeholder of this project, but needed for the session content) ;
- The information analyst;
- The designers;
- Product owner;
- Digital transformation lead;

6.5.2 Results

The session was successful as it provided a lot of insights on current

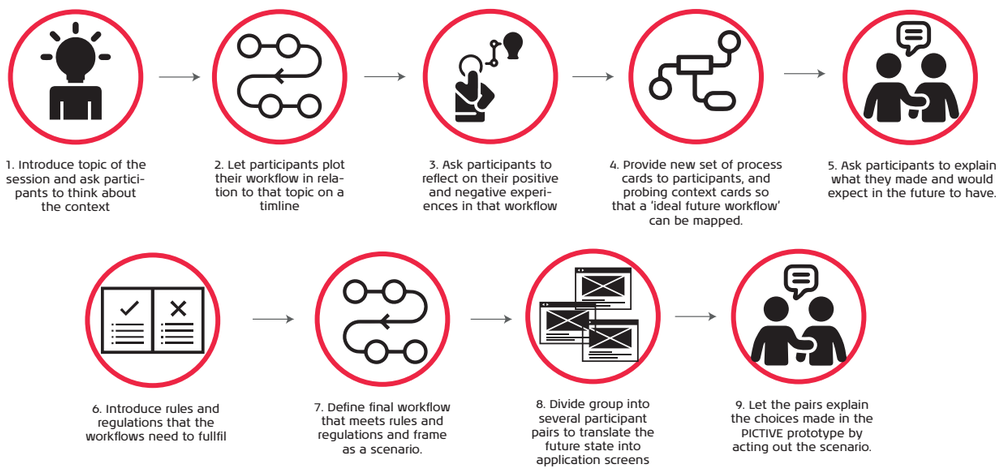

Figure 69: Test approach

Figure 70: Workflow created in session

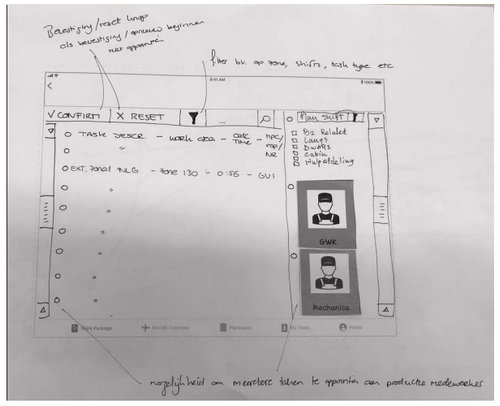

Figure 71: Low-fidelity screen created in session

ways of working, user needs for future ways of working and how this might look in an application. In Figure 70 one of the future workflow outcomes is depicted, and in Figure 71 a low-fidelity proposal for a screen in the application.

Although a handout for the session was given to all participants this was not enough. The facilitator role, therefore, became more important than expected, as the facilitator, who was me, needed to guide all groups of participants in doing the right exercise.

The session resulted in rich insights and complete screen designs, showing what the technicians need. As a result of such rich insights, the 'User need canvas' turned out to not be sufficient to communicate all findings. The session enabled to iterate the user needs of users by filling in the user need canvas, but there is the need for an additional canvas that enables the digitising teams to communicate what underlying needs lie in the designed screens.

Based on this session the airline started wondering how to check that the translation of low-fidelity screens to high-fidelity screen proposals has been done correctly. This can be done with user testing, but should be part of the Scrum process in which the screens are conceptualised.

6.6 Final framework

Based on the framework evaluation test, the design solutions have been updated as visualised in Figure 72. An additional canvas has been designed to communicate insights about the screens designed by users. This canvas is the user screen canvas, explained in Section 6.6.1.

6.6.1 User screen canvas

The last canvas is a user screen canvas (Figure 73) has been designed to support the user need canvas once the prototype stage has been completed. This format enables the digitising team to capture all user insight in the created user screens (Appendix M shows how this format can be used in the gather user insights).

