Data as a creative material supporting ideation in Ford

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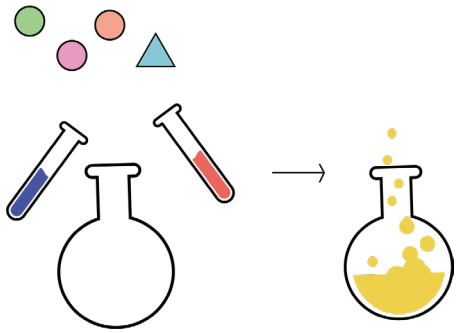
Preface



Dear Reader,

Before you dive into this thesis, I would like to give you a short introduction to myself and my journey with this project.

First, I am a DFI student and am passionate about user experience research. Ten months ago last September, I was thrilled to find this graduation opportunity to explore how to use data to understand user experience and support product innovation, which was such a novel yet exciting topic for me. Then, as you could expect, I got this opportunity and was engaged in this thesis's research, design, and writing work from January to July 2021. The journey was not easy, but the extensive research and design iterations allowed me to answer the research question and deliver a recognized design intervention.

This project is part of the collaboration regarding data-enabled design between Ford and the TU Delft, in which I participated as a student researcher, under the guidance of my supervisory team: Milene Gonçalves and Jacky Bourgeois. I would like to thank you for your academic guidance and mental support and that you were always available and willing to keep me motivated in this long journey. To my mentors from Ford company, Marcel Grein and Nicole Eikelenberg, thank you for all the patient support and arrangement for all the research and design activities. Your trust in me made me more confident about myself and the impact of "design" in a big company like Ford.

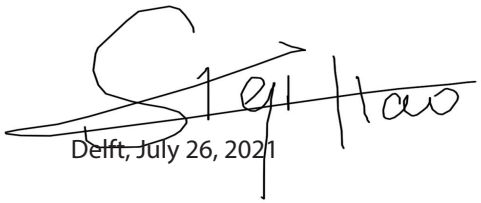
Much thanks to the other students working in the "student community"- Tiara, Deborah, Yen and others, who were like my teammates in this journey. I enjoyed all of our collaborations and discussions, where you always shared your insights, learnings and views generously.

Thanks to my family and friends, Jackie, Qian, Alex and others, for your ever-present love and accompany. I could not have achieved what I have now without you.

Thank myself for being persistent and responsible throughout the whole journey.

I hope you enjoy your reading,

Siqi Hao



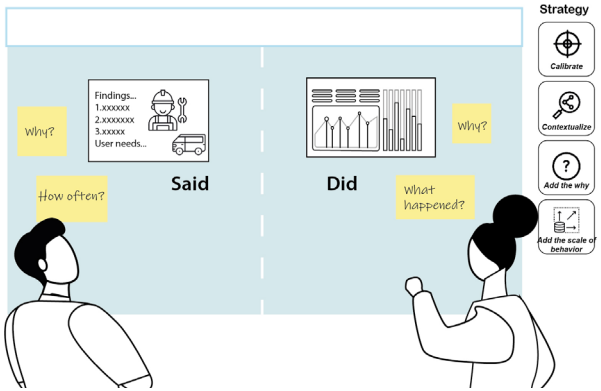
Delft, July 26, 2021

Abstract

Vehicles are becoming more and more connected, and in combination with various services, they generate large amounts of data, which is mainly used in development processes for testing purposes in Ford. However, sensor data has more potentials for product development, and one valuable potential is to contribute to product innovation in the early design stage, which can be seen from existing studies on data-enabled design. However, the large amount and complexity of data make it hard for the Ford Research and innovation (R&A) team to approach data, nevertheless apply data in the design process. In addition, there are no available methods and tools that fit in with Ford's data availability and workflow to guide them to apply data for product development, which can make the R&A team feel clueless in their practice.

Based on the challenge, I framed the initial research question of this project as: How to facilitate the Ford R&A team to apply user data to enhance creativity in their ideation process? Then, I conducted research, product development, and evaluation to deliver the final design intervention. The research phase with in-depth literature research and interviews revealed insights from three different perspectives relevant to the initial research question. These insights were analysed to identify challenges and opportunities for design intervention. Very prominent was the opportunity to facilitate the creation of data combinations with creative techniques during the session, which can potentially enhance creativity by supporting the problem framing process. The design goal and interaction vision were then formulated to define the scope and design directions of the project.

Afterwards, the concept "A toolbox for creative problem solving with data "was developed and tested. Based on the evaluation of the toolbox, I designed a guidebook containing a three-step method as a guide to applying the toolbox. The second-round evaluation shows that the final design intervention is believed to provide innovative methods and tools for the R&A team to generate insights from data combinations for the problem framing process and cultivate creative thinking during the session. Moreover, the three-step method for combining data fills the method gap for the implementation of data-enabled design in organizational practice. In conclusion, the final design intervention sufficiently fulfils the design goal and contributes to the method study on data-enabled design.



Content

Chapter 1
Introduction

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Research Question

"How to facilitate the Ford R&A team to apply data to enhance creativity for the ideation process?"

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1.1 Background

Introduction

The Internet of Things dramatically facilitates big data collection, generating vast streams of quantitative data from connected devices, which gives designers new opportunities to learn about people's habits and behaviours and gain insights for new designs (Marti, Megens, and Hummels, 2016). Relevant studies to apply data in the design process as problem exploration material (Kun, Mulder, & Kortuem, 2018), qualitative research material, and design material-visualised data as part of the solution (van Kollenburg and Bogers, 2019) have brought new design approaches, methods, and tools.

However, data usage as a creative material to generate insights and support creativity is still under-explored (Gorkovenko et al.,2020). In a systematic study on Data-enabled design by van Kollenburg and Bogers (2019), different data roles are explored in three healthcare projects collaborated with Philips. As shown in the 8-shape model proposed (Figure 1.1), the potential roles of data in the creative process can be summarised as providing contextual and experiential insights and serving as design materials. Kollenburg and Bogers (2019) also proposed methods to contextualize sensor data by participatory research, such as interviewing users with visualised data-overview, enabling users to send instant feedback on data-overview via an app. From their design practices, it can be seen that the choice of methods largely depends on various factors such as user's availability and data availability, and context-specific tools should be designed for data collection.

Regarding apply data for enhancing creativity, existing studies mainly focus on the data's contribution to the problem framing process, defined as data sensemaking (Klein and Moon, 2006b), where data is analysed with different techniques for generating insights. However, as Kun et al. (2020) pointed out, many designers have limited knowledge of data processing techniques, making it challenging to understand or interpret data. More concerns about data usage are summarised in the study of Gorkovenko et al. (2020). **First, quantitative data was seen as being potentially uncontextualised, misleading, and susceptible to hacking. Thus, it was seen to have a strong potential to be used for optimisation and predictive maintenance. Besides, designers may misinterpret the meaning and implication of the data when they maintain it too complex. In this situation, data might only lead to optimisation but not creativity.**

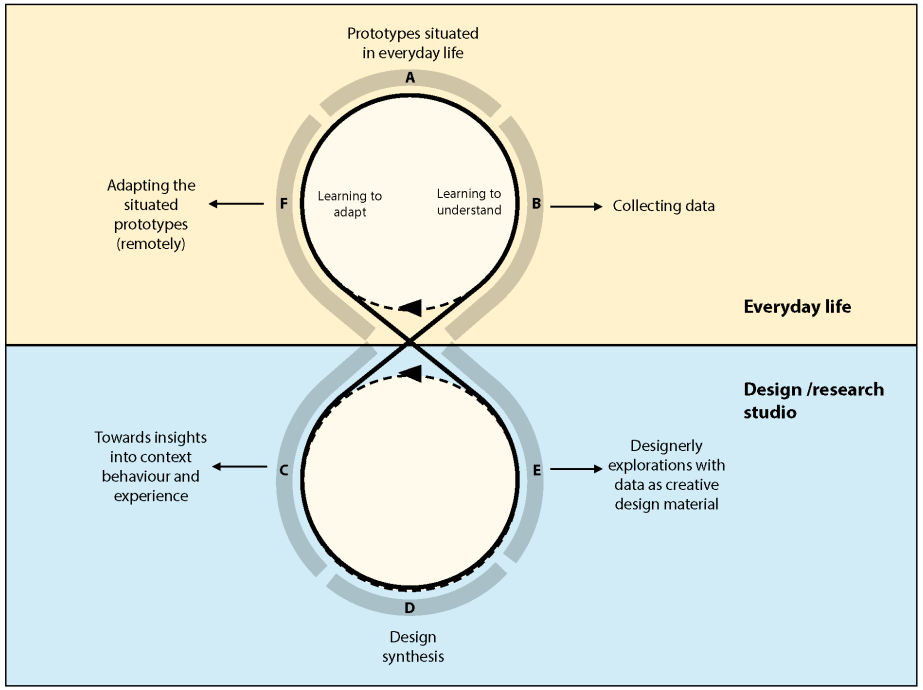


Figure 1.1, design model from the study on Data enabled design from van Kollenburg and Bogers (2019)

Context

At Ford, an ever-larger amount of sensor data is generated with the advent of connected vehicles and services. The potential value from data being used in the product development process still requires exploitation. Ford's Research and Innovation (R&A) team wants to develop capabilities in using data during their development process to contribute to their services and products' design innovation,

especially for the early design phases as shown in figure 1.2 as "Identify insights and themes" and "Generate ideas and prototypes." For this project, they provide cases in the context of commercial vehicles that focus on developing intelligent systems to improve user experience through digital connectivity and automation (Spierings et al., 2018). Here comes the opportunity to explore data as a creative material to develop intelligent systems in the mobility industry.

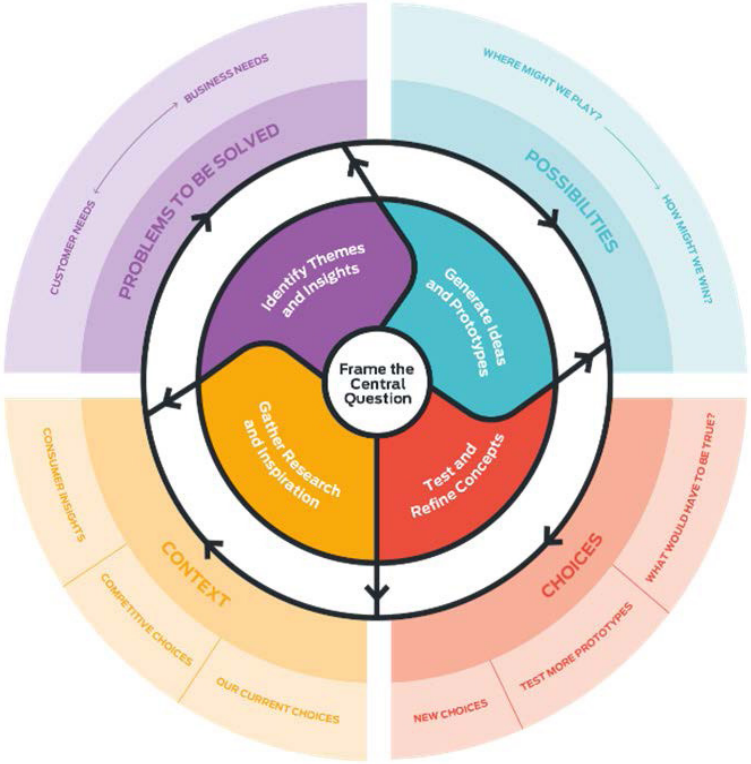


Figure 1.2, phases of Ford's design model.

Scope

Starting with the Ford Aachen & TU Delft research collaboration, the R & A team at Aachen described "Data enabled design" as an opportunity for further research into data usage in the service design process. The main goal of the development of this opportunity has been formulated as: Use data in the very early process of design thinking to better understand the user. Then, use data in the creative process to generate new ideas/service opportunities based on data. To reach these goals, three threads have been formulated that were -in collaboration with the TU Delft- further developed into three graduation projects:

Data strategy	Which data helps better understand the user and its context in order to create new insights? How are different sources of data relevant for designers?
Data as creative material	How can data be collected and used during the development process to create new and improved products and services? How does data as design material influence creativity?
Data visualisation	How can data visualization increase engagement and facilitate communication when generating user insights, and when proposing new smart commercial vehicle concepts?

In the first project regarding data selection strategy, Pim Jansen (2021) proposed the process, strategies, and the design intervention "Data enabled user profile" (Jasen, 2021), which focuses on facilitating Ford to approach potential data that are valuable to understanding user behaviour. His research and design outcome was of great reference value to the following projects including this project. **To bring those data into the creative process, this project, "Data as a creative material" aims to explore how data can serve as a creative material for product/service development.**

1.2 Stakeholders

Since this project aims to support the application of data in the early product development stage, I first identified the target group of the design as the Research and Innovation (R&A) department at the Ford Aachen innovation centre. With interviews set up in the research stage with Ford coaches, it is acknowledged that the data specialists supporting the R&A teams mainly belong to the Global Data, Insights and Analytics (GDIA) department. Therefore, these two departments are the most relevant stakeholders to this project(Figure 1.3).

To achieve an in-depth investigation in the creative activities of R&A teams, the craftsman project team was chosen for two reasons: Frist, this project team can collect data from connected devices and intend to apply data in their design session. Then, the R&A team aims to develop innovative product solutions and identify the potential of applying data in design solutions. It is worth mentioning that the study of Gorkovenko et al. (2020) also identified that data-driven design would be particularly beneficial for companies with a service business model where they remotely support customers.

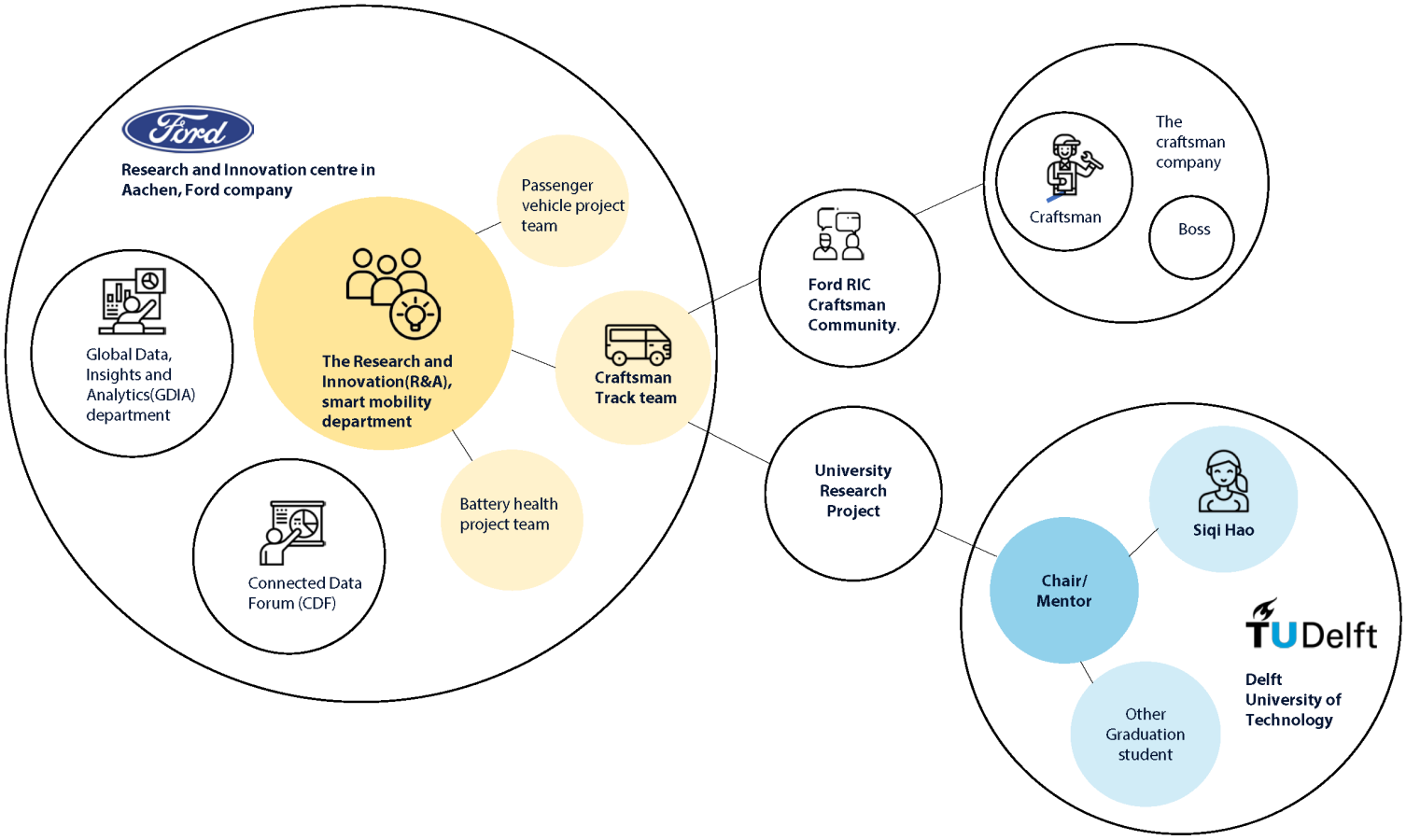


Figure 1.3, a stakeholder map of this project.

To sum up, all stakeholders are identified as shown in Figure X, and a detailed description of each stakeholder summarised from the previous study (Hnatiuk, 2016; De Jong, 2020; Jansen, 2021) and interviews is included as follows.

The Ford Research and Innovation Centre in Aachen
The Research and Innovation Center in Aachen (Germany)is the only Ford R&A department outside of Detroit. The R&A centre in Europe does research and development work for Ford Europe and also the global organisation.

The Research and Innovation (R&A) department
As part of Research and Advanced Engineering in Europe, a department is formed around smart mobility. The R&A smart mobility department consists of multiple tracks that focus on different projects and target groups. This is the department that this thesis mainly focuses on and, therefore, can be regarded as the target group.

The Global Data and Information (GDIA) department
The GDIA department offers a wide range of data analytic services inside Ford, supporting the project teams to develop connectivity and mobility solutions. The data specialists from this department are usually approached by requests from R&A project teams for data analysis but will not directly participate in any projects.

The Connected Data Forum (CDF)
This is a newly launched forum by representatives from other departments, mostly data specialists. It aims to support everyone to get the right data for individual use cases in different stages, including usage analysis, decision making, etc.

The Craftsman track (C.T.) team
This R&A team aims to develop products and services that support craftsmen. They currently work closely with their craftsman community to gain user insights.

The Craftsman community
This group consists of craftsmen with various types of vehicles (not only Fords) and various specific professions: plumbers, painters, etc. in the area of Aachen. The craftsman can have various specialisations depending on the boss's needs.

The University research projects(URP)
The URP is initiated from the Ford Aachen & TU Delft research collaboration, where the Ford R&A team described "Data enabled design" as an opportunity for further research into data usage in their design process. The main goal of these research projects has been formulated as: Use data in the very early process of design thinking to better understand the user. Then, use data in the creative process to generate new ideas/service opportunities based on data.

The Chair & Mentor
The Chair of this project- Milene Gonçalves is an assistant professor of Creativity in Product and Service Design at the Faculty of Industrial Design Engineering. Her research interests are creativity, visual thinking, design process and cognition, inspiration, strategic design, framing and reflection. She is also responsible for the university research project, works closely with the R&A team in Ford and coaches several graduation students working on the data-enabled design related projects from URP. The Mentor of this project- Jacky Bourgeois is an assistant professor of Data-Centric Design at the Faculty of Industrial Design Engineering. He develops tools and methods for Responsible Data-Centric Design.

Siqi Hao (Me)
I take ownership of this project and am the author of this thesis. First, I am passionate about the creativity involved in the design process, which motivates me to explore the methodology and techniques for enhancing creativity. Besides, I would love to explore the potential of quantitative data, which is a new material for the ideation process since it is mainly used for evaluation. With this project, I aim to gain more in-depth knowledge and know-how about the practical application of the Data-enabled design methodology in the mobility industry context.