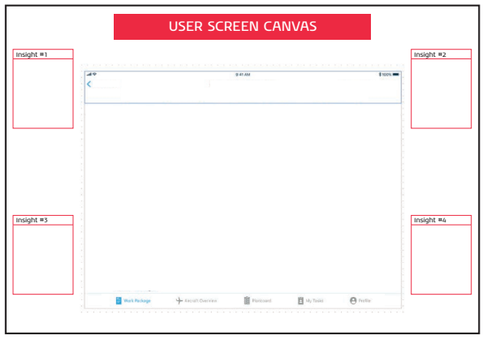

Figure 73: User screen canvas

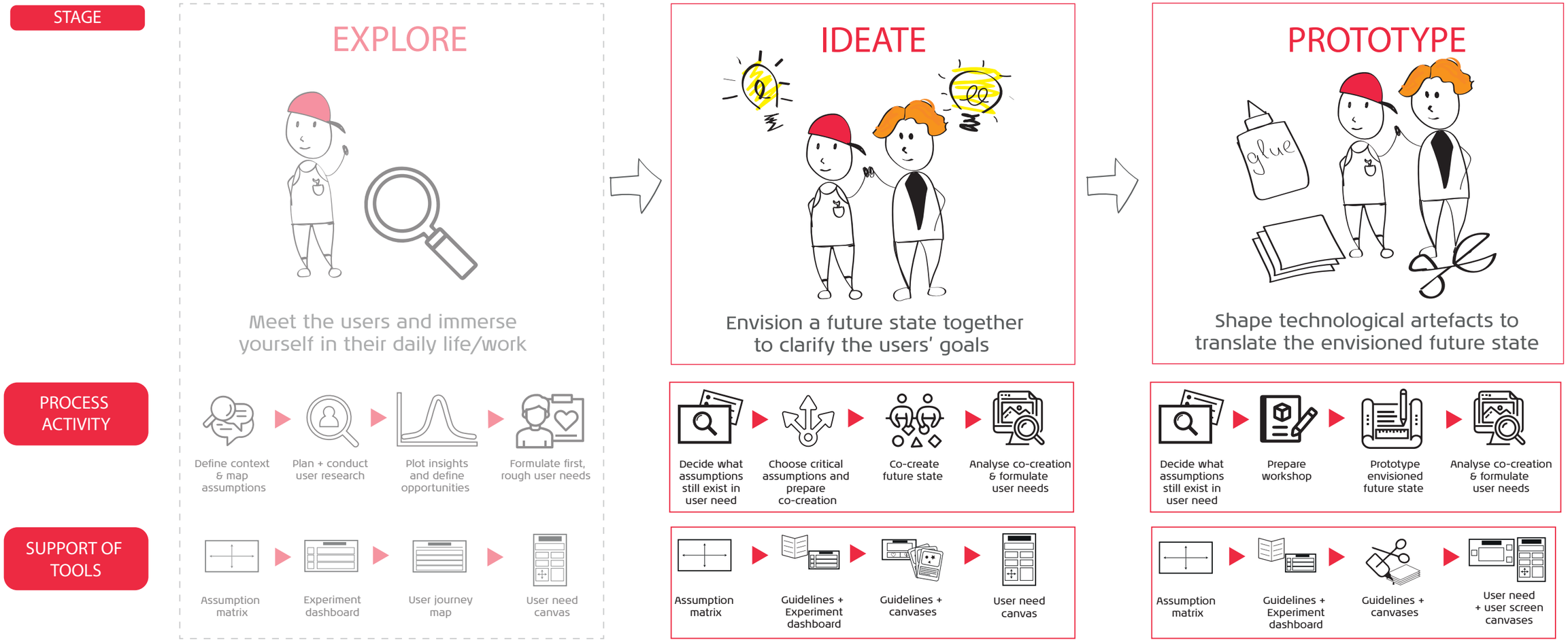

Figure 72: Final co-creation framework

6.7 Strategic usage of the framework

The designed framework can be used to find opportunities for new features in the current application or to find opportunities for new applications, all depending on how the scope is set in the exploration phase.