1.3 Research question

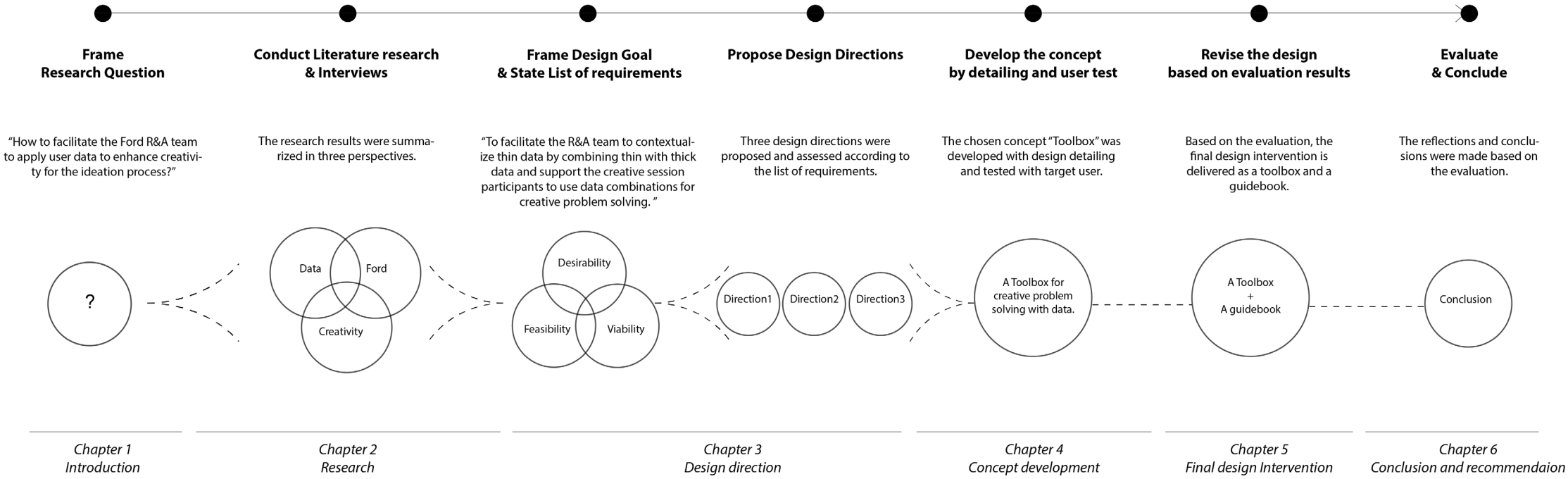
As explained in the project background, the sensor data is currently only used in the evaluation stage for product development. However, the sensor data has more potentials for product development, very prominently are the potentials to contribute to product and service innovation in the early development stage, which can be seen from existing studies and design practice on data-enabled design, such as the design projects collaborated with Philips by van Kollenburg and Bogers (2019). Therefore, the Ford R&A team wants to apply sensor data to support their product development in the early design phases. However, there are still challenges for Ford's practice:

The large amount and complexity of data make it hard for the Ford R&A team to understand data, nevertheless apply data in the design process for product innovation. Moreover, even though the data-enabled design process model proposed by van Kollenburg and Bogers (2019) offers much practice for incorporating data into the design process. For Ford, the data collection and research process can be more complex since more sensors inside and outside the vehicle are involved, considering their data availability and organisational settings. Without context-specific approaches, methods, and tools, Ford designers can feel unguided when working with data before and during ideation.

To sum up, this graduation project explores how quantitative data from sensors can be applied to enhance creativity in the ideation stage for Ford's service/product innovation. And my initial research question is framed as:

How to facilitate the Ford R&A team to apply data to enhance creativity in their ideation process?

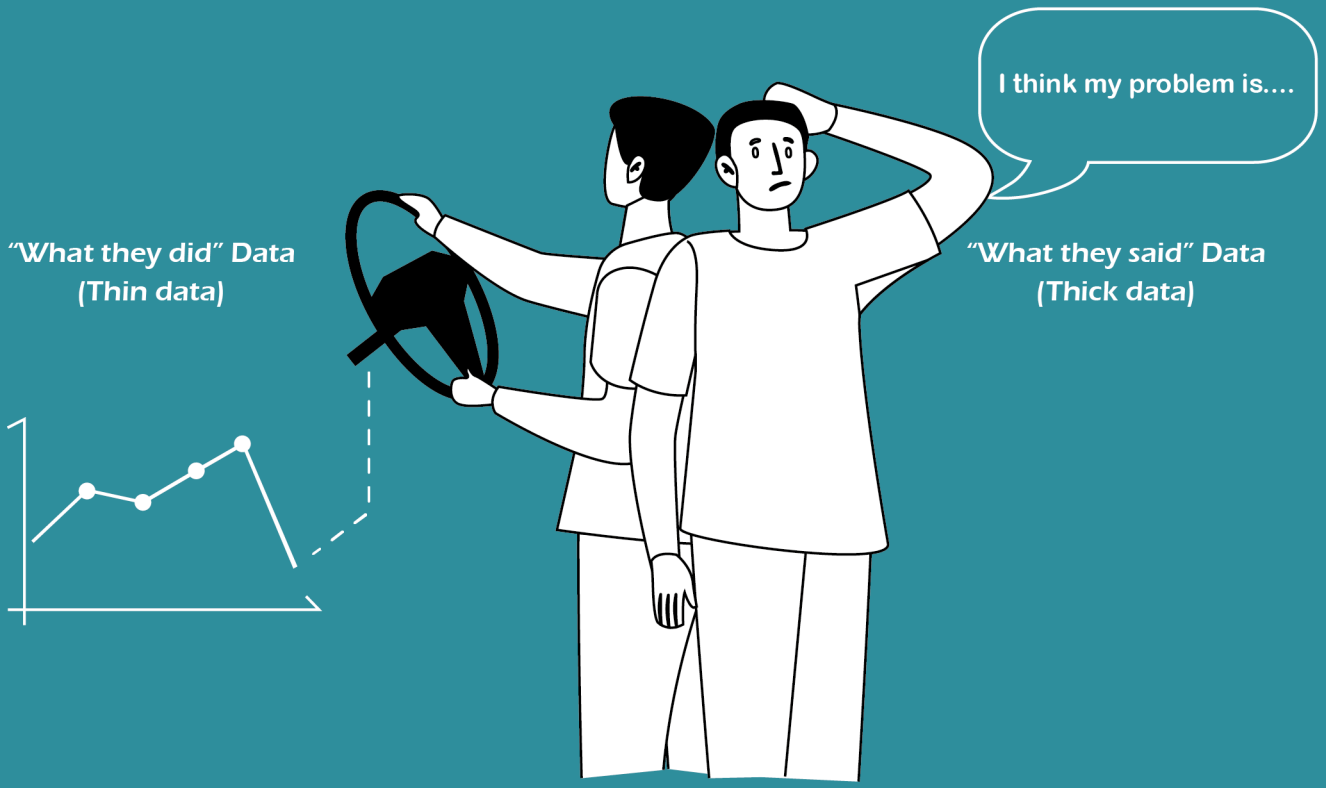
1.4 Approach



As shown in the roadmap, I started by framing the research questions based on the project brief from Ford. Then, the method interview was first applied to understand the availability, challenge and visions of the Ford R&A team on data-enabled design. To learn from existing studies and practices for data-enabled design, I conducted a literature review on the relevant literature.

With the research results from interviews and literature review, I framed the design goal together with interaction vision and a list of requirements to express the vision for my design intervention, which were also used to communicate with the main stakeholder- the Ford R&A team to get feedback and iterate. During the design stage, I conducted design detailing and two rounds of evaluations to get sufficient explorations and iterations on the solutions to reach the design goal.

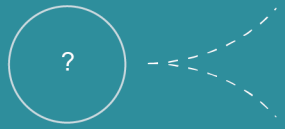
In the end, I concluded based on the evaluation of the final design intervention and gave recommendations for further exploration, making the contribution and limitations of this project explicit.



Chapter 2
Research

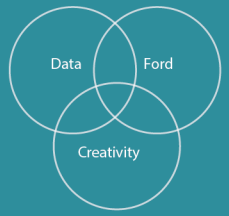
Frame Research Question

"How to facilitate the Ford R&A team to apply user data to enhance creativity for the ideation process?"



Conduct Literature research & Interviews

The research results were summarized in three perspectives.



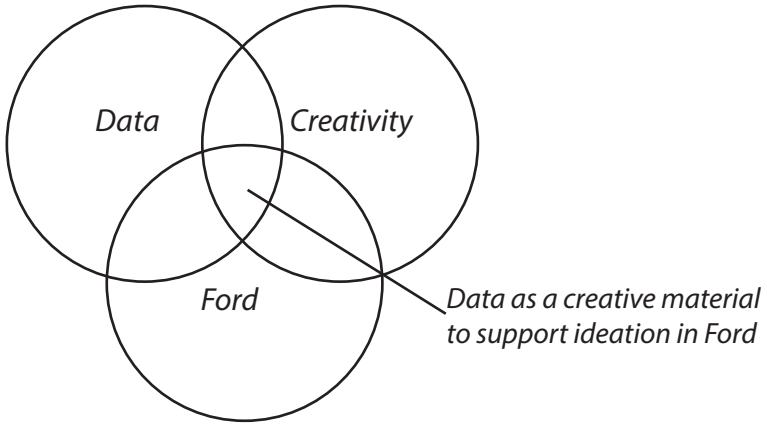
2.1 Research set-up

Research questions

As mentioned before, the initial research question is:

How to facilitate the Ford R&A team to apply data to enhance creativity in their ideation process?

With some disassembling, it can be seen that the keywords in this question represent different fields as creativity, user, data, Ford, etc., which need more in-depth research to give a concrete definition and identify influence factors, etc. Therefore, it was decided that the research of this graduate project should start from the different fields and the intersection of them to dissect this research question from different perspectives and explore possible answers. Three perspectives have been identified that cover the main themes in this project, and for each perspective, sub research questions are formulated to guide the research.



In the following chapters, the research result is sorted into different themes with sub-titles to answer these questions.

Ford perspective

- How do the R&A teams approach and apply data in Ford?
- What are the challenges and visions of Ford on data application?
- How do the R&A teams conduct ideation for product development in Ford?
- What are the challenges and visions of R&A teams on their ideation session?

Data perspective

- What are the definitions of different types of data?
- What are the limitations and availability for data usage of Ford's R&A teams?
- How can data be used for product development?
- What are the approaches to collect and contextualise data to support the data-enabled design process from existing practice?
- How can the target **user group*** of Ford be involved in the data-enabled design process?
- What are the benefits and pitfalls of the user group's involvement? How to avoid pitfalls?

Creativity perspective

- What is the definition of creativity in design?
- How to improve the problem framing and inspiration process?
- What are the existing methods or tools to facilitate creative thinking skills?
- How can data contribute to creativity in design?
- How to evaluate creativity?

User group*: the user group being researched with different methods, such as interviews, observation, sensor data collection etc. Such research can generate both qualitative and quantitative data.

Method

First, to understand the availability, challenge and visions of the Ford R&A team on data-enabled design, it is essential to understand Ford's organisation and their workflow from their employees in different departments. Since there was no existing information on this summarised before my project, a semi-structured interview method was chosen to enable the respondent to give detailed answers to the questions customised according to his/her expertise and profession.

Afterwards, to learn from existing research and design practice, the method Literature review was first chosen to investigate sub research questions from the data, creativity and user perspective. The findings are summarised in the following chapter, "Literature review".

2.2 Interview with Ford

Since there was no literature summary of relevant information on Ford's workflow with data and ideation, I organised semi-structured interviews to obtain information to understand employees' experience, concerns, and expectations from different departments based on their practices in Ford. During such interviews, each interviewee can give detailed answers and personal opinions according to his/her expertise and experience, making the result

Two sets of interview questions (Appendix A) for the interviewees from R&A teams and Data related departments (Figure 2.1) were designed to be open and flexible with the interviewees' responses. Afterwards, eight semi-structured interviews were arranged with interviewees from two sides-the R&A project teams and Data analysis departments. A list of the interviewees is included here.

The interviews were conducted together with fellow students from the Ford data-enabled design community. During the interviews, all students asked questions in turns to make it efficient for both the students and Ford side.

Afterwards, I conducted an analysis on the statements from all the interviews on Miro (Appendix B), where quotes and interpretations were first added to come up with insight cards, and then insights cards were labelled with themes. Finally, I summarised all findings in the following sub-chapter, "Ford perspective".

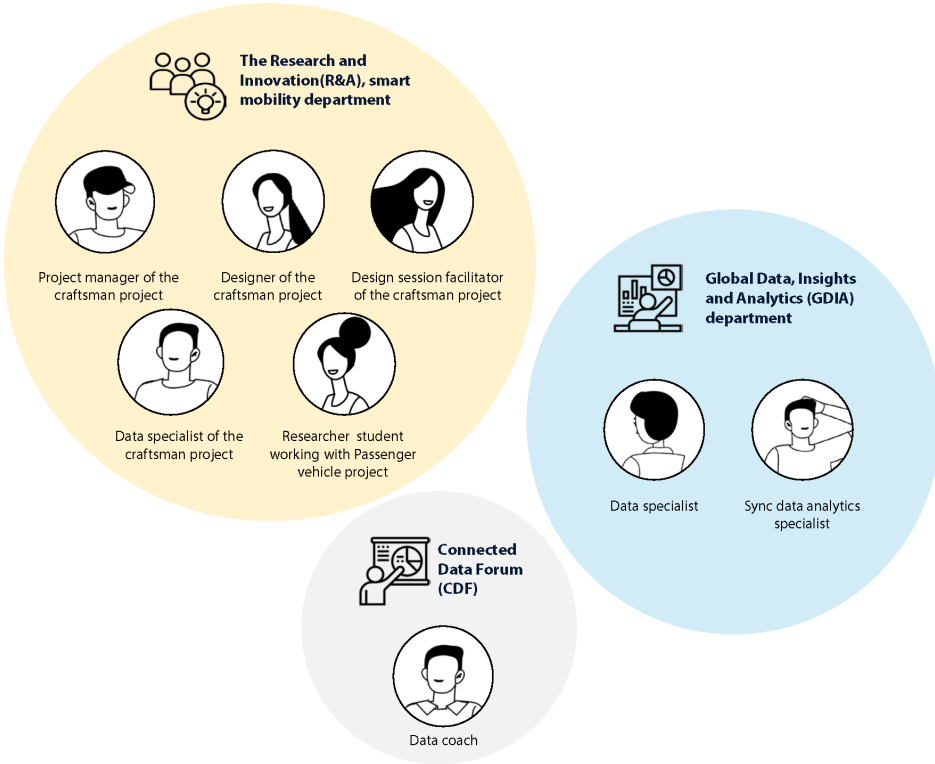


Figure 2.1, the interviewees from R&A team, GDIA and CDF.

Ford perspective

How do the R&A teams approach and apply data in Ford?

The R&A teams currently request quantitative data from data specialists working in GDIA and conducted user research themselves for qualitative data. As shown in Figure 2.2, the data specialists in Ford see different R&A teams as their clients, trying to process data according to their requests, where the R&A teams can explain what data they want and what outcome they want. The data specialists apply various software to process and visualize the data based on the request. Then there are mainly three types of outcomes delivered to R&A teams. The most basic one is an excel file containing structured data, where the receiver can easily find a specific item such as "speed of the car". Another way to presenting the result is to put graphs of the data and some distinguished insights on the slides. Moreover, the most time and cost consuming one is the QlikView dashboard that includes all the available parameters and enables the user to set the X/Y axis for a data graph. The Qlikview dashboard is highly interactive and can be customized to present the available parameters and export desired graphs. However, the Ford employees need to get training and a licence to operate Qlikview.

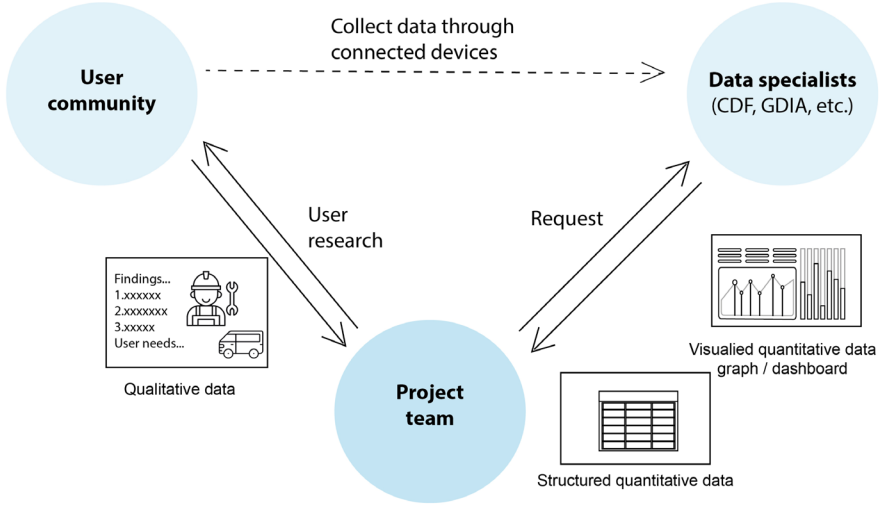


Figure 2.2, the current data collection of the R&A team.

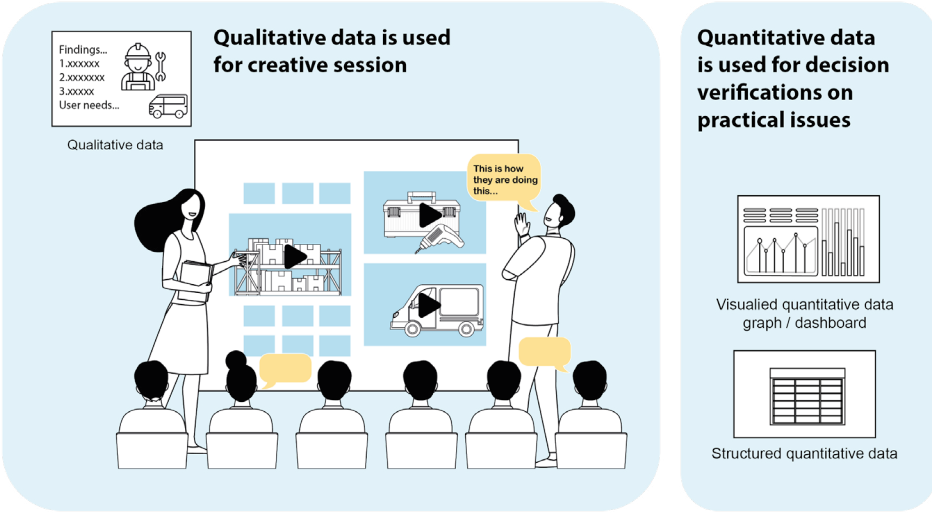


Figure 2.3, the application of data in Ford.

After the data is collected and processed by researchers and data specialists, the R&A team usually apply them separately in their practice (Figure 2.3). Currently, the R&A teams mainly use quantitative data for verifying decisions and avoiding bias (calibrating the qualitative data they have). Moreover, with qualitative data, the R&A project manager usually initiates creative sessions with employees from other departments who have the required expertise for their projects.

What are the challenges and visions of Ford on data-enabled design?

Challenge 1: There are no straightforward questions for requesting data and no clear approach to applying data since the outcome is not clear to both the R&A team and the data specialists. This challenge is also identified by Jansen (2021) as the mismatch between two perspectives of abductive and deductive thinking. On one side, they want first to know what data to get, and on the other side, they want first to know what could be the outcome from the data. Therefore, there is no clear questions and approach of applying data since the R&A team find it hard to envision the outcome from data application.