The first way requires an application with a basic employee journey already to exist. Then the framework can be used to research what features are needed and how to shape such features with technological artefacts. Going through the framework would mean that in the first stage, the product owner and its team would define a context. This needs to be researched and analysed. The framework tools enable to map the findings into the employee journey progress, after which a first user need can be formulated (e.g. "As team lead I want to see the check progress so that I know what tasks need to be done next"). In the next phase, this user need is investigated further, by imagining a future. An exam-ple outcome could be: "As the team leader, I want to have a digital aircraft twin to digitally see if the aircraft's ETR will be met". As this is not concrete in terms of how an iPad feature needs to look to enable this future state, the last stage will make the need more concretely in the prototype workshop by letting technicians prototype an artefact that fulfils their needs. Then an outcome could be "As a tech-nician, I want to have an aircraft visual in the planning board with subzones, that light up in case of time-criticality so that I know which subzone needs the most attention of my team".

The framework could also be used on a more strategic level, to define the purpose of a new applica-tion. Then the co-creation loop would focus on a bigger context and the research could, for example, show that technicians do need help in being the connected technician in the connected hangar, that is envisioned to exist in 2030 (Section 3.1). Based on this problem a future state for a new application could be ideated in stage two by using the principles of the card game, showing the use scenario of that future application. The last stage would help to shape this future state by prototyping pages that could help to fulfil this future state. However, to use the framework for such projects on a strategic level, the framework will need to be extended with more tools as more tools or sessions might be needed to come to a desirable, feasible and viable future state for a big investment like a new applica-tion.

6.8 Framework guidelines

To ensure that the framework can be used, guidelines have been designed for all canvases and all co-creative sessions designed. This booklet explains the purpose of each canvas or session, explains who should be involved and how to use it. The guideline booklet is delivered as extra booklet.

6.9 Conclusion

To design this framework several experiments have been set up to test what principles for co-creation would work in a hangar environment. This has resulted in the framework described in this chapter. At the end of the projects a final validation experiment was conducted. This session has demonstrated that the co-creation principles (to both ideate future states and prototype such needs in screens) work. The framework opens discussion between digitising teams and the users of the applications and therefore concreates a better understanding of needs. However, the framework does not provide a tested solution to exploring the context before starting an ideation and a prototype stage. This could be an interesting topic for further research in the field of software development and co-creation. Although the framework already was perceived as useful due to the insights it created, the framework could be extended with more creative session principles.

7. RECOMMENDATIONS, LIMITATION & IMPLEMENTATION

This chapter explores the recommendations for the airline, and considerations for implementation of this project. This chapter concludes with a reflection of the limitations of this project and provides interesting topics for further research.

7.1 Discussion & Implementation recommendations

This section discusses the complete project and gives answer to the research questions. Besides, it clarifies the implications and recommendations related to the implementation of the co-creation framework.

7.1.1 General discussion

The purpose of this project has been to discover how co-creation can be applied in software development to enable a better translation of needs into actual application features. Chapter 2 explores already existing knowledge about co-creation, value creation and user involvement in software development. In chapter 3 the company's context is explored through two ethnographic studies to better understand the problem. Based on literature study and company context research, design requirements are set in Chapter 4. Chapter 5 explores how these requirements can be translated into a co-creation process with supporting tools by organising several creative sessions and setting up several experiments. Chapter 6 translates those insights into an evidence-based solution. This final chapter concludes the research by answering the research question, evaluating the design solution.

How can co-creation be used to give support during the translation of user needs into product backlog items?

To better understand the context in which the framework that needed to be designed would be used, two additional research questions were formulated:

How does a day in the life of an aircraft mechanic look with digital tools?

How does the digitising team develop applications at this moment?

The general view on what co-creation is differs. This thesis therefore has defined co-creation as a collective creative activity that is about the exchange of ideas and experiences. This activity can also occur in a collaborative process that has several tools that give users a voice in the entire design process to express their needs. The user needs are important, since the extent to which user needs, wants, and preferences are met, underlie what value users attach to the product. However, to co-create with users, tools are needed to enable users to express their needs and step in the shoes of a designer. Some literature was found about user involvement in software development. This literature showed that a UX role in development teams could help to gather user needs and propose solutions that can be developed into the applications. However, the literature did not provide an answer to how exactly to incorporate co-creative activities in the development of applications, although it did provide insights about

what would need to be included in the solution.

The second research question was formulated to understand how the mechanics work, how digital tools are changing their life, and to understand how a co-creation framework could provide added value to them. The extensive ethnographic study about their daily work showed that technicians are currently not helped by the digital artefacts. In fact, the study showed that the technicians consider the digital tools to negatively impact their work and that features desired by the technicians are built in the applications in the wrong way or are not built at all. To better represent the technicians' needs in the company's digital transformation program, an IT council had been founded some years ago. However, the ethnographic study has showed that even with the IT council technicians do not succeed to gather their own needs for digital tools, let alone have their needs implemented in the right way in the digital tools. Therefore, a co-creation framework would be of added value fo the technicians, as it would improve how user needs are met now by the applications.

To answer the last research question a second ethnographic study was set up. This study resulted in a thorough understanding of the current application development process of the digitising teams. The teams use the Scrum framework to develop applications. The Scrum framework requires the product owner to gather user needs in the format user stories, that represent what a user wants to see in the application. The gathered user needs are then turned into prioritised into product backlog items, which are developed in 2-week sprints. However, in the creation of the product backlog items a lot of assumptions exist that are not tested before the actual development of application features start. Therefore, often features built attempt to meet user needs, but actually do no as the need are not translated right into screen designs. Additionally, it was found that the UX role in the digitising teams was not performing tasks related to user need research and solution creation.

Based on these insights, a co-creation framework has been designed as answer to the first research questions. This framework contains a process that can be followed to together with users ideate future states for their needs and prototype these future states into low-fidelity screens. By doing so, a better understanding is created of how product backlog items need to be defined so that the right screens and application features can be built by the digitising teams.

To support the ideation and prototype activities, both principles to set up such activities and canvases to use during these sessions have been designed. Since co-creation is a time-intense activity, additional tools to choose suitable topics that are worth the time-invest required have been designed. It was choosen to use a workshop format to enable technicians to make artefacts that express their latent needs, which only can be achieved by make-excercises (Vissers et al, 2005). Lastly, to enable communication of the co-creation findings for the creation of product backlog items, communication tools have been designed.

Table 3 performs an evaluation of the created value. As can be seen, only one requirement is not met: Users need to be available to co-create. Their availability is decided by the hangar management. However, during this project, in total 4 co-creation with technicians were organised over a course of 7 weeks, and at all times time resources were available.

Table 3: Design criteria check

Criteria type	Criteria	Explenation	
Framework tools	The design needs to incorporate the user perspective at the fuzzy front end and design phase.	The user perspective is included in the framework in both the fuzzy front end when future states are defined and in the design phase when screens are prototyped. However, the framework does not change the Scrum process and therefore could not change the way in which the screens are conceptualised and developed.	✓
	The user perspective is included by either hearing the users or providing tools to the users to become a designer and exchange ideas with the development team.	This is achieved by the 'screen ideation' and 'prototyping screens' principles that have been designed to set up co-creative sessions.	✓
	To structure the process, the design needs to have deliverables or formats that need to be filled in.	The design has deliverables to structure gathered insights and to communicate findings and to ease decision-making.	✓
	The design balances co-creation and decision-making activities.	Co-creation principles and decision-making canvases has been designed and incorporated in the process to balance those.	✓