" We need to have the right question to have at the end the right action. (From a GDIA

data specialist on their collaboration with the R&A team)

Challenge 2: There is limited data available from the project team. It is considered time and effort consuming to collect data because they have to overcome several problems: know what they want to collect, agreement from the company, set up devices, convince users etc.

"I just want to say that it would be possible to create more data, but they're not coming from nowhere. That's a huge amount of effort to collect data." (From a Ford R&A Project manager on data collection in Ford)

Challenge 3: Considering the regulations on user data privacy in Ford, it is not allowed to trace back to the person who generated the data, making it harder for the R&A team to understand the context of the collected data.

Visions for data application in Ford
The R&A teams envision that they can interact with data and get user behaviours insights from data, then they can use those insights to develop innovative product/ service.

“The passenger vehicle project team wants to use data to understand user's behaviour and experience. Furthermore, they have the vision to identify unmet user needs from data as a base for new feature development.” (From the student researcher on the vision of her researched R&A team’ data application vision)

Th vision above is also affirmed by the data coach from CDF, who stated that a wide range of project teams envision applying data in the product development phase. Besides, they also envision enriching the data with the knowledge about customers and expecting more design practices with data.

"Using Data from vehicles is a key element of our plan to success. Therefore Jim Farley (current CEO of Ford) requests everybody within Ford to utilise connected vehicle data, which means any engineer, designer, or economic at Ford should use those data." (From a CDF data coach on data visions of Ford)

How do the R&A teams conduct ideation for product development in Ford?

According to the interviews with members from two R&A teams- the Craftsman project team and the Passenger vehicle project team, the project manager usually initiates continuous sessions to gather insights from research and then ideate for service/product solutions. The insights/ideas from the previous session can be used as input for subsequent ones. **A design session's goal can be to gain insights into the target user and ideate new ideas for the design solution based on the qualitative data they have collected from past user research.**

There are three roles in a session, the problem owner, the facilitator and the participants:

The creative session participants
There are usually 8-10 participants in a creative session. They are Ford employees with different knowledge backgrounds, including engineering (mostly), management, design, data analysis, etc. They are usually invited by the R&A team manager to participate in the session. However, most of them are not trained in design thinking and are more used to deductive and critical thinking.

The creative session facilitator
There is usually one dedicated facilitator assigned by the project manager about the goal of the session. He/she is usually trained with design thinking and can set up the session process and activities.

The creative session problem owner (R&A project manager)
She/he is usually trained with management knowledge and can request data, other resources, or employees from different departments and initiate a session.

Moreover, the current materials used in a session are mostly visuals, including photos and videos taken from field research on the user community and online sources related to the user group or existing product/service. In summary, most materials are highly related to the problem domain. Furthermore, according to the one session participants, the videos are usually delivered with some pre-defined messages, while the images leave many questions open when they are not explained by the providers. Based on the insights from the statement analysis on R&A team members, I visualized the "creative session scenario“ in figure 2.4.

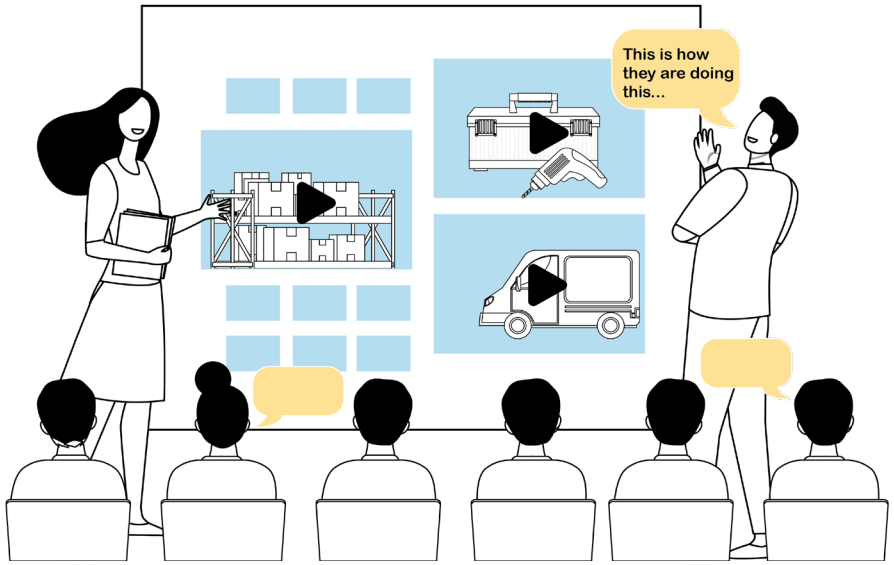


Figure 2.4, the author's visualization of the creative session in Ford.

To sum up, the creative session is Ford's regular approach to conduct ideation for product development, therefore I consider it as the potential approach for the Ford R&A team to interact with quantitative data and apply data for ideation.

What are the challenges and visions of R&A teams on their ideation session?

According to the facilitator and participants of such creative sessions, one most significant challenge for the facilitator is to deal with critical discussion on the steps/ creative activities from participants, especially those without training on design thinking(Figure 2.5).

"The audience of the participants tends to question all the steps you propose. So, it's not a team that you can set up a schedule, and they will follow, you know, they will question every step." (From a Ford design session facilitator's answer on challenges in the current design session)

Regarding the visions for the creative session, the project manager mentioned that it is vital to have people in a creative and engaging mindset, and participants should find the creative session enjoyable and valuable for themselves. Then, it is essential that the participants can generate new insights or ideas/concepts, depending on the particular goal of the session.

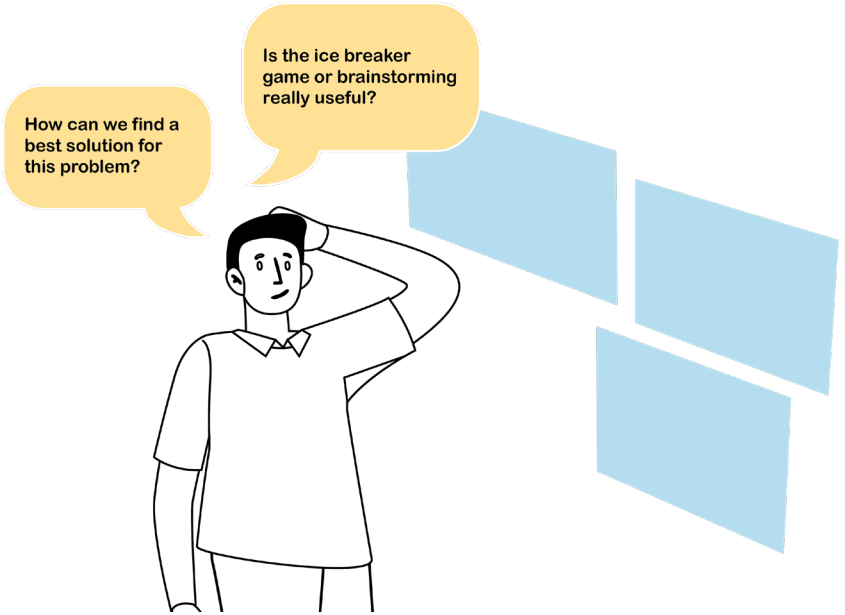


Figure 2.5, the author's visualization of a creative session participant who is lack of creative thinking.

Conclusion on Ford perspective

In this chapter, eight interviews were conducted to understand the current design practice with data in Ford. First, the relevant departments and teams were identified to support the data-enabled design, then their detailed workflows, challenges and visions for data application and ideation were summarized together with quotes from interviewees. The main insights from this chapter are as follows.

1. As shown in the right visualization of the Ford workflow with data(Figure 2.6), quantitative and qualitative data are handled separately by R&A team members and data specialists, and quantitative data is not yet used for Ford's early stage of product development since they don't know the possible outcome from data analysis and the approach to apply data.
2. The R&A project members usually approach data specialists to get raw data or visualised data graphs by sending a request. They mainly use data to verify decisions and avoid bias (calibrating the qualitative data they have).
3. The data applicattion vision of the R&A team is that they can interact with data to generate insights on user behaviour and then use these insights for product/service development.
4. The creative session is Ford's regular approach to conduct ideation for product development, therefore I consider it as the potential approach for the Ford R&A team to interact with data and apply data for ideation.
5. Current ideation for product development is done chiefly with qualitative data-user research data from interviews and observations. One crucial challenge in the current creative session is that the critical thinking mindset of the participants is likely to hinder the creative activities.

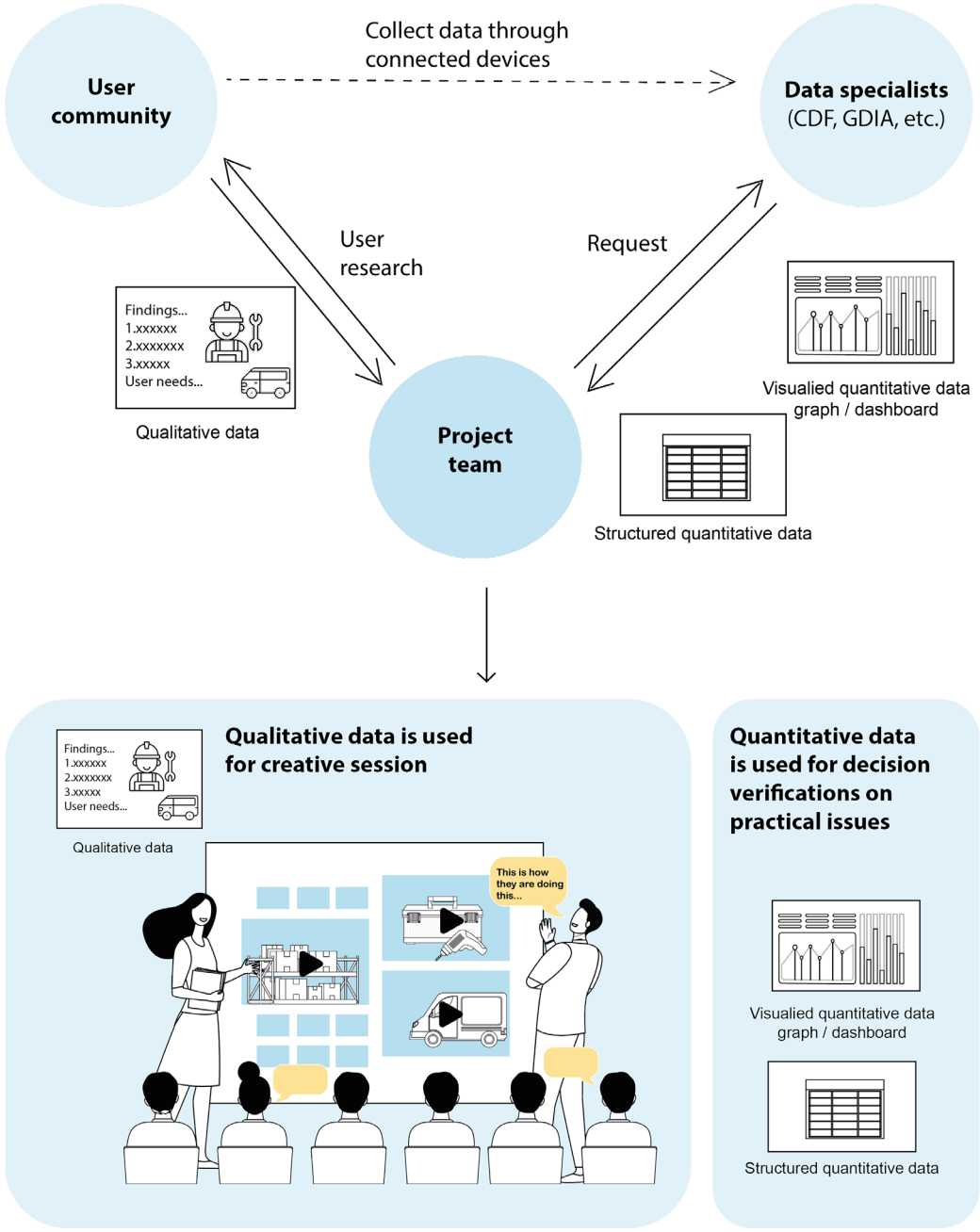


Figure 2.6, the author's visualization of the data collection and application in Ford.

2.3 Literature research

As shown in figure 2.7, I summarized the keywords for the Ford perspective with the insights from previous interviews. However, to gain a more comprehensive understanding of all three aspects of data-enabled design in Ford, more review is needed for all the relevant literature to "Data" and "Creativity". Therefore, the keywords generated from the other two perspectives were used for searching relevant literature. The main findings are summarised in the following sub-chapters "Data perspective" and "Creativity perspective".

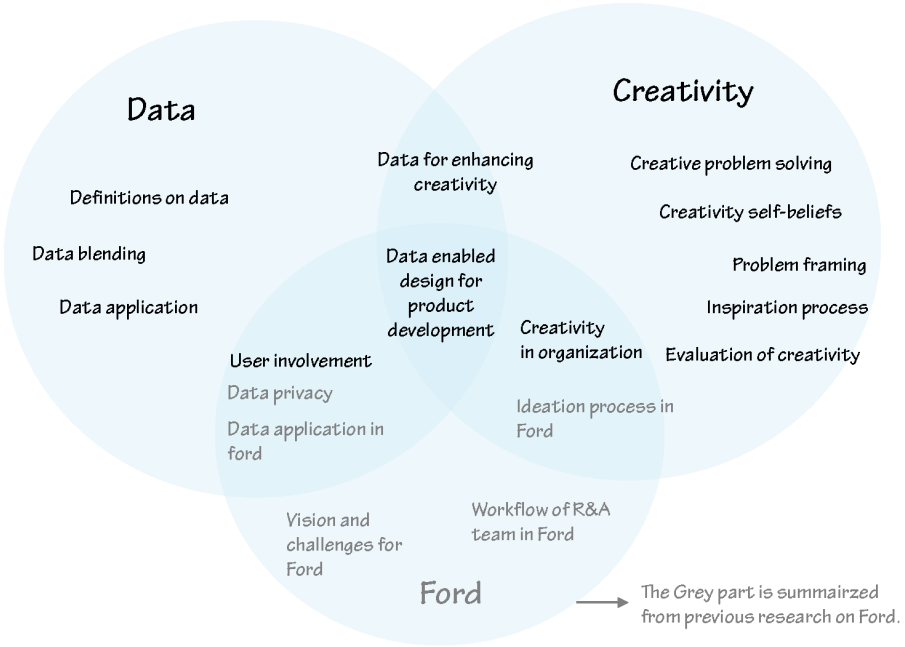


Figure 2.7, the keywords from three perspectives and their intersections.

Data perspective

What are the definitions of different types of user data?

A review on the use of data in the design process shows the development of the type of data (Big/ thick/thin/small), the used analytics (technique) and the aimed value of the researchers. Bornakke & Due (2018) distinguished big-small and thick-thin data in their model (Figure 2.8): The two yellow areas in, respectively, the extensive–thin and thick–small define the data sources that their blending methodology has been developed from and where the complementarity is strongest. Besides, social media data (text), big thick data, and big data sets from sensors (like in ethno-mining: GPS, time codes etc.) referred to big thin data. Small thick data are from observations/ interviews, and small thin data are from sensors used in a small sample size. (Descriptive analytics).

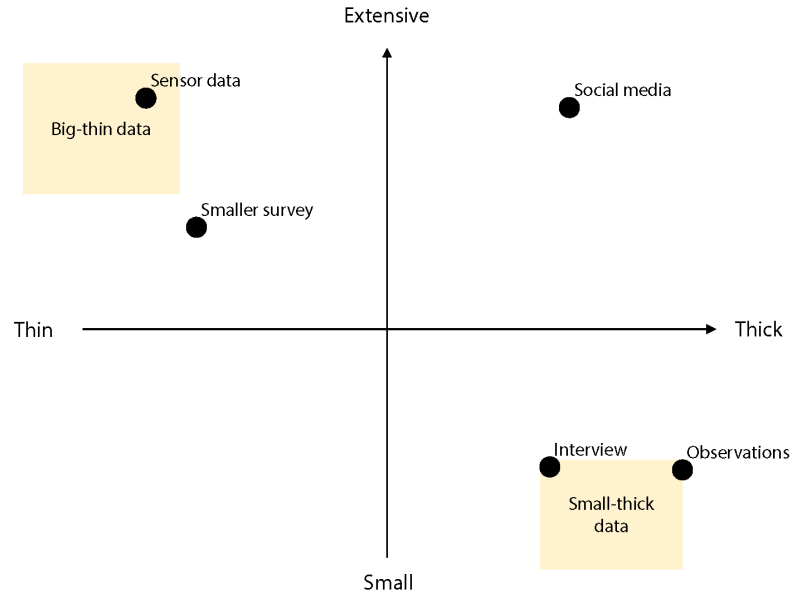


Figure 2.8, the two dimensions for defining data from Bornakke & Due (2018)

What are the limitations and availability for data usage of Ford's R&A teams?

As mentioned in the introduction, there is a graduation project regarding data selection strategy for Ford, in which Jansen (2021) conducted Interviews and workshops mainly with the Craftsman project team to understand their challenge and visions of data application in the early product development stage for service innovation.

According to the research on the data availability and preference in Jansen's study (2021), he summarised two valuable approaches for service design and not linked to one specific problem or use case. The first uses open and social media data early in the service design process to (re)frame complex open problems. (Kun, 2019) The second uses behavioural data to develop personalised and context-dependent services where in an iterative process, in-situ data is gathered to understand the value the service should deliver. (Kollenburg & Bogers, 2019; Gorkovenko, 2020; Pannunzio et al., 2020). However, according to Jansen (2021), the general view in Ford was that this did not fit the capabilities of Ford's research institute as they are more used to using sensors and sensor data. Therefore, considering the features of different data and Ford's vision on data application, two types of data will be used to contribute to the creative session in Ford as shown in figure 2.9.

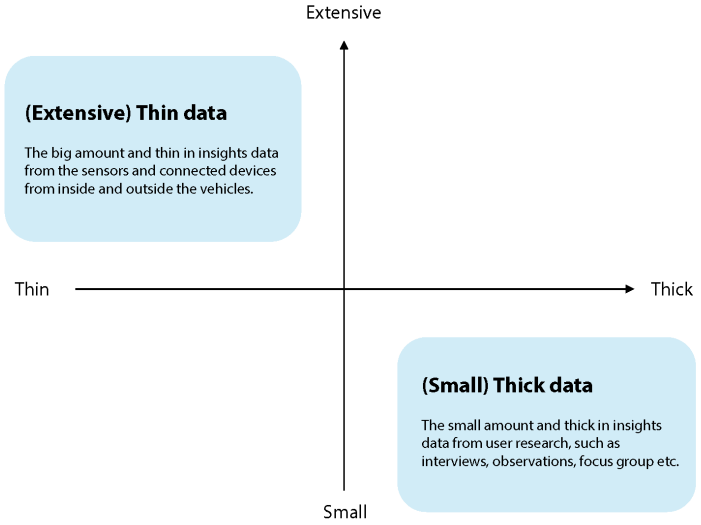


Figure 2.9, the thin and thick data chosen as this project's focus according to Ford's availabiliy and preference.

Now that the available data was identified for Ford, it is still unknown how data can be used for product development instead of only for testing or verification.

How can data be used for product development?

Although that data has a great potential for design teams to understand user behaviour and develop products, there are common pitfalls that could severely hinder data's application for product development. First and most prominently, thin data is uncontextualized and has a powerful potential to be used for optimisation and predictive maintenance (Gorkovenko et al.,2020). Then, designers may maintain data so complex that they lose understanding of their meaning and im¬plications. Besides, Correll (2019) believes that by visualising the end product of data analysis alone "but not the process by which it was created, we risk propagating false, misleading, or unreproducible findings". Conversely, data visualisation with too much extraneous detail increases their complexity and weakens their rhetorical impact.