Criteria type	Criteria	Explenation	
	The framework enables to early test assumptions/ ideas and to early co-create to avoid waste.	Principles have been provided to let the digitising teams structure the session. In addition, an assumption matrix and experiment dashboard have been designed to structure assumption testing.	✓
	The design has at least two stages that enable the teams to envision a future state that clarifies goals and to prototype technological artefacts to fit that vision.	Three types of principles to ideate and prototype have been developed.	✓
	The design enables co-creation with users that work in 24/7 shifts due to the operation.	During the project it has been proven that technicians were able to attend the sessions.	✓
	The design provides a clear allocation of roles in the stages and activities.	A role allocation has been designed and visualised in the framework guidelines.	✓
	The design shows when and how different co-creation activities can be performed by which role.	This is communicated through framework guidelines.	✓
	The design can be performed in all stages of a project (when a project still needs to be set up, during the minimum viable product creation or during the development of features).	The framework has been designed with templates enabling the digitising teams to set the scope of session how they need it.	✓

Criteria type	Criteria	Explenation	
	The design can be used in parallel to a Scrum software development process.	The framework is used to define product backlog items better before development teams start working on the items.	✓
Tools	The designs uncover needs that are both on the surface and deep levels.	Several experiments have proven that technicians were enabled to express what they are dreaming of for the future.	✓
	The designs help to go from need to artefact that fulfils the need.	The prototype activities facilitate this.	✓
	The designs incorporate rules and regulations in this process to guarantee feasibility.	Session guidelines have been set up that take this into account.	✓
	The designs enable the teams to use more techniques than interviewing and observation to uncover user needs.	The designed sessions help to uncover needs in a different way than interviewing or observing.	✓
General	The framework and tools provide a way to broadly recruit participants, rather than selective.	In the experiment dashboard questions are asked about what technicians are needed for a representative user test group.	✓
	Users need to be available to co-create.	Time needs to be allocated for this by the hangar management. In the given time and scope of the project, it was not possible to find a solution to this.	X

Criteria type	Criteria	Explenation	
	The framework and tools need to be designed in such a way that the teams can use it, meaning that the tools have to be self-explanatory.	A booklet with framework guidelines has been designed to meet this re-quirement.	✓
	The framework and tools need to be designed in such a way that this thesis does not have to be read before one understands how the tools need to be used.	A booklet with framework guidelines has been designed to meet this requirement.	✓

7.1.2 Recommendations for implementation

This work highlighted, from both practical and theoretical point of view, the importance of addressing how co-creation can be used in the translation of user needs into application features. The co-creation framework outlined provides a way to do such a translation.

However, to benefit from the co-creation framework, the airline has to consider several implications for implementation. By considering these implications, the airline will ensure a better understanding of user needs, increasing the value created.

CO-CREATION PROCESS

It is recommended that the process as presented is used, so that a good overview of assumptions is kept and only co-creation is applied to the topics that are worth the time-invest due to the high amount of assumptions involved in the topic and low amount of knowledge available to back up the assumptions. By following the guidelines the right set of co-creation principles can be chosen to create a better understanding of the user need and to translate the need into screen solutions for software development. If the process is not followed as intended, but only parts of the process, e.g.only find a future state rather than also translating this future state in a screen. By doing so, the risk arises that the value expected will not be created, as it might be that the wrong need is prototyped. The same principle applies to only using a prototype activity to translate needs: the risk exists that the prototype is well-designed, but that it does not adress the right future state of needs.

CO-CREATION PRINCIPLES

It is strongly recommended to promote the co-creation principles that have been designed for the ideation and prototyping activities to create understanding of the reasoning behind session set ups. As it was found in one of the design experiments in Chapter 5, not everyone is familiar to co-creation and creative session, which can result in session interruptions. This might negatively impact session outcomes. By promoting the session guidelines, all stakeholders involved will know the goal of sessions and can behave accordingly.