To avoid the pitfalls and use data for product innovation instead of optimization, it is emphasised that thin data should be contextualized so that the design team can understand the user behaviour behind the data (Gorkovenko et al.,2020).

Then, it is also important to make sure that designers are not overloaded with info or visualization to well understand the meaning of data. Moreover, it was stated that data-driven design tools should show designers raw data along¬side amalgamations and inferences to reduce misinterpretation or bias. (Gorkovenko et al.,2020)

What are the approaches to collect and contextualise data to support the data-enabled design process?

Data collection and data contextualisation were investigated by reviewing the existing data-enabled design study and practice. The following research insights first described the specific methods for collecting data and the strategies for contextualising data. Then, I summarized three approaches from by reviewing existing study and theories. In the end, I visualised the three approach by adding examples from Ford's context, thus enabling readers and stakeholders to understand the potential workflows for the data-enabled design implementation in Ford.

From a macro perspective, there are three approaches proposed(Figure 2.10) by Creswell and Clark (2017) to collect qualitative and quantitative data and combine findings, and it depends on the purpose of the study to choose the approach.

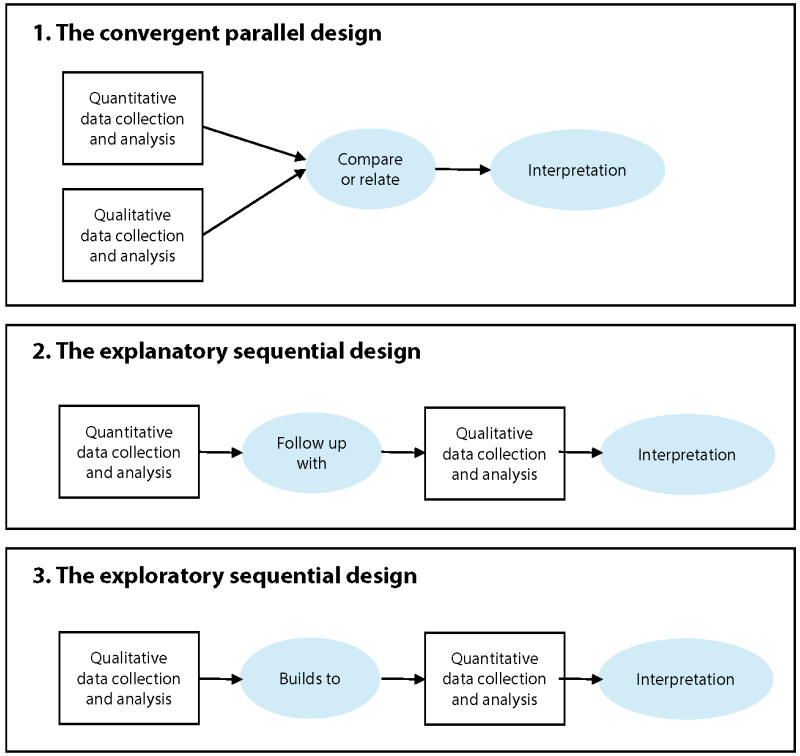


Figure 2.10, three workflows proposed by Creswell and Clark (2017)

Similar to the "convergent parallel design" approach from Creswell and Clark (2017), Bornakke and Due (2018) also separately collected big data from tracking movement in the recorded video and thick data from observations, shadowing, contextual inquiries, interviews, etc. They proposed four strategies(Figure 2.11) to blend the complementary findings from the two types of data because of the shared generic space. They summarized that it is essential to identify the affordance of big data and thick data, link big-and-thick insights through shared behavioural traits (generic space) and then project them into a blended space with emergent properties.

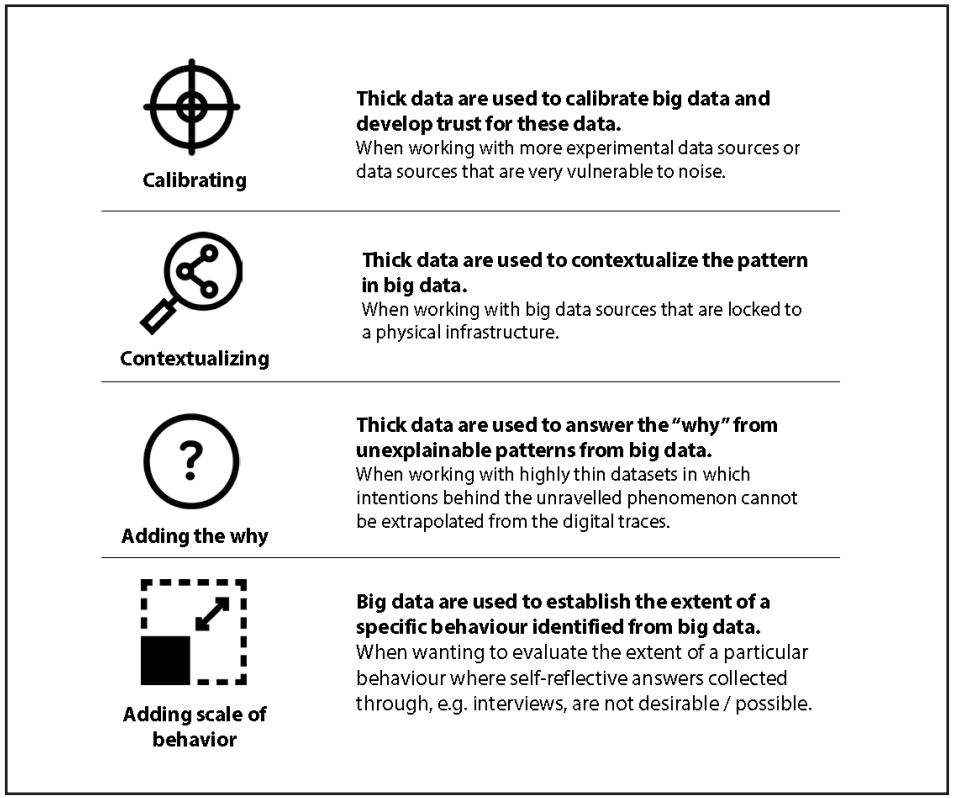


Figure 2.11, data blending strategies from Bornakke and Due (2018)

I identified their approach on data as shown in figure 2.12, where the researchers first collect the thick and big data separately from the same generic space and then apply the four strategies to blend two types of data to get complementary findings in the end. Their approach corresponds with the "convergent sequential design" proposed by Creswell and Clark(2017).

Different from the study from Bornakke and Due (2018), the Data-enabled design practice from van Kollenburg and Bogers (2019) conducted their study from the collection of sensor data, They practised two sensor data collection method: The open collection method enable the user to define what is relevant and what data to collect. It could still be used as input for personalisation by the user. In contrast, the closed collection method requires the researchers to decide what data to collect and set up sensors. The consequence of this closed approach to data collection is that the boundaries of the solution's scope are clear. Afterwards, they applied interviews and live discussions with the user to contextualize the thin data. It can be concluded from their study (van Kollenburg and Bogers, 2019) that the contextualising of thin data requires the collection of qualitative data, which needs the user's involvement. They applied interviews and real-time experience-sampling approaches via mobile app (Vastenburg & Herrera, 2010). It is worth noticing that in both cases, the thin data should be visualised to be readable for the user and the real-time experience-sampling approaches require real-time access to the data collected from the sensor.

A similar approach can be found in the social science area; the study by Smets and Lievens (2018) proposed a toolbox that use a frame to combine thick and big data for human sensemaking. This toolbox proposed the approach for researchers to collect objective, big

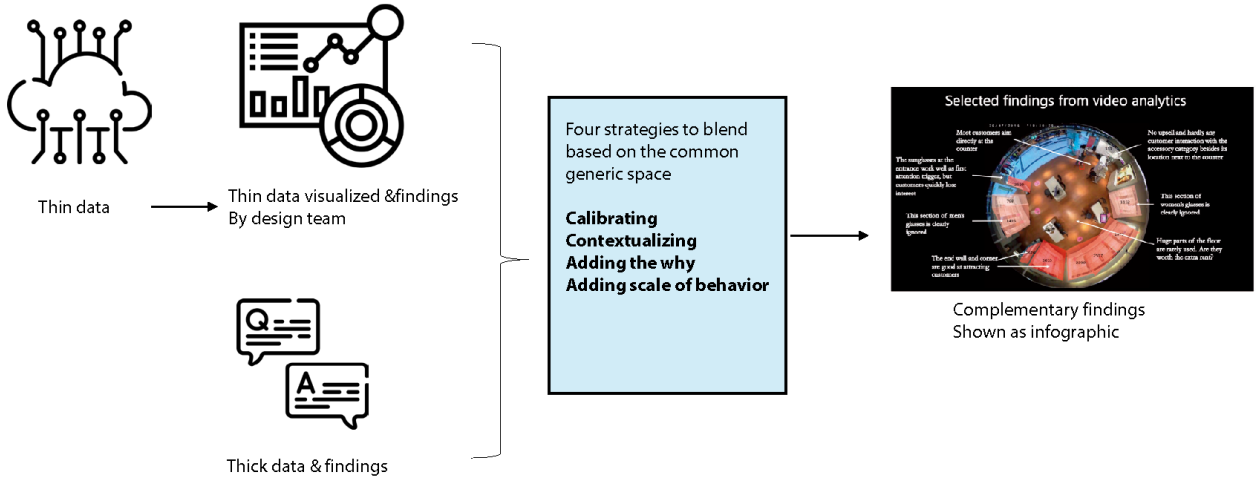


Figure 2.12, **convergent approach** summarised by the author from the study on Bornakke and Due's data blending studies(2018).

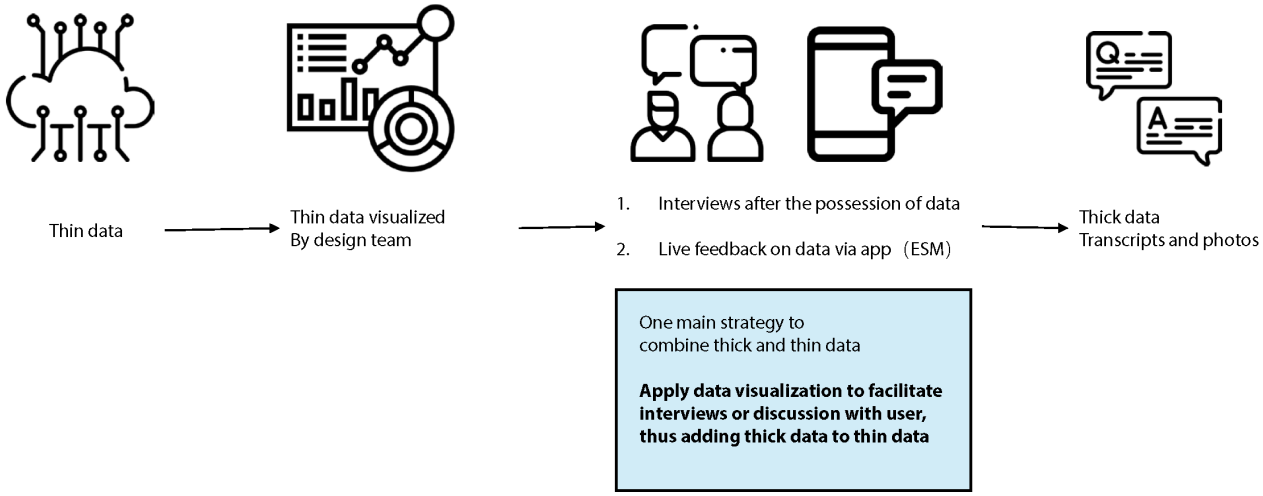


Figure 2.13, **explanatory approach** summarised by the author from the data-enabled design study from van Kollenburg and Bogers (2019) and Smets and Lievens (2018)

data and then use it to interact with the end-users to make sense of this data by enriching it with thick data. The sensemaking strategies here coincides with the contextualising method from the practice of van Kollenburg and Bogers (2019).

I summarized the data-enabled design study from van Kollenburg and Bogers (2019) as the approach shown in Figure 2.13, where the researchers first collect thin data, then arrange interviews or participatory discussion with their researched user, thus adding thick data to the previously collected thin data. This approach corresponds with the "explanatory sequential design" proposed by Creswell and Clark(2017).

Even though the above summarised the primary approach of van Kollenburg and Borger's study(2019) that fits with explanatory sequential design, the 8-shaped model they proposed (Figure 1.1) is not a linear process but includes iterations and multiple rounds of data collection. In some periods of their projects, they analysed the thick data collected and then further improved the prototype based on the insights to collect more sensor data to verify previous insights or answer questions raised from sensor data. **Therefore, I believe that this approach can also be summarised as an independent approach, starting from collecting thick data, then collecting complementary thin data, and finally combining two types of data to generate insights. This approach(Figure 2.14) corresponds with the "exploratory sequential design" proposed by Creswell and Clark(2017).**

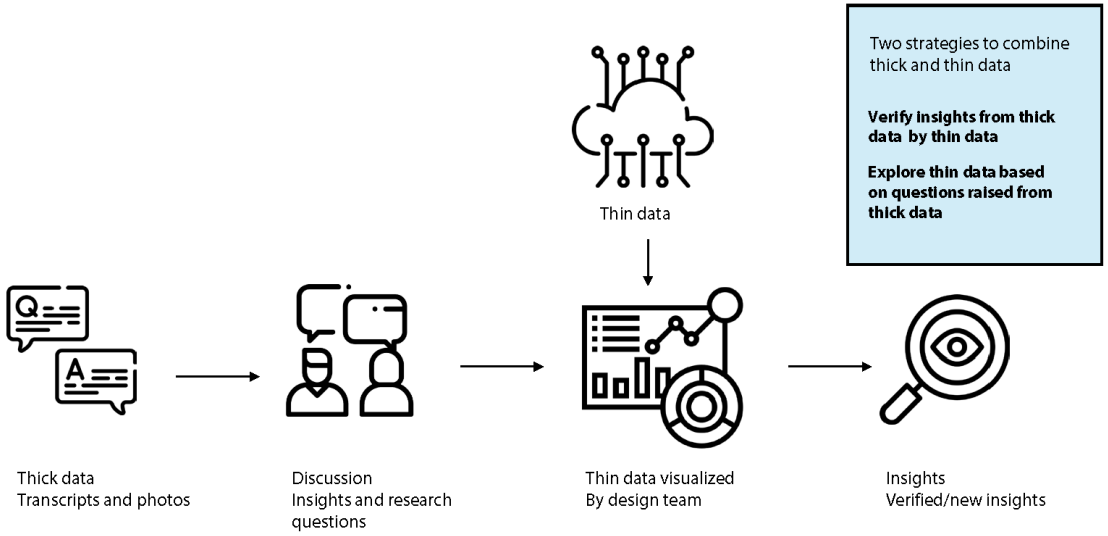


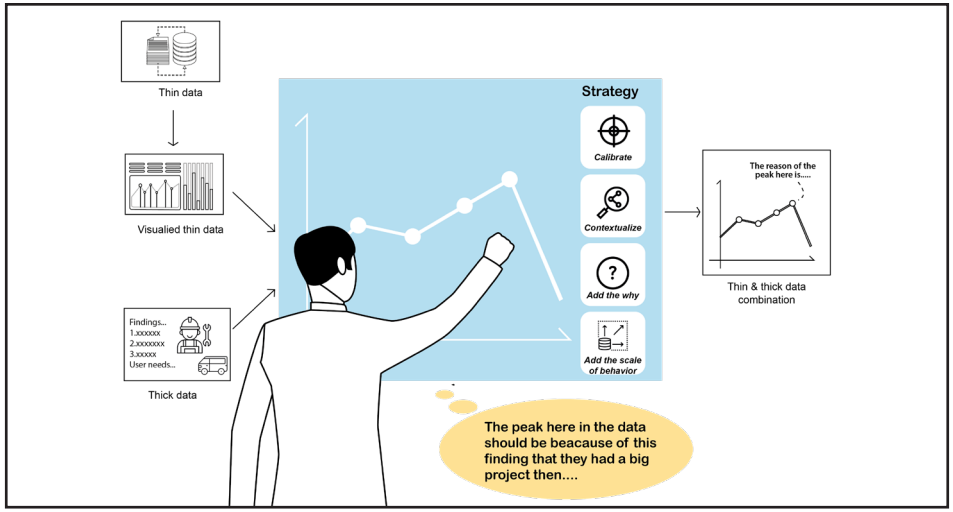
Figure 2.14, **exploratory approach** summarize by the author from the study on van Kollenburg and Borger's data-enabled design practice (2019).

Visualized potential approaches for Ford

The literature review above presents the existing theories and practices on combining thick data and thin data in the design and social science area. To propose the three approaches for Ford R&A Team, I reviewed the insights on Ford's current data application summarised in the last chapter and visualised the approaches with examples faked to be similar to data from their current projects. Since it was not settled down who will be conducting the data collection and processing work, here I named the person who conducts this work as "the researcher".

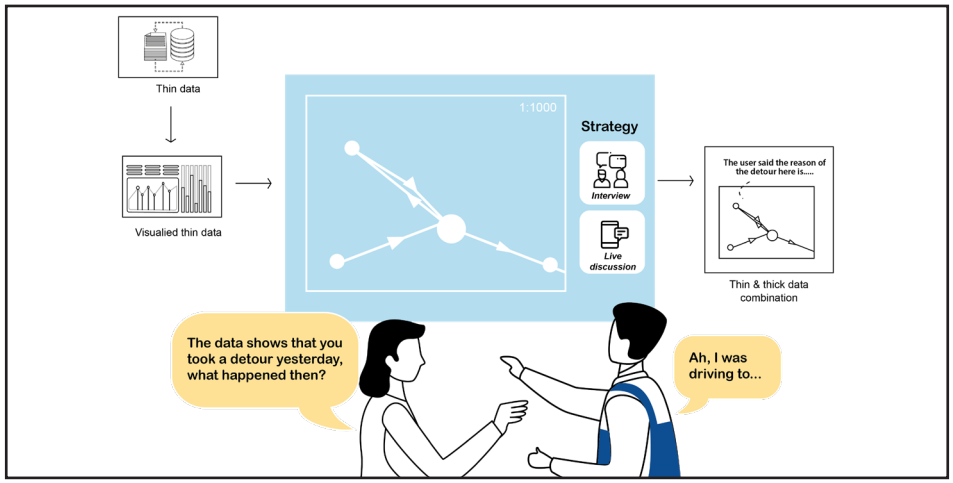
The convergent approach

when two types of data are generated from the same context and offer complimentary insights, the researcher can apply the four data blending strategies: calibrating, contextualising, adding the why, and adding the scale of the behaviour from Bornakke and Due (2018), thus combining the insights from two types of data and generate new insights.



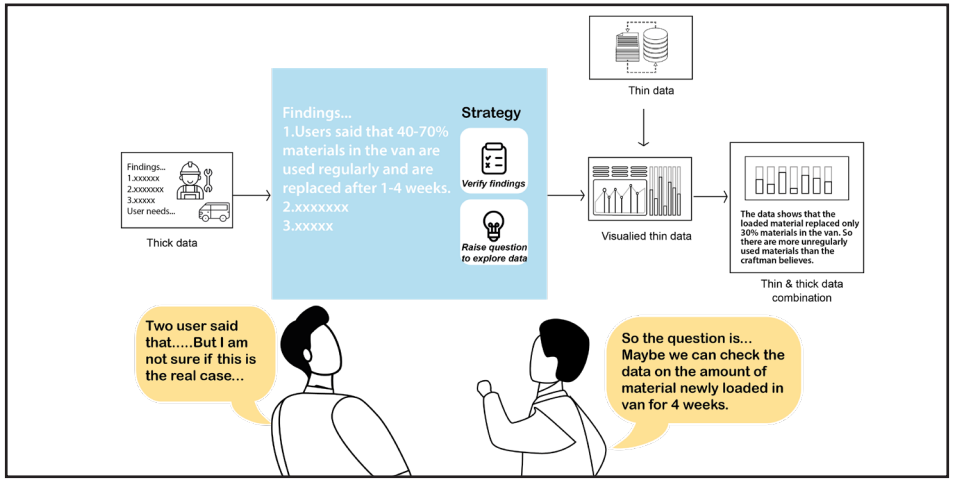
The explanatory approach

The researcher can first collect and review the visualised thin data to raise questions and propose what complimentary thick data are needed to answer these questions. The research methods for complimentary thick data include interviews, live discussion, and user participation in the design session. After obtaining complementary thick data, the researcher can apply the four strategies of data blending to combine two types of data and generate insights.



The exploratory approach

The researcher first reflects on the thick data from user research, then decide whether to verify the thick data or raise questions from the thick data. With such review on thick data, the researcher can then request the needed complementary thin data and its visualisations from the data specialists. After obtaining complementary thin data, the researcher can apply the four strategies of data blending to combine two types of data and generate insights.



With the three approaches summarised before, the R&A team can connect the two types of data and get the outcome- thick and thin data combination. Concluding from previous studies on data blending practice (Bornakke & Due, 2018) and data-enabled design practice (van Kollenburg and Bogers, 2019), a basic representation of a data combination is text and data in graphs and charts, and the analysis on data combination can lead to various insights with following features:

- Most insights generated are about use cases, user experiences and behaviours that can potentially inspire new design directions (van Kollenburg and Bogers, 2019)
- The insights generated are highly related to the problem domain since both the thin and thick data are from the same generic place. (Bornakke & Due, 2018)
- Some insights are about the value of the provided data for the user, since that some data visualisations can potentially be part of the design solution to provide information for the user. (van Kollenburg and Bogers, 2019)

User involvement is necessary from the previous review on the data-enabled design practice since it is crucial to contextualise data and understand user behaviour. Therefore, the specific methods to involve the user to contextualize data should be reviewed. So, the following research question is phrased as:

How can the target user group of the design team be involved in the data-enabled design process?

Summarised from the theory and practice of previous studies (van Kollenburg and Bogers, 2019; Bornakke & Due, 2018), Interviews with the user, live discussions with the user via mobile devices are two main approaches for user involvement. In addition, I believe that participatory design methods can also actively engage users in the design process, where the users express their views and problems through discussions with designers and directly contribute to understanding the context of the problem(Hosseini, 2019).

To sum up, Interviews with the user, live discussion with the user, and user's participation in design sessions are three main strategies for involving the user in the data-enabled design process. To support such discussion, it is concluded from design practice (van Kollenburg and Bogers, 2019) that visualised data should be presented during the discussion and then used to raise questions to initiate a discussion.

What are the benefits and pitfalls of the user group's involvement? How to avoid pitfalls?

It was concluded that communication with the user could significantly contribute to product development, especially for companies with a service business model remotely supporting customers (Gorkovenko et al., 2020). However, the pitfalls were also highlighted by the experts from Gorkovenko et al. (2020) that industry might seek to make more desirable products through gathering vast amounts of data about their customers through their products, and such approach can disempower users by reducing pri¬vacy, manipulate behaviours, and limit informed consent. Therefore, it is essential to avoid these adverse effects, thus bringing value to all stakeholders, including customers. Recommendations are summarised from the study of Gorkovenko et al. (2020) for involving users in the data-enabled design process as well as reduce adverse effects from ethical issues on users.

- Users should be provided with negotiated consent and reasonable burden during participatory research and later usage.
- Users should be informed about the policy for data privacy, feeling the whole process transparent for them.
- Users can be motivated to share their data when they are aware of the benefits of the service.

Conclusion on Data perspective

In this chapter, to understand how to apply data in design for product development, I first reviewed the current definitions to distinguish different types of data, then reviewed Ford's availability and limitation in data from existing literature. Then, it was concluded that it is essential to contextualize data by combining thick data with thin data to use data for product/ service innovation. Afterwards, the approach, methods and strategies from existing studies were summarized into potential approaches for combining thick and thin data in Ford. In the end, another emergent perspective was identified as user involvement, which is believed to be crucial for the data combination process. Therefore, the specific methods and strategies for involving the user group to support data contextualization were reviewed. The main insights from this chapter are as follows.

1. The model from Bornakke and Due (2018) helps me to understand the data universe by the two dimensions, thin/thick–extensive/small.
2. According to the research of Jansen (2021), the sensor data (thin data) fits in well with the interests and capability of Ford. At the same time, they prefer not to apply social media data in their product development process. Therefore, the (small) thick data and (Extensive) thin data are identified as the focus of this project.
3. To avoid the pitfalls of applying data only for optimisation in design, there are strategies summarised to enable data application for innovation, and the key is to contextualise data and its interpretation (Gorkovenko et al.,2020).
4. There are four existing data blending strategies for the convergent approach to combine thick and thin data from the study of Bornakke and Due (2018). Besides, I concluded two other approaches- the explanatory approach and the exploratory approach-by reviewing other data-enabled design projects.
5. There are three methods summarized for user involvement to support data combination: interviews with the user, live discussion with the user, and user's participation in design sessions.
6. One major challenge for data-enabled design in Ford is that they have limited capacity in collecting data and can not trace back to the user who generated the data due to privacy issues. The approaches should therefore be adjusted based on Ford's limitation in the later design intervention.
7. The prominent strategies for motivating users' involvement are making the process transparent and showing them the benefits of future services/products (Gorkovenko et al., 2020).

Creativity perspective

What is the definition of creativity in design?

As defined in the "handbook of creativity" (Brown, 1989), Creativity consists of at least four components: (1) the creative process, (2) the creative product, (3) the creative person, and (4) the creative situation (MacKinnon, 1970). It has been studied from different theoretical perspectives, each with its definitions, assumptions and methodologies.

However, in design practice, it is widely believed that creativity is related to divergent thinking, opening up the solution space, coming up with multiple solutions (Onarheim and Friis-Olivarius, 2013), and convergent narrowing down the solution space, converging multiple ideas into an appropriate solution. As defined by the Buffalo creative problem solving (CPS) model (Parnes, 1967), there are five steps in this process: fact finding, problem finding, idea finding, solution finding and acceptance finding. This model has been practised and adjusted by different designers and researchers, among whom Heijne and van der Meer (2019) had adjusted the model to a five sequential series of diamond-shaped steps based on the European design practice (Figure 2.15).

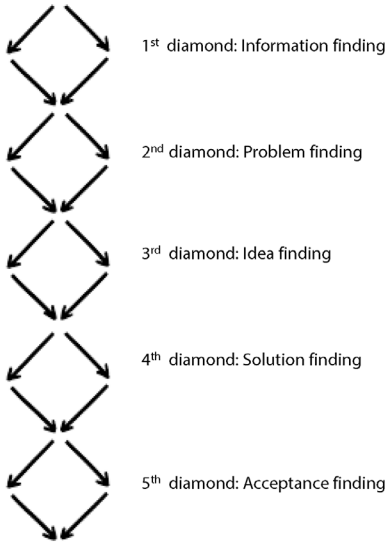


Figure 2.15, the five diamonds of the CPS stages by Heijne and van der Meer (2019)

The two steps of "problem finding" and "idea finding" correspond with the current study on problem framing and the inspiration process, during which people conduct analysis and then generate insights and ideas. Since that Ford envisions to enable their employees to use data to generate user insights and ideas, I believe these two processes are the most relevant process to data application in Ford. Therefore, I decided to explore what the "Problem framing process" and "Inspiration process" are and the existing methods for improving creativity through these processes. So the next research question is framed as:

How to improve the problem framing & inspiration process?

The Problem framing process

'Framing' is a term used within design literature (Schon, 1983) for the creation of a new standpoint from which a problematic situation can be tackled. Dorst (2011) argued that framing in response to paradoxes in the problem situation is a core and a rather special element of design's problem-solving practices. In terms of his logical framework on design reasoning (Figure 2.16, 2.17), a 'frame' is the general implication that by applying a certain working principle, people create a specific value.

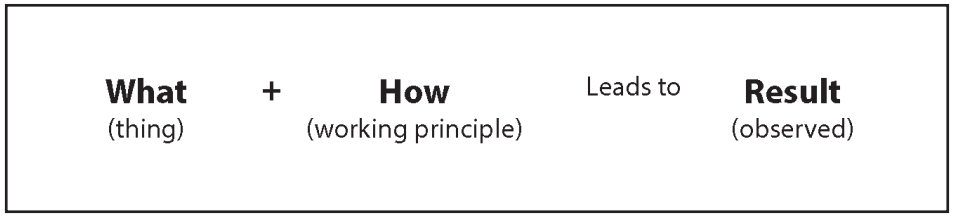


Figure 2.16, basic reasoning (Dorst, 2011)

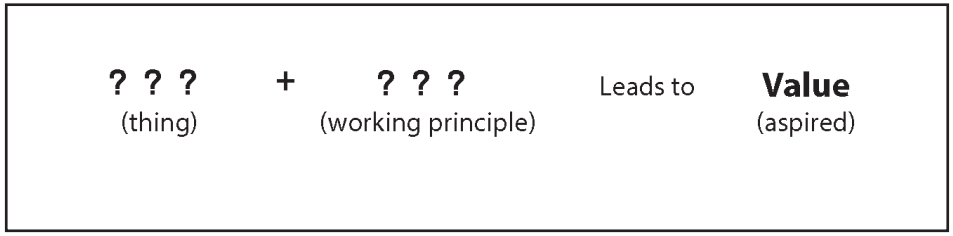


Figure 2.17, design reasoning (Dorst, 2011)

The study on the impact of problem framing by Cardoso, Badke-Schaub and Eris (2016) also concluded that High-level questions (deep reasoning and generative design questions) could facilitate the emergence of inflexion moments during idea generation. Before the inflexion moments, reflection built the basis on which high-level questions were formulated and interpreted as resistance to design fixation.

Regarding the how of problem framing in design practice, the study of Lockton et al. . (2014) explores behavioural heuristics to frame problem-solution pairs (Dorst & Cross, 2001) in terms of simple rules. These act as a 'common language' between insights from user research and design principles and techniques and draw on ideas from human factors, behavioural economics, and decision research. It is concluded that the heuristics derived from empirical user research can help ensure that product users themselves and their understanding of situations are included in the design process, thus contributing to problem framing and solution-finding.

Methods and tools for support problem framing process

Regarding how to use the insights from user research for problem framing, a review was conducted to summarize existing methods, as shown in figure 2.18. One primary category of methods helps the designer to map out known data on experience, stakeholders etc., examples are journey map, empathy map, context mapping, stakeholder mapping etc. The other category is to help designers understand the context by simulating the scenarios or the user group in the scenario. Examples are "a day in the life", persona, scenario, roleplay etc.

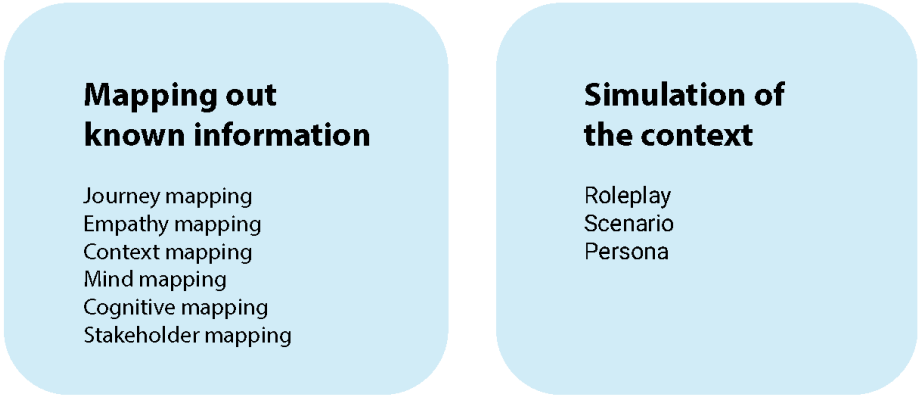


Figure 2.18, two categories of methods for problem framing in design practice.

Next, I select representative methods from the two categories. Considering the vision of the Ford team is to gain insights into user's experience for product development. Two methods, Context mapping and Empathy map, were selected for the Mapping category, for they both focus on gaining a better understanding of user experience.

A context mapping study typically involves a sequence of research steps, including preparation, sensitizing participants, group sessions, analysis and communication, in which information is elicited through generative techniques (Visser et al., 2005). The diagram in figure 2.19 shows the relationships between the various forms of data gathering and their ability to access different types of understanding of the user experience, which shows that the generative techniques in context mapping are located in the lower parts of the triangles and can discover what people know, feel and dream.

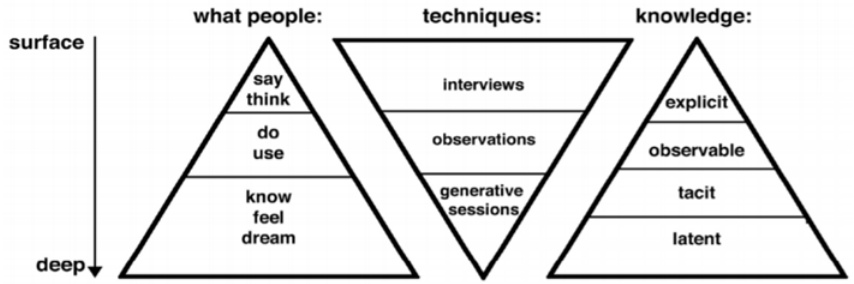


Figure 2.19, the diagram that shows different levels of knowledge about experience are accessed by different techniques from Visser et al.(2005)

Similar to the "say, do and make" in the above diagram (Visser et al., 2005), the empathy map (Figure 2.20) maps out the said, did, felt and thought of the target group, which is widely used in "Design thinking workshops" for it is precise and efficient for the problem framing phase. After analysing insights relevant to the four aspects of data on the empathy map, the next step could be framing the questions, such as encourage the participants to come up with a "How might we...?" question.

Roleplay is a representative prototyping or simulation technique that can help quickly simulate the user experience for a product or service from the target audience. Roleplay can be exhausting and usually restricted to an hour in duration (Hosseini,2009). For support Roleplay, props are usually designed to recreate the scene.

Empathy map

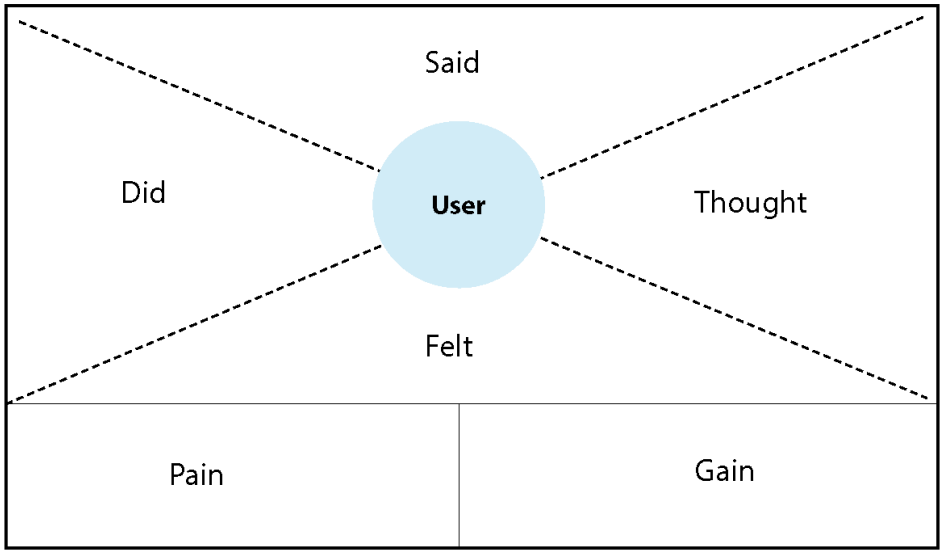


Figure 2.20, the empathy map

Inspiration process

From the study of Gonçalves, Cardoso, and Badke-Schaub (2016), three main stages in the inspiration process are defined as the definition of keyword, the search of stimuli, and the selection of stimuli. Furthermore, it was concluded by Gonçalves, Cardoso, and Badke-Schaub (2016) that it would be helpful for designers to be aware of their stage in the inspiration process. Other findings are that search tools should try to provide stimuli from different levels of semantic distance to the problem domain. Besides, the study on external stimuli by Borgianni and Tomassini (2017) conducted experiments on the impact of common stimuli types- text, objects and images on the inspiration process. It is found that the relatedness with a specific domain can affect its contribution to the inspiration process. Therefore, a balance between specific and general should be considered.

Tools for supporting inspiration process

Bacciotti, Borgianni and Rotini (2016) conducted a review of all the available tools to enhance the ideation process. Examples are Brainstorming and Mind Maps, Patent inspiration tools, Web inspiration tools, Crowdsourcing etc. They listed the current problems within these tools: first, they do not ensure a suitable design space exploration. Then, knowledge is missing regarding the produced workload and the time the presented simulation tools can support in proposing analogies. Besides, the reviewed tools do not fulfil the need to systematically inducing far-field abstract analogies. To deal with these problems, they designed a tool Idee (Figure 2.21), that gives a clear structure of all types of stimuli and showing existing customer requirements, thus easing benchmarking activities. Besides, this tool guides a systematic procedure.

Other studies on the inspiration process focus on generating and presenting different stimuli to the designers. The tool proposed by Han et al. (2018) is based on a simulation of aspects of the human brain in achieving combinational creativity, which could combine familiar ideas for generating new combinational ones as new stimuli. Moreover, Chan et al. (2011) explored the generation of analogies as stimuli for inspiration. They concluded that Far-field and less common analogies could improve the novelty and variability of the ideas generated.

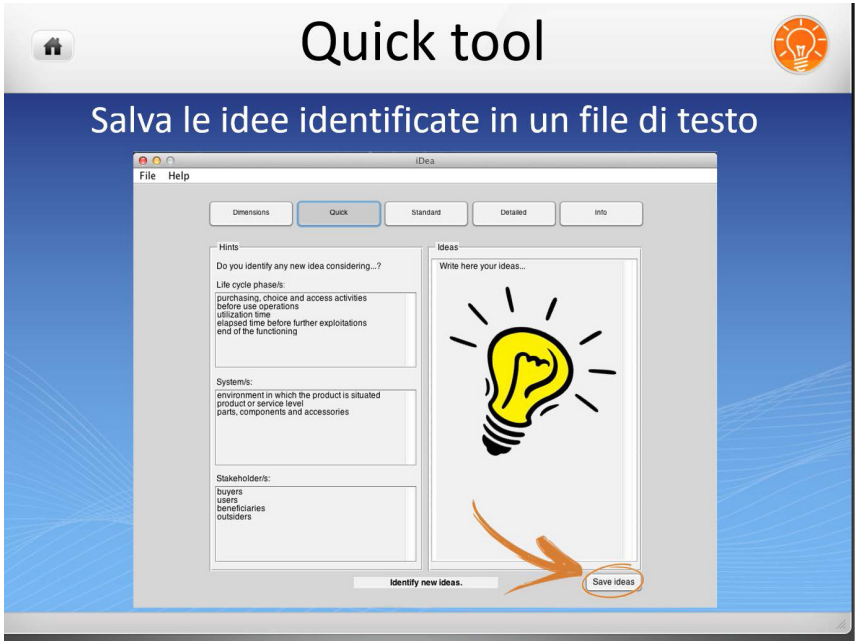


Figure 2.21, the "idee" -tool for enhancing creativity in ideation(Bacciotti, Borgianni, & Rotini, 2016)

So far, the methods and tools for supporting the creative problem-solving process were reviewed. However, the main challenge for the Ford R&A team's ideation session was identified as the lack of design thinking among participants. Therefore, another review on creative thinking was conducted to find methods and techniques to facilitate creative thinking. The research question was phrased as follows:

What are the existing methods or tools to facilitate creative thinking?