The co-creation principles will enable the company the explore user needs, define goals for the future and prototype such future state in to screens. It is crucial to both ideate and prototype, as the prototype activities make the actual translation from need to solution.

EXPLORATION BEFORE CO-CREATION

This work has found that exploration is a pre-requisite for co-creation. One must first meet the users and immerse in their daily work to understand their needs, before co-creation in the form of ideation and prototyping can be applied. However, this exploration stage is not completely supported by the co-creation framework, although, a suggestion for exploration approach

is done. It is strongly recommended to the company to use this suggestion. Additionally it is advised to the airline to use this foundation and build an exploration guide, complementary to the co-creation framework.

7.2 Contribution to new knowledge

This research has outlined how co-creation can be included in software development. Additionally, this research provides tools to set up co-creations. The provided process and tools can contribute to already existing theory.

The findings of this work could be used to understand how co-creation can be applied to the creation of digital artefacts. Furthermore, the proposed session guidelines can support this way of working. The practical canvases can be used to investigate already existing knowledge, identifying topics that are worth further exploration by applying co-creation.

Furthermore, this research builds on the argument of Sanders (2001) for using the path of expression to enable users to express their latent needs. This research has developed practical approaches to using this principle in digital innovation projects.

Finally, this research contributes in addressing how to translate user needs into tangible, low-fidelity screens, building on the argument of Muller (1991, 1993) that users need to be provided with design components to build screens. This research shows how to use principles of PICTIVE and enables users to collaboratively make new components for screen designs, rather than only using the components they were provided with. This takes away the risk of wrong translation of needs into technological artefacts.

7.3 Research limitations & Future research

This section elaborates on the limitations of this research performed and suggest what could be research in the future in the field of combining co-creation with Scrum software development.

7.3.1 Research limitations

The objective of this thesis is to support the airline with a co-creation framework to enable better understanding of user needs and translation of needs into product backlog items. To provide this solution to the airline an extensive research was conducted, including literature review, ethnographic research methods and design experiments. However, the research has some limitations.

One of the limitations throughout the entire research has been gaining the trust of the digitising teams. While interviews were conducted with the digitising teams and while they participated in co-creative sessions to build this framework, they were not willing to organise co-creative sessions for items on their product backlog items and test the framework.

Therefore a lot of fictional cases were set up to test co-creation principles, however, technicians needed to be warn that the case was only fictional and the outcomes would most likely not be implemented.

Due to the fictional cases, user needs were not analysed deeply. The co-creation outcomes resulted in incremental findings. The question arises what would have happened if actual product backlog items would have been used for the co-creation and insights would have shown that radical innovation is needed to meet user needs for example. Democratising the workplace and enabling users to contribute to products they will use, has many advantages. However, there are also some weaknesses of co-creation. Co-creation is time intensive, but allows to create deep insights. This is conflicting with the 'building fast'-principle of Scrum to learn fast. The research has not experienced what happens when the creation of deep insights slows down the fast development of Scrum due to the usage of fictional backlog items.

Finally, the use of fictional product backlog items did not allow to see what happens when democratising the workplace does not work, as needs of users are not aligned with the company's vision and therefore top-down decisions need to be take.

7.3.2 Future research

This project has contributed to the field of including co-creation to the software development process.

The co-creation framework provides guidance, when one already has assumptions, in what and how features should be build. However, it does not provide guidance in the exploration stage, where new assumptions might be created. This exploration stage, however, was found to be a pre-requisite for co-creation (Spinuzzi, 2005). Further research could investigate what kind of exploration activities are needed to strengthen co-creative activities.

Besides, the co-creation framework has been tested in a qualitative way. Next steps should validate the framework in a quantitative study.

Finally, it could be interesting to investigate the value created with digital artefacts that applied co-creation. Co-creation enables the creation of deep insights, however, it requires a lot of time investments. It would be an interesting topic to measure if co-creation is worth the time investment, compared to Scum that promotes building fast to check if the right thing is being build.

7.4 Personal reflection

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