Since creative activities often take the form of groups, creative facilitation can be a crucial support. Current insights on creativity facilitation are mainly based on the creative problem solving (CPS) model (Parnes,1967). As introduced by Heijne and van der Meer (2019), diverging is at the heart of CPS, and the core messages of diverging in brainstorming are "postponing judgments" and "quantity breeds quality".

Moreover, existing creative strategies and tools are designed to help participants enter a specific thinking mode and mindset. First, the six thinking hats technique (Figure 2.22) by De Bono (2017) facilitates participants' different thinking modes by asking the participants to pretend to wear different thinking hats during a session, aiming to encourage more orderly thinking and reduce unnecessary debate. Then, Disney's "Dreamer, Realist and Critic" strategy (Elmansy, 2015), inspired by Walt Disney, encourages different thinking by giving the design team three separate roles. Unlike the six thinking hats technique, Disney's strategy offers a particular sequence from the dream, realist to critic, while the six thinking hats can be applied in a random order as long as everybody is in the same thinking mode. In addition, spatial design is added to facilitate the practice of the "Dreamer, Realist and Critic" technique (Figure 2.23), which offer different rooms for each stage and ask the session participants to move from one room to another as they shift thinking mode. The seats and desks in the three rooms are placed accordingly to the goal of the roles.

Another relevant study on creative mindset focuses on the fixed and growth mindset (Dweck, 2006), which pointed out that the growth mindset can help people cultivate their creative ability, and the strategies to cultivate a growth mindset is summarised as rewarding the process and effort, as well as celebrating small wins.

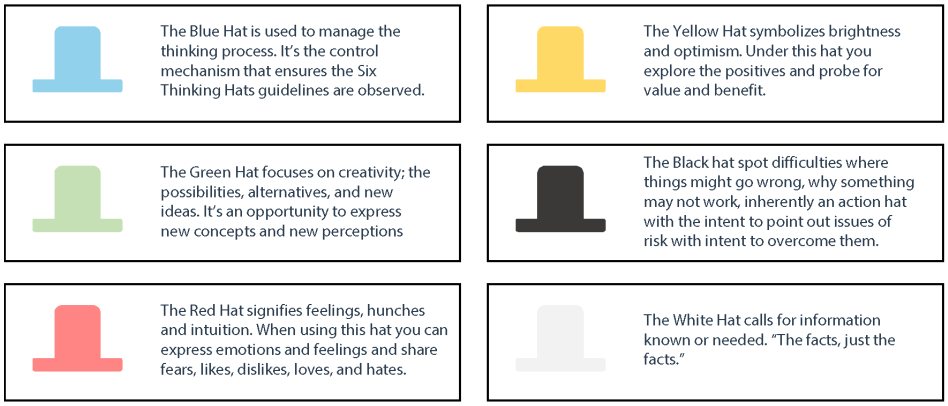


Figure 2.22, the six thinking hat techniques (De Bono, 2017)

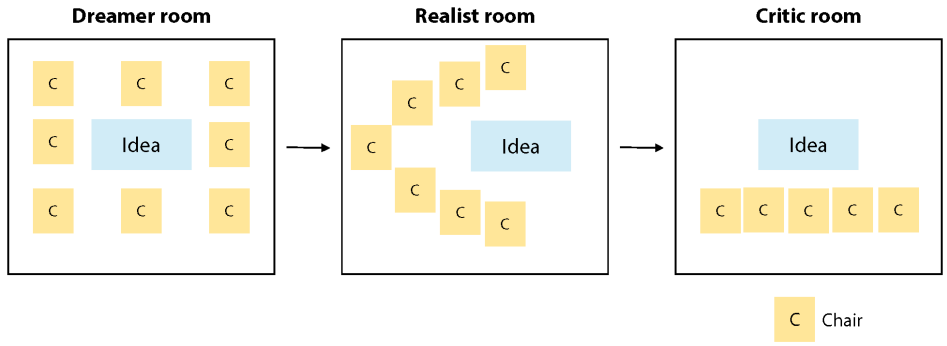


Figure 2.23, the space design in the practice of the "Dreamer, Realist and Critic" technique (Elmansy, 2015)

Other studies on personal creativity (Kaufman & Sternberg, 2010) pointed out that to transform people's creative potential into creative action, they need to have confidence in their ability to act creatively and believe that there is value in doing so. There are different methods and tools from the book "Creative confidence" (Kelly & Kelly, 2018) that are believed to improve creative self-beliefs based on design practice in IDEO. For example, the thirty circles exercise - a creative challenge exercise to jumpstart a session.

Moreover, McFadzean (1998) focused his study of creative thinking exclusively within organisations. He proposed a creativity continuum (Figure 2.24), describing three different types of techniques – paradigm preserving, paradigm-stretching, and paradigm-breaking. It is essential to know which type of technique should be chosen for a particular situation. Besides, It was concluded that paradigm preserving techniques are deemed more comfortable but less innovative, whereas paradigm breaking techniques "Wishful thinking" and "Rich pictures" encourage participants to develop highly novel ideas. They can, however, be uncomfortable to use and should therefore not be utilised by the unwary, which means that stretching and breaking techniques require trust/experience between facilitator and participants.

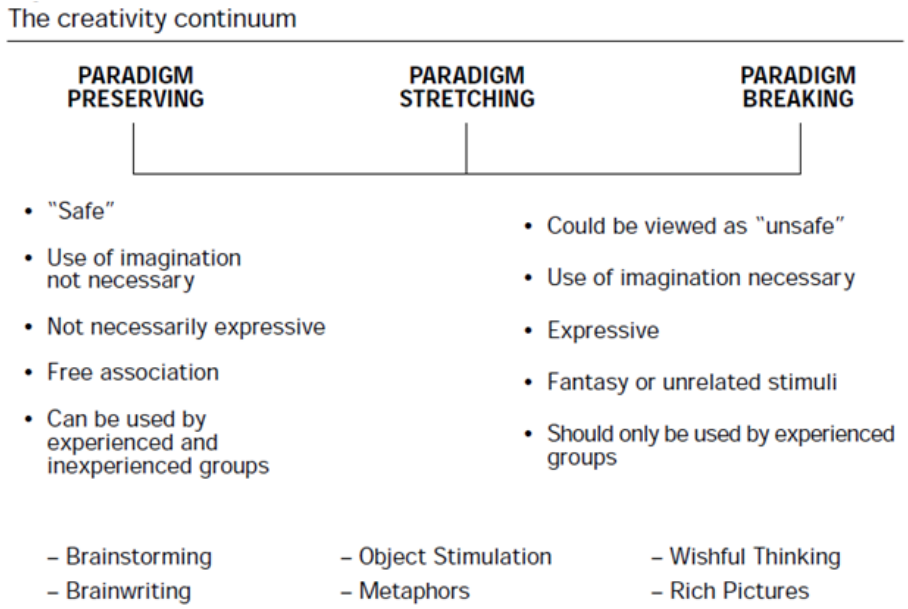


Figure 2.24, the creativity continuum with techniques from McFadzean (1996a).

To sum up, there are existing techniques approaches to facilitate the creative problem solving process and creative thinking of the participants in a session. To move forward from the topics only related to creativity, I wanted to explore the intersection of creativity and data in the next step. Therefore, I framed the following research question as:

How can data contribute to creativity in design?

Existing studies on data's application to enhance creativity mainly focus on the data's contribution to problem framing, defined as data sensemaking.

Data sensemaking is the process of using available data for framing and reframing (Klein and Moon, 2006b). It is normal in practice that designers have large quantities of data from the problem domain, gathered through primary research methods and secondary research methods, but the data itself is inactive and lacking context (Ackoff, 1999). Therefore, The designer needs to extract meaning from the data to generate insights, to inform the design of solutions through abductive reasoning (Kolko, Hoffman and Klein, 2006).

Following the approaches and methods for using data to support creativity are summarized for problem framing.

As mentioned in the "data perspective" chapter, the data-enabled design(van Kollenburg and Bogers, 2019) and data blending practice (Bornakke and Due, 2018) both include such sensemaking process of the data, leading to rich insights on user's experience, the data blending strategies proposed from Bornakke and Due (2018) provide concrete directions for data blending and sensemaking.

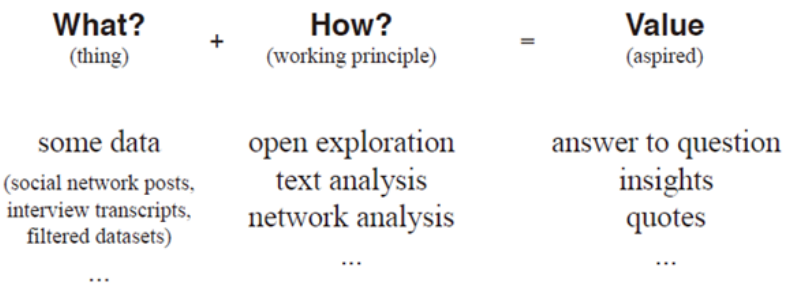


Figure 2.25, the framework for creative work with data from Kun et al.(2019)

Another study on data applied for problem framing from Kun et al.(2019) proposed a framework (Figure 2.25) to structure data work methodologically and coherently into design processes based on the framing model for Dorst (2011). By experiments with case study teams, they concluded that the framework could help designers and other professions use designerly techniques to operationalize data work in the early phase of the design process. The data in their study is the extensive thick data from social media, which is both in an enormous amount and thick in user insights. Even though the difference in the data of their study from this graduation project, I believe this framework is instructive since it summarises the essence of data work in framing theoretically.

Based on this framework, Kun, Mulder and Kortuem (2020) proposed the data inquiry method and tools to support methodical designerly data exploration. The tools include booklets and card sets to introduce the process and present the basic data types and available data analysis techniques.

Moreover, data visualization is also found to be helpful for the data sensemaking process. The study by Dove and Jones (2014) concluded that insights gained from the data could inspire imaginative responses that reflected the participants' broader experiences and that data visualisation can make quantitative data more accessible and engaging to key stakeholder representatives during service design workshops.

Since this project aims to enhance creativity in the product development process by data-enabled design, a big part of evaluating this project's design intervention will be on its impact on creativity. With the following research, I aimed to review the current dimensions and measurable parameters to evaluate creativity in design.

How to evaluate creativity in the product development process?

Creativity can be assessed through different dimensions. From the literature, there are process-based and outcome-based methods to evaluate creativity. (Shah, Vargas-Hernandez and Smith, 2003). Process-based methods can analyze through verbal protocols in the design process using Linkographies, enabling people to look into the reasoning process to get to the concept. (Hidalgo, 2020). Outcome-based methods evaluate the ideas generated through different dimensions:

- Fluency, the number of ideas generated by the designers) (Vasconcelos et al., 2016)
- Conformity, the extent to which the designers incorporate features from the example design (Vasconcelos et al., 2016)
- Flexibility, the proportion of the potential design space explored by the designers (Vasconcelos et al., 2016) (Gonçalves, Cardoso and Badke-Schaub, 2012)
- Originality (Gonçalves, Cardoso and Badke-Schaub, 2012) or novelty (Badke-schaub and Cardoso, 2011)
- Practicality (Goldschmidt and Smolkov, 2006)
- General quality (Goldschmidt and Smolkov, 2006; Chan et al., 2011)

Moreover, creative thinking skills are also considered crucial for design sessions to keep the participants flexible in dealing with the opportunities and challenges(Ritter and Mostert, 2017), which is also recognized in previous research on the Ford R&A team. Divergent thinking is considered at the heart of the creative problem-solving process(Heijne and van der Meer, 2019), which is the capacity to generate multiple alternatives and solutions. Besides, many studies suggest that divergent thinking represents a distinct ability necessary for many forms of creative performance (Bachelor and Michael 1997; Mumford et al. 1998; Plucker and Renzulli 1999). One of the frequently used and well-validated divergent thinking tests is the Alternative

Uses task (AUT, Guilford 1967). During the AUT, the participants are asked to list as many different uses for an ordinary object as possible and to make sure that the ideas they come up with are not too common and not wholly impossible(Ritter and Mostert, 2017).

To sum up, there are dimensions and test methods mainly from the three aspects to evaluate creativity: outcome-based evaluation, process-based evaluation and creative thinking evaluation. However, the evaluation methods for this project still need to be proposed according to the design goal and other requirements from this project.

Conclusion on Creativity perspective

To understand how data can contribute to creativity in design, I first reviewed the definitions of creativity in design and the Creative problem-solving model to understand creativity in design. Then, I summarized the existing methods and techniques to improve the creative problem-solving process. Besides, since the main challenge for the Ford R&A team's ideation session was identified as the lack of design thinking among participants, I conducted another review on creative thinking to find methods and techniques to cultivate creative thinking. Moreover, I reviewed the intersection between data and creativity, which shows that the current study focuses on data's contribution to problem framing.

In the end, I reviewed the evaluation methods for creativity since the goal of the design intervention of this thesis is to enhance creativity. Therefore, the design intervention should be evaluated on its impact on creativity in the later phase. The main insights from this chapter are as follows.

1. The CPS model from Heijne and van der Meer (2019) can support my understanding of creativity in design, within which the problem framing and the inspiration process, are most related to the Ford's vision on data application.
2. The methods "Empathy map" and "Context mapping" for enhancing problem framing in user experience design both map out the data related to "say", "do", "feel" etc., of the user to gain a better understanding of the user experience.
3. The existing techniques and tools for facilitating creative thinking should be taken for reference for the design intervention.
4. Existing studies on the data applied to enhance creativity mainly focus on the data's contribution to problem framing, defined as data sensemaking. The data inquiry framework and tools from Kun, Mulder and Kortuem (2020) offers a methodical designerly way for exploration on extensive thick data from social media.
5. There are dimensions and test methods mainly from the three aspects to evaluate creativity: outcome-based evaluation, process-based evaluation and creative thinking evaluation.

2.4 Research conclusion

The research result from the three perspectives is summarized here to answer the sub research questions briefly as a conclusion.

Ford perspective

How do the R&A teams approach and apply data in Ford?
Currently, thick and thin data are handled separately by project team members and data specialists in Ford and are not yet combined for Ford's early stage of product development. The R&A team collect qualitative data themselves through interviews, observations etc., while the data specialists have access to sensor data from the vehicle. The R&A team can request a specific visualized data graph or data dashboard from data specialists, while the data specialists do not directly participate in the projects.

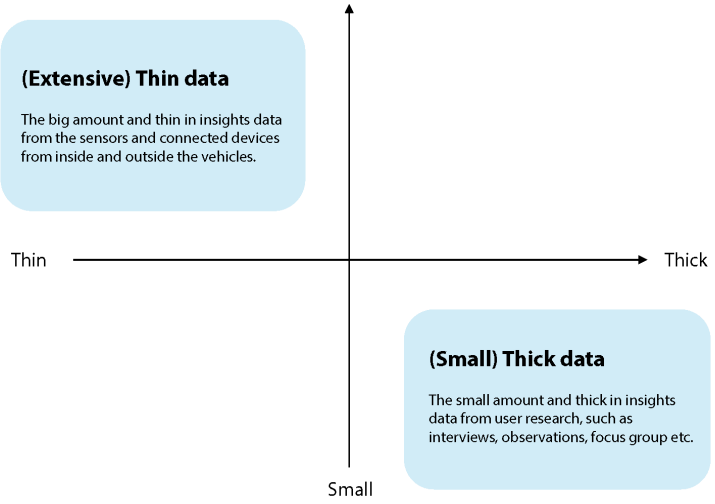
What are the challenges and visions of Ford on data application?
One major challenge for data-enabled design in Ford is that they have limited capacity in collecting data and can not trace back to the user who generated the data due to privacy issues. The approaches should therefore be adjusted based on Ford's limitation in the later design intervention. However, it is Ford's vision to apply more thin data to generate user insights for product development.

How do the R&A teams conduct ideation for product development in Ford?
This is chiefly done by creative sessions with 8-12 participants in Ford. The project manager usually initiates continuous sessions to gather insights from research and then ideate for service/product solutions, during which the participants work with the qualitative data the R&A team collected from user research. The participants invited to the session can be from various departments with different expertise.

What are the challenges and visions of R&A teams on their ideation session?
The most prominent challenge for the R&A team is the critical mindset and lack of creative thinking skills of the participants in current design sessions. The vision for the ideation session is to have people in a creative and engaging mindset, and participants should find it enjoyable and valuable for themselves.

Data perspective

What are the limitations and availability for data usage of Ford's R&A teams?
Considering the features of different data and Ford's vision on data application, two types of data will be used to contribute to the creative session in Ford according to the R&A team's availability for data usage.



How can data be used for product development?
For applying the thin data for product development, it is essential to contextualise the data and its interpretation(Gorkovenko et al.,2020) by combining thick data with thin data before the ideation work, which requires user involvement, such as interviews or participation in the design session.

What are the approaches to collect and contextualise data to support the data-enabled design process from existing practice?
There are three approaches summarized by the author: convergent approach, explanatory approach, exploratory approach, by which the R&A team can contextualize thin data and get the outcome- thick and thin data combination.

How can the target user group of Ford be involved in the data-enabled design process?
Interviews with the user, live discussion with the user, and user's participation in

design sessions are three main strategies for involving the user in the data-enabled design process.

What are the benefits and pitfalls of the user group's involvement? How to avoid pitfalls?
User involvement in data-enabled design can disempower users by reducing pri¬vacy, manipulate behaviours, and limit informed consent (Gorkovenko et al.,2020). The prominent strategies for motivating users' involvement are making the process transparent and showing them the benefits of future services/products.

Creativity perspective

What is the definition of creativity in design?
In design practice, it is widely believed that creativity is related to divergent thinking, opening up the solution space, coming up with multiple solutions (Onarheim and Friis-Olivarius, 2013), and convergent narrowing down the solution space, converging multiple ideas into an appropriate solution.

How to improve the problem framing and inspiration process?
For problem framing, the methods are divided into two categories: one primary category of methods helps the designer map out known data on experience, stakeholders etc., examples are journey map, empathy map, context mapping, stakeholder mapping etc. The other category is to help designers understand the context by simulating the scenarios or the user group in the scenario. Examples are scenarios, roleplay etc. Among them, the method "Empathy map" for enhancing problem framing in user experience design maps out the data related to what the user "said", "did", "felt", etc., to gain a better understanding of the user experience. The "what the user said" corresponds to the thick data from interviews, and "what the user did" corresponds to the thin data from sensors in Ford's context (Figure 2.26).

For the inspiration process, the primary methods are summarized as 1) make designers aware of the inspiration stage they are at by a well-organized framework (Cardoso, & Badke-Schaub, 2016). 2) generate analogies as stimuli for inspiration (Chan et al., 2011). 3) Provide provide stimuli from different levels of sematic distance to the problem domain(Gonçalves, Cardoso, & Badke-Schaub, 2016).

What are the methods or tools to facilitate creative thinking?
There are existing creative strategies and tools designed to help participants enter a specific thinking mode and mindset. Very prominently are the six thinking hats technique by De Bono (2017) and Disney's "Dreamer, Realist and Critic" strategy (Elmansy, 2015).

How can data contribute to creativity in design?
Existing studies on the data applied to enhance creativity mainly focus on the data's contribution to problem framing, defined as data sensemaking (Klein and Moon, 2006b), where data is analysed with different techniques for generating insights.

How to evaluate creativity?
There are dimensions and test methods mainly from the three aspects to evaluate creativity: outcome-based evaluation, process-based evaluation and creative thinking evaluation.

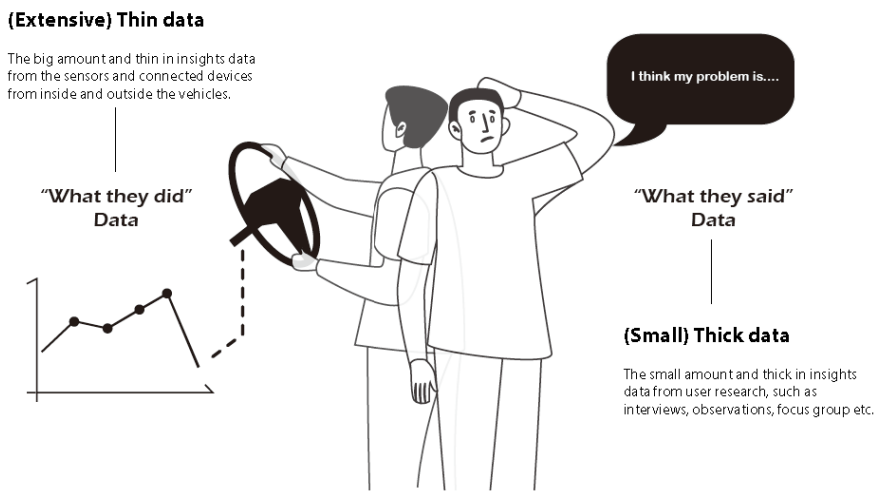
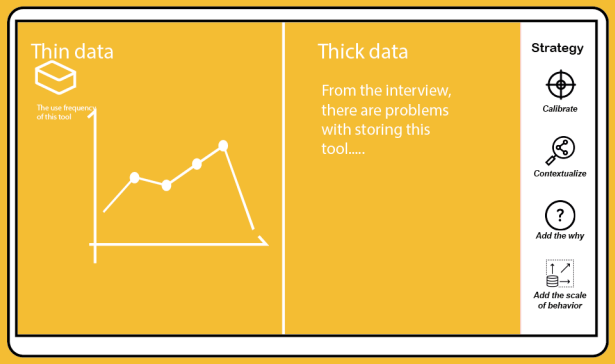
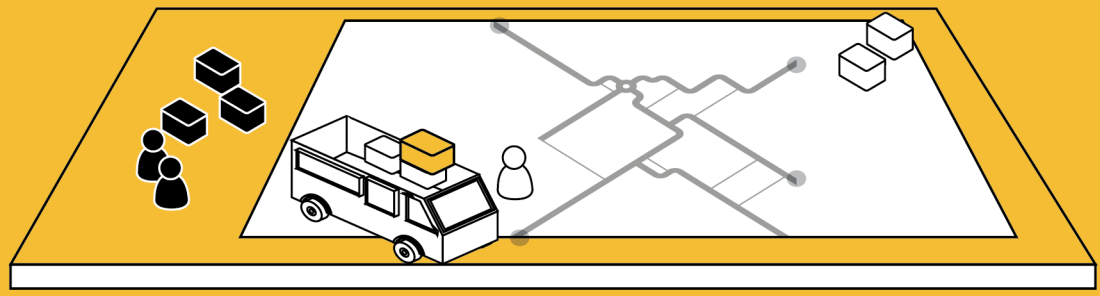


Figure 2.26, the visualization to explain the types of insights from thick and thin data.

Chapter 3
Design direction





Frame Research Question

"How to facilitate the Ford R&A team to apply user data to enhance creativity for the ideation process?"

Conduct Literature research & Interviews

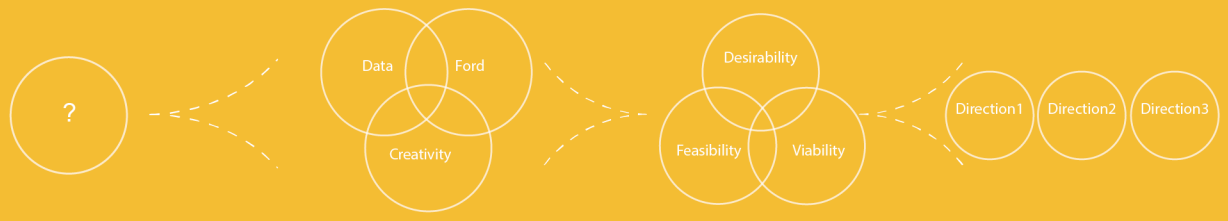
The research results were summarized in three perspectives.

Frame Design Goal & State List of requirements

"To facilitate the R&A team to contextualize thin data by combining thin with thick data and support the creative session participants to use data combinations for creative problem solving.

Propose Design Directions

Three design directions were proposed and assessed according to the list of requirements.



3.1 Design goal

So far, I have conducted interviews to understand the Ford perspective and reviewed the relevant literature from the data perspective, and creativity perspective and summarized insights in the intersections of these perspectives. Now that I have a better understanding of the context, I reframed the problem statement as follows.

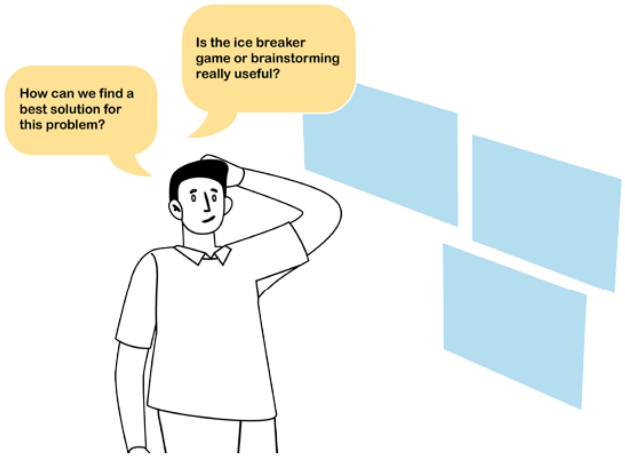
Ford R&A team wants to use data to support product development in their creative session, but there is no specific process, method and tool to contextualize data. Moreover, Ford's limitation in data collection - The person who generated the thin data cannot be traced back due to privacy issues - makes it impossible to interview the data generator to contextualize the data directly. Another challenge is that the creative session participants' lack of creative thinking is likely to hinder creative thinking and the planned creative activities, thus affect the creative problem solving process.

Previous research pointed out that the main ideation work for the Ford R&A team is now carried out in the form of the creative session, in which participants analyze existing information and produce insights and ideas. Therefore, I think that the analysis of thick and thin data should also be carried out in the creative session, during which session participants are the ones who interact with the data - they are the target group of the design intervention.

Among the design opportunities very prominently are the chances to facilitate the creative session participants through analysing thick and thin data, framing design questions, and ideating. Therefore, the process and tools design are essential to facilitate the target user, and my design goal is formulated as:

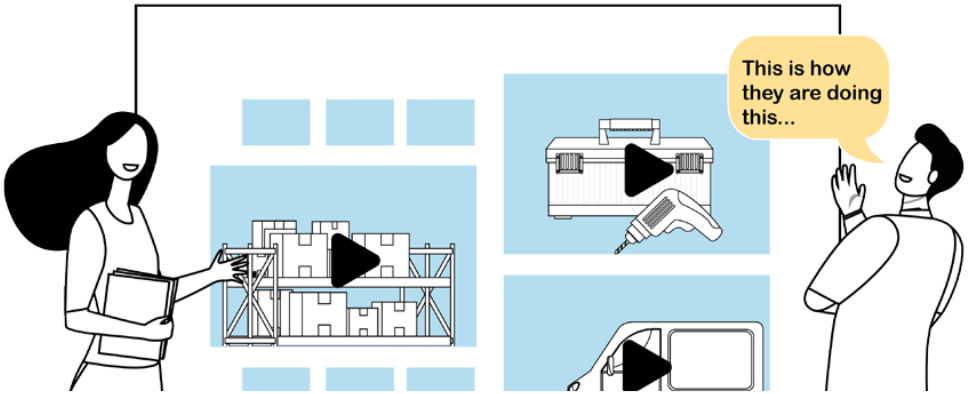
To facilitate the R&A team to contextualize thin data by combining thin with thick data and support the creative session participants to use data combinations for creative problem solving.

Besides the participants who should interact with data, the problem owner (project manager) and facilitator work closely with the participants. Therefore, the main stakeholders of the design goal is visualized here.



The creative session participants

Ford employees with different knowledge backgrounds, including engineering (mostly), management, design, data analysis, etc. They are usually invited by the R&A team manager to participate in the session. However, most of them are not trained in design thinking and are more used to deductive and critical thinking.



The creative session facilitator

There is usually one dedicated facilitator assigned by the project manager about the goal of the session. He/she is usually trained with design thinking and can set up the session process and activities.

The creative session problem owner (R&A project manager)

She/he is usually trained with management knowledge and can request data, other resources, or employees from different departments and initiate a session.

Interaction vision

The most prominent user-product interaction within the design goal is the interaction between the creative session participants and data. To make this aimed interaction more specific and concrete, I chose the method Interaction vision to express and identify the qualities of this user-product interaction. These qualities should be transferred to the particular design context at hand and translated into actual design qualities, such as form, material, texture and colour (Pasman, Boess & Desmet, 2011). As identified in the design goal, the target group for the design interaction is the creative session participants. Therefore the interaction vision is framed as:

The participant's interaction with the combination of thick data & thin data in the creative session should be engaging, insightful, convincing and creative, like doing a chemistry experiment.

Engaging
The design intervention should engage the creative session participants to interact with data and other activities during the session.

Instructive
The design intervention should provide clear instructions and expected resultslike the "chemistry formula" to guide the process for the participants.

Insightful
The design intervention should inspire the participants to summarise insights and findings from their interaction with data.

Convincing
The design intervention should first convince the participants of the authenticity of the insights from data and data itself.

Creative
The design intervention should cultivate the participants' creative mindset and creative self-beliefs, including their creative confidence and belief in creativity.

List of requirements

Then, to summarise the design requirements and communicate with the client Ford, I applied the "List of requirements" method to think systematically about the requirements besides the Interaction vision. I defined eight requirements as follows to cover the three aspects of desirability, feasibility, and viability (Figure 3.1) in the innovation model originated from IDEO (Admin, 2017) so that the design intervention can solve problems and support long-term implementation.

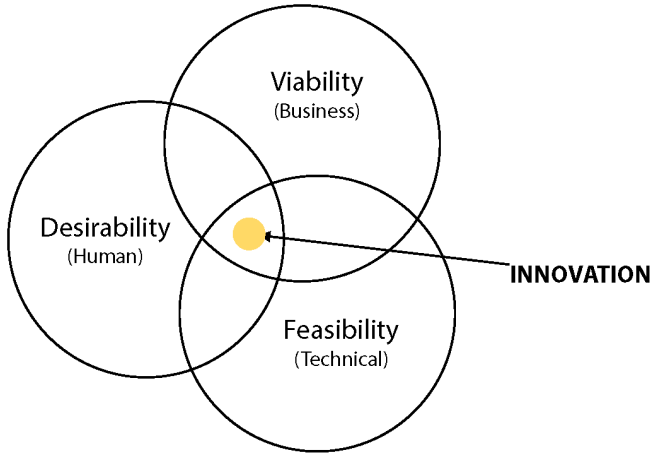


Figure 3.1, the innovation model originated from IDEO (Admin, 2017).

Disability aspect

- Empower participants and facilitators without design thinking background to have a creative mindset during the session
- Engage the participants without data or design background to interact with data and draw insights on user behaviour, the interaction with data should be engaging, insightful, convincing and creative.
- Enhance the quantity of ideas generated from the session.
- Enhance the flexibility of the ideas (diverse perspectives) generated from the session.

I set the first two requirements to evaluate the creative thinking and interaction with data, corresponding with the design goal and interaction vision. Then, as mentioned in the previous interview result, the session's outcome also matters to the R&A team, where they want "novel and various" ideas. According to the different dimensions to evaluate the creative outcome, there are mainly two aspects: quantity and quality. The quantity dimension can be measured by counting the number of ideas generated from the sessions. In contrast, the quality dimensions such as originality can require evaluation from design experts, which can be difficult to conduct for this project. Considering the needs of the R&A team, originality, flexibility and quantity were considered more important than practicality, conformity and other dimensions when evaluating the outcome of their creative sessions. Therefore, the quantity and flexibility of ideas from creative sessions are considered the measurable dimension to evaluate creativity for the design intervention of this project.

Feasibility apsect

- Feasible to be built and adapted by the facilitator of different R&A teams.
- Fit in with Ford's data and design capability to get the materials prepared for this toolbox.

I summarized two requirements on the feasibility aspect based on the insights from interviews with the R&A team and CDF coach, enabling me to consider the data availability and capability of the Ford side.

Viability aspect

- Cost-effective to be adapted by different R&A teams.
- Measurable and visible effects ("KPI") from this toolbox, including the feedback from R&A teams and assessments on ideas.

The two requirements on viability aspect focus on enabling the long-term implementation of the design intervention.

Afterwards, a rating on the importance of each item was conducted with three Ford R&A team members, who usually act as the problem owner, participant, and facilitator in their design sessions. Based on the rating result and later discussion with the R&A team manager, ten requirements were adjusted and divided into two groups, from very important to less important. This list will serve as a basis of the criteria for evaluating the design intervention, incorporated with user testing and interviews.

Very important

- Engage the participants without data or design background to interact with data and draw insights for product/service development.
- Empower participants and facilitators without design thinking background to have a creative mindset during the session
- Enhance the quantity of ideas generated from the session
- Enhance the flexibility of the ideas (diverse perspectives) generated from the session
- Fit in with Ford's data and design capability to get the materials prepared for this toolbox.

Less important

- Measurable and visible effects ("KPI") from this toolbox, including the feedback from R&A teams and assessments on ideas.
- Feasible to be built and adapted by the facilitator of different R&A teams.
- Cost-effective to be adapted by different R&A teams.

3.3 Design directions

Starting from the design goal, I used the mind mapping method to map the existing methods and tools and techniques reviewed in the research chapter. Then, I identified three design opportunities. Each of them offers a variety of branches for divergent ideas (Blue circles in figure 3.2):

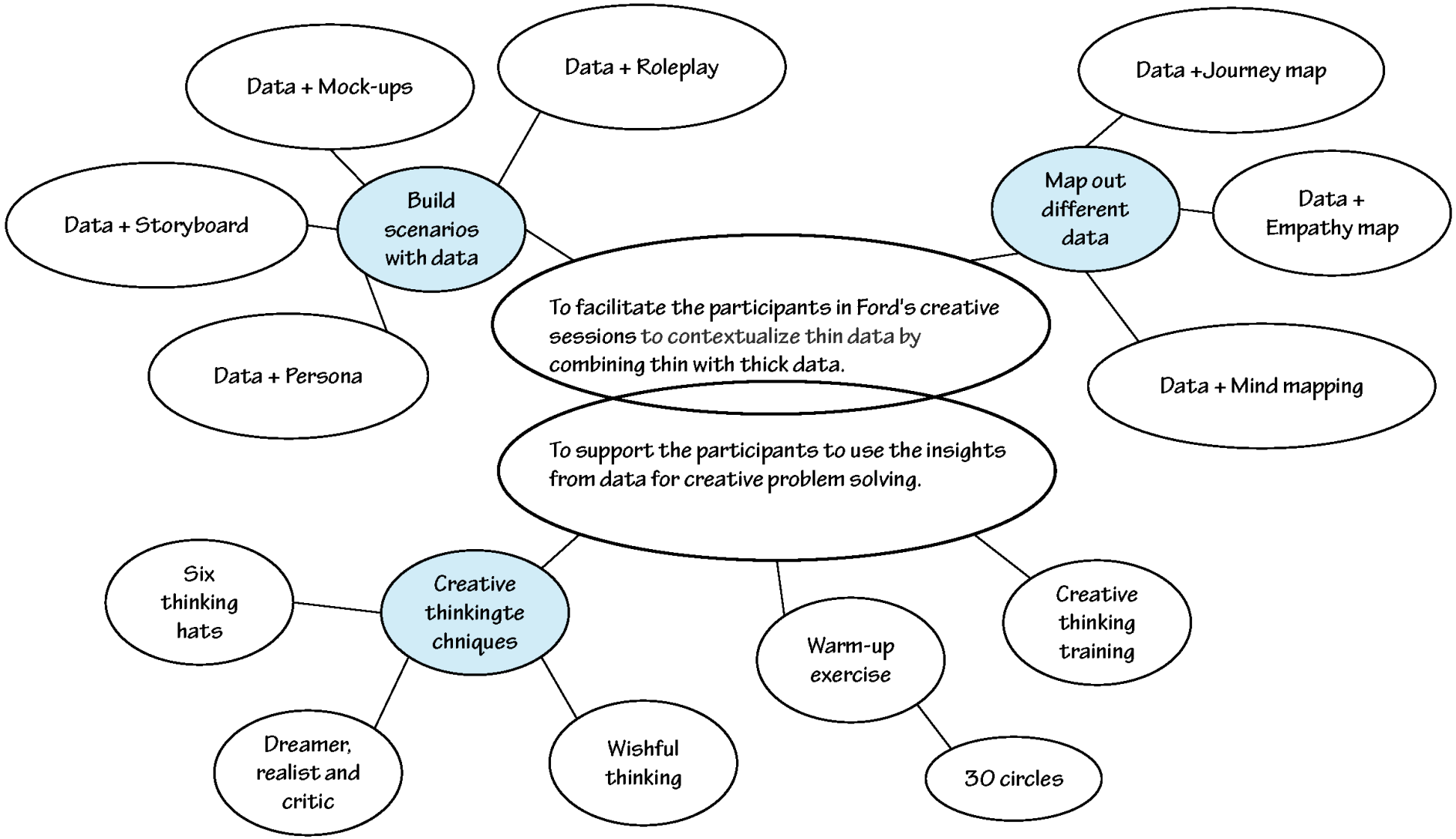
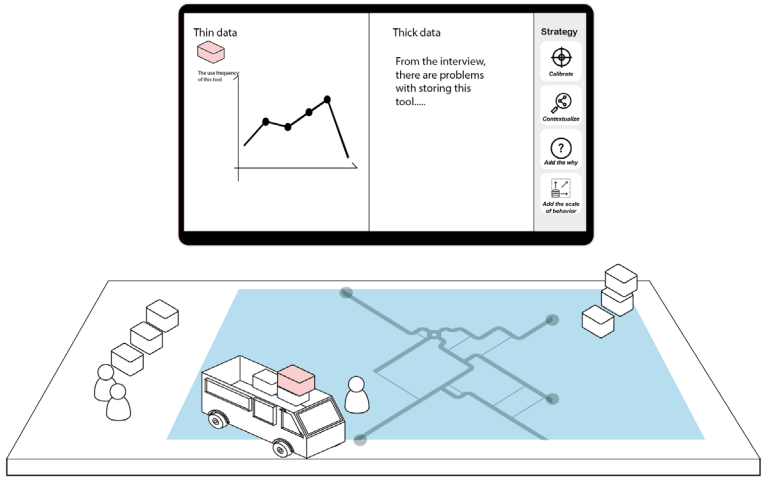


Figure 3.2, the mind mapping for my ideation process.

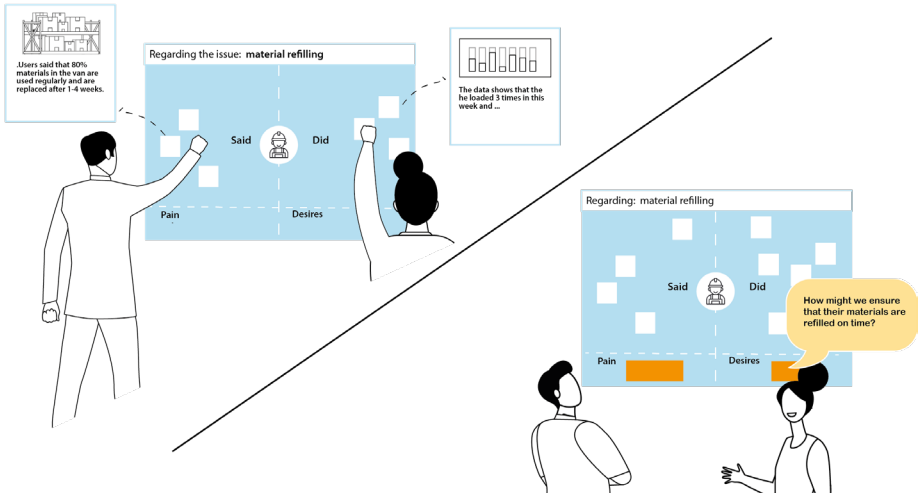
1. **Build scenarios for the participants to combine thick and thin data in the design session.** As mentioned before, one category of methods to contextualize the user scenario for problem framing is to simulate the actual scenarios, such as storyboard, roleplay etc. For the Ford creative session, building scenarios can be a good way to contextualize the thin data and thick data combination, thus contributing to problem framing and idea generation.
2. **Guide the R&A team in problem framing by mapping and combining available thick and thin data.** It was identified in the research synthesis that the methods "Empathy map" and "Context mapping" for enhancing problem framing in user experience design both map out the data related to what the user "said", "did", "felt", etc., to gain a better understanding of the user experience. Among these dimensions, the "what the user said" corresponds to the thick data from interviews and "what the user did" corresponds to the thin data from sensors in Ford's context. So, the design opportunity is to contextualize the thin data by mapping it out as the "did data".
3. **Encourage creative thinking during the design session with techniques.** From the research on creative thinking techniques, we can see that the creative technique "six thinking hats", "Dreamer, realist and critic" etc., can help the session participants to adopt different thinking, thus contribute to the whole creative problem solving process.

After that, I generated Ideas by combining data with methods related to the design opportunity, such as "Data + Journey Map" for mapping available data. With further developing different ideas and a selection based on my design goal and interaction vision, I proposed and visualized three design directions corresponding to the three design opportunities:

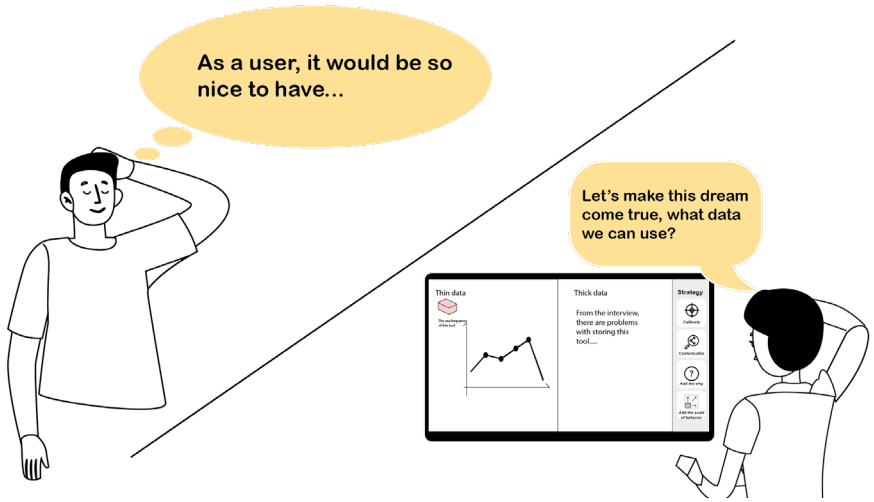
Direction 1: Real scenario and IOT in a nutshell
This direction aims to immerse the participants of an ideation session in the real scenario by projecting data into physical mock-ups, contributing to a simulation of IoT in the real context. When you grab one physical mock-up, the related data graph will be shown on the screen. For example, when you grab the car's body, you see related data graphs such as speed, GPS etc. When you grab the user figure, you see the related thin data (behaviours such as the time spent inside the car) and thick data (photos etc.)

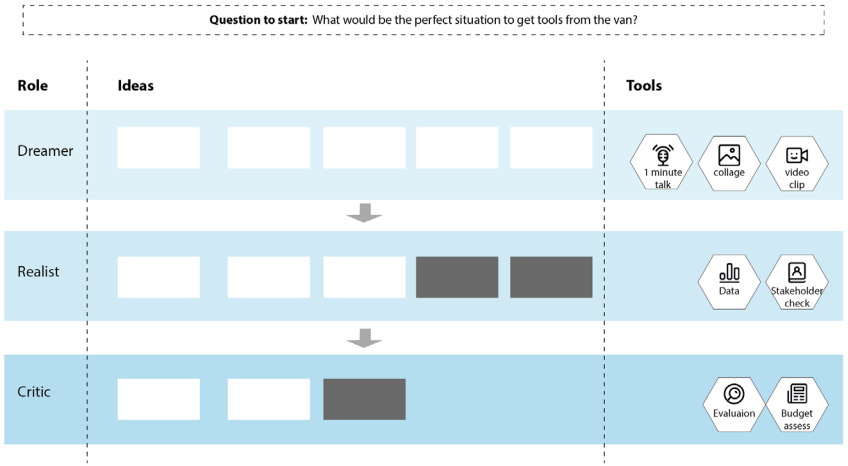


Direction 2: "Said and did" data map
This direction aims to facilitate the participants to reflect on user's perception and behaviour by letting a two-person group map out data cards on one issue from two sides "did" (thin data) and "said" (thick data). Afterwards, the group can discuss and reflect the users' needs and desires for this specific issue and frame the "How might we question". This direction is inspired by the problem framing tool "Empathy map".



Direction 3: Dream with data
This direction aims to help the participants abandon their "engineer mindset" during the ideation stage and dream first to envision the future experience as a vehicle user. So, this tool should guide the participants to first brainstorm and align with future visions and values. Then, they can explore and combine thick data and thick data by keyword with the strategies offered. This direction is inspired by the service design tool "Tomorrow's Narratives" and the Disney creative strategy (Elmansy, 2015).





3.4 Assessment & Conclusion

I conducted an assessment of the three design directions to see their potential to fulfil the List of requirements agreed by all the stakeholders.

Direction 1 Real scenario and IOT in a nutshell
Strength: The prototype can be highly interactive to engage participants to draw insights on user behaviour.
Weakness: It is less feasible to be built since it involves a technically functional prototype, and the guidance of the ideation process is missing in this direction,

Direction 2 "Said and did" data card map
Strength: The mapping can be straightforward and convincing for participants to draw insights into user behaviour and frame design opportunities.
Weakness: This mapping only covers the problem framing stage before generating ideas, therefore missing a complete process and could not be evaluated on its effect on ideas generated from the session.

Direction 3 Dream with data
Strength: The three roles setting is likely to cultivate a creative mindset among participants, thus enhancing the originality, quantity, flexibility and quality of ideas generated from the session. Besides, there is a relatively complete sequence of the process to guide participants during the session.
Weakness: It can be less convincing to participants if they go directly to the ideation stage without acknowledging facts and insights from user research.

In the later discussion with stakeholders, the direction one was recognised by the R&A project manager as not feasible, while the direction two and three are more promising for implementation. Meanwhile, I believe that the direction two and three are to some extent complementary in their strengths and weaknesses.

Therefore, I concluded that for the upcoming concept development stage I would explore how directions two and three can be combined to magnify their strengths. By developing these two directions, I aimed to fulfil the list of requirements and the design goal: To facilitate the R&A team to contextualize thin data by combining thin with thick data and support the creative session participants to use data combinations for creative problem solving.

Chapter 4
Concept development

Frame Research Question

"How to facilitate the Ford R&A team to apply user data to enhance creativity for the ideation process?"

Conduct Literature research & Interviews

The research results were summarized in three perspectives.

Frame Design Goal & State List of requirements

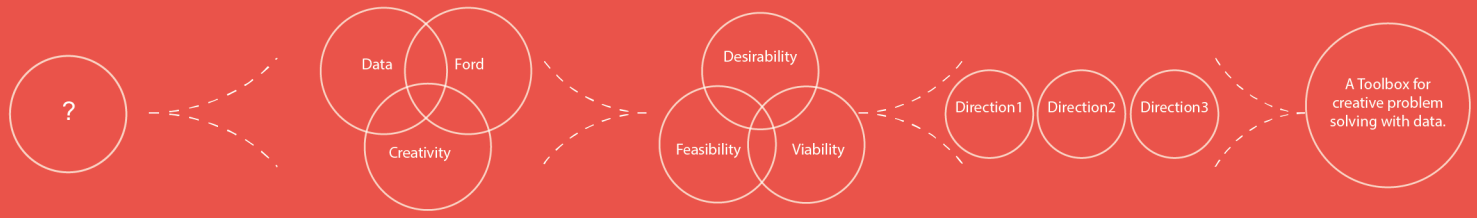
"To facilitate the R&A team to contextualize thin data by combining thin with thick data and support the creative session participants to use data combinations for creative problem solving."

Propose Design Directions

Three design directions were proposed and assessed according to the list of requirements.

Develop the concept by detailing and user test

The chosen concept "Toolbox" was developed with design detailing and tested with target user.



4.1 Concept

The previous chapter concludes that the elements from these directions, "Said and did data map" and "Dream with data", can be further considered in the concept development stage. Since the primary user-product interaction defined in my design goal is the interaction between creative session participants and data, it is essential first to develop the tool that brings data into the session and facilitate data analysis.

1. Bring data into the session: Said vs did data map

I identified in the research conclusion that the "what the user said" from the knowledge diagram(Vissor et al., 2005) corresponds to the thick data from interviews and "what the user did" corresponds to the thin data from sensors in Ford's context (Figure 4.1). **I believe such translation can help people without data related knowledge to understand the insights from thick and thin data in an easy and convincing way. Therefore, the term "Said data" and "Did data" are applied in this tool.**

The tool "said and did data map" (Figure 4.2) is based on the structure of the empathy map and is the key to introducing the "Thin Data Perspective" to the creative session. Besides, the strategies for combining data are provided to the participant to help them combine "Said" and "Did" data and generate insights and design opportunities from them. **To encourage discussion on the data, the participants should work in pairs and analyse existing thin and thick data separately. Then they are asked to write down insights and questions from the data they are working on.** The strategy cards are designed to facilitate them raising questions, which are developed based on the data blending strategies from Bornakke and Due (2018), as shown in Figure 4.3. Then, the two participants can discuss the insights and questions, trying to get answers from each other, thus combining thin and thick data.

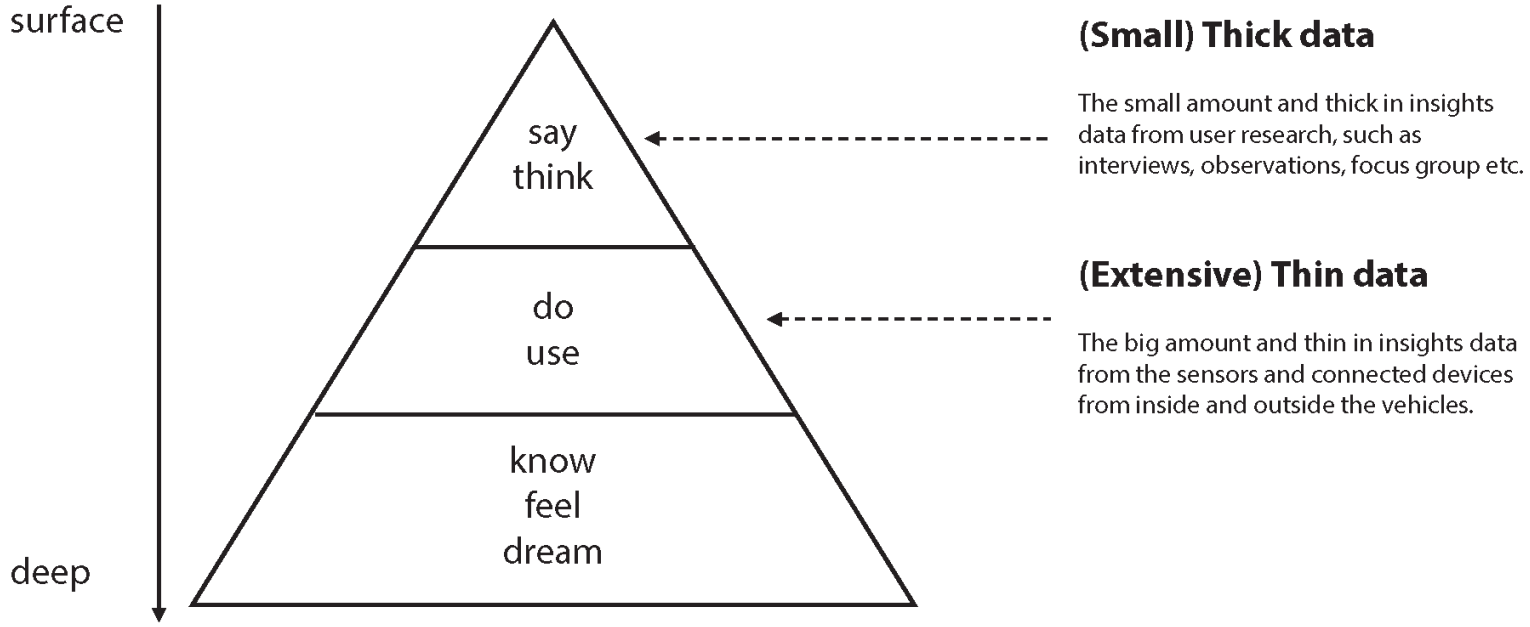


Figure 4.1, the data with the corresponding user insights.

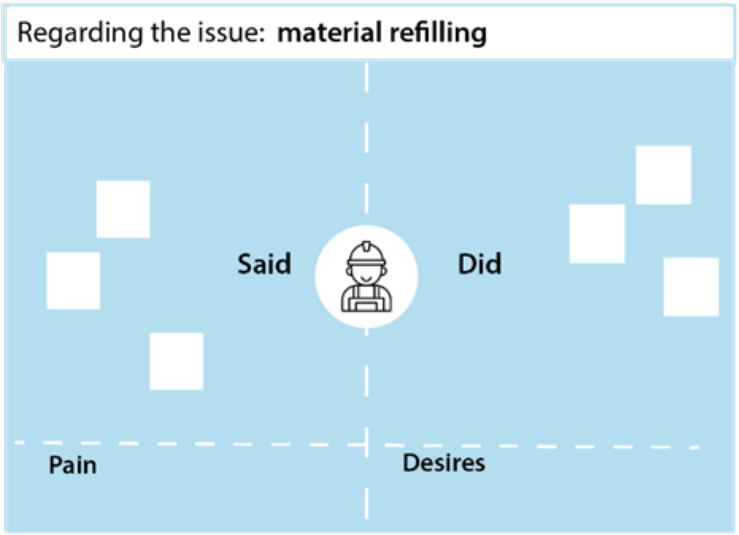


Figure 4.2, the said and did data map template.

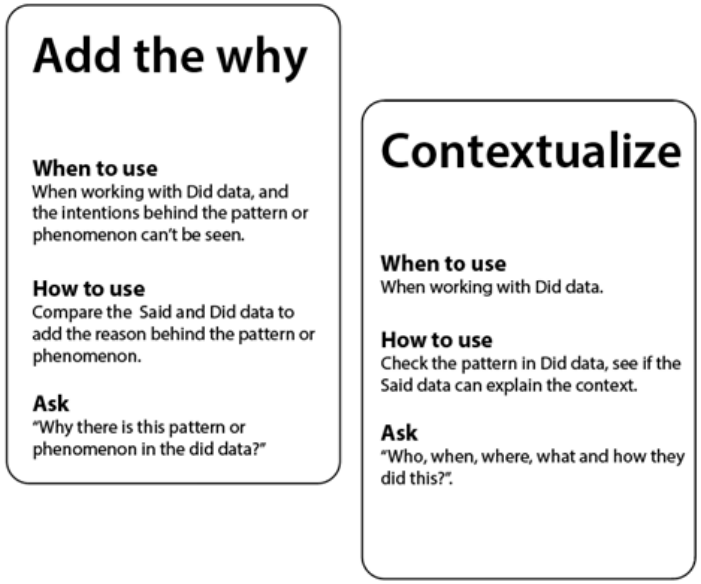


Figure 4.3, the strategy cards to facilitate the participants to raise questions.

2. Facilitate the creative problem solving process: the roadmap

In addition to the data map, the Ideation phase after the data analysis should also contribute to the participant's engagement and creative mindset. Therefore, I decided to make a roadmap for all stages of the whole session first and then design methods or tools that can facilitate activities according to the goals of different stages. From research on data combination strategies in the data perspective chapter, there are two possible approaches for the Ford R&A team to combining thin and thick data. Considering their design session settings, the approaches are shown in the following two roadmaps (Figure 4.4, 4.5).

The activities in these two roadmaps are most the same, but the difference lies in the time when data mapping and combination happens. In the first roadmap (Figure 4.4), raising questions and collecting new data to answer the questions were completed in advance by the R&A team. In this way, in session, Participants have been given the Q&A, which is the combined thick and thin data, and then they will summarize insights and ideate on product development based on the existing data. However, in the second roadmap (Figure 4.5), the session participants work with the said and did data mapping tool and ask the questions to the researched user, who will attend the session and help the team contextualise data.

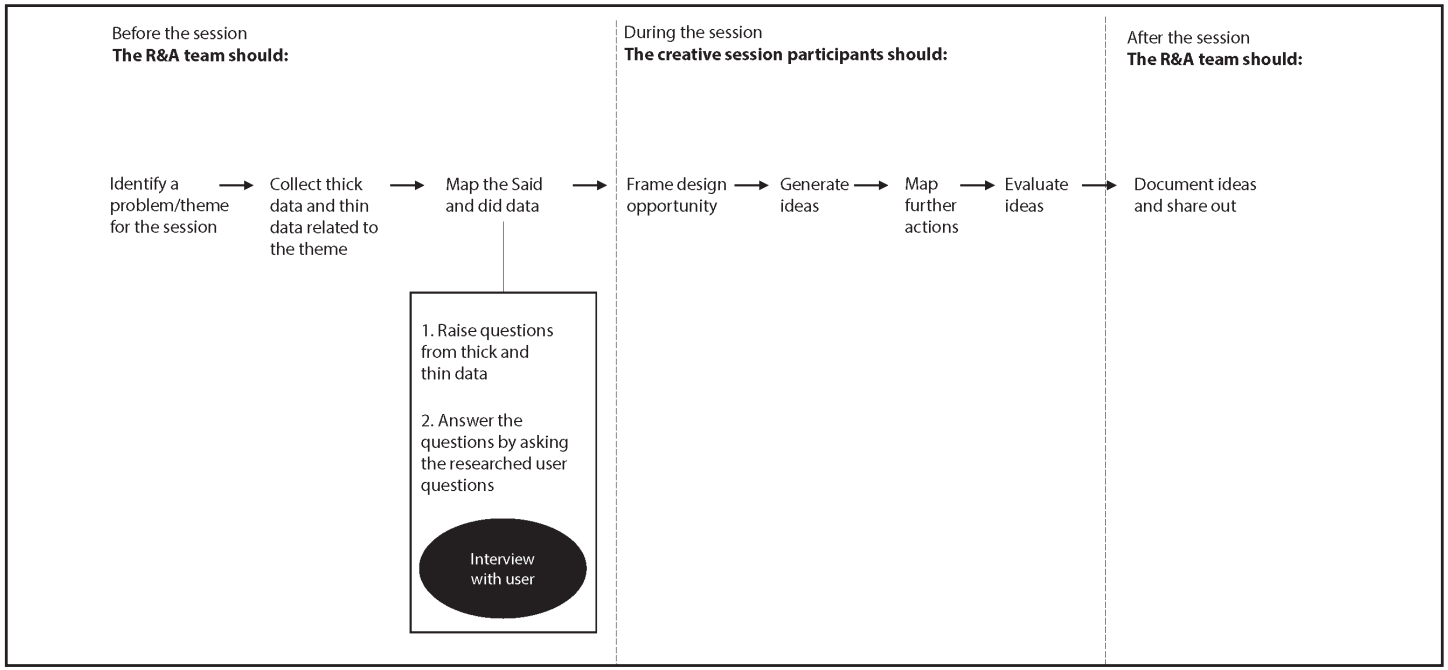


Figure 4.4, the 1st roadmap that contextualises thin data by interviews with the researched user before the creative session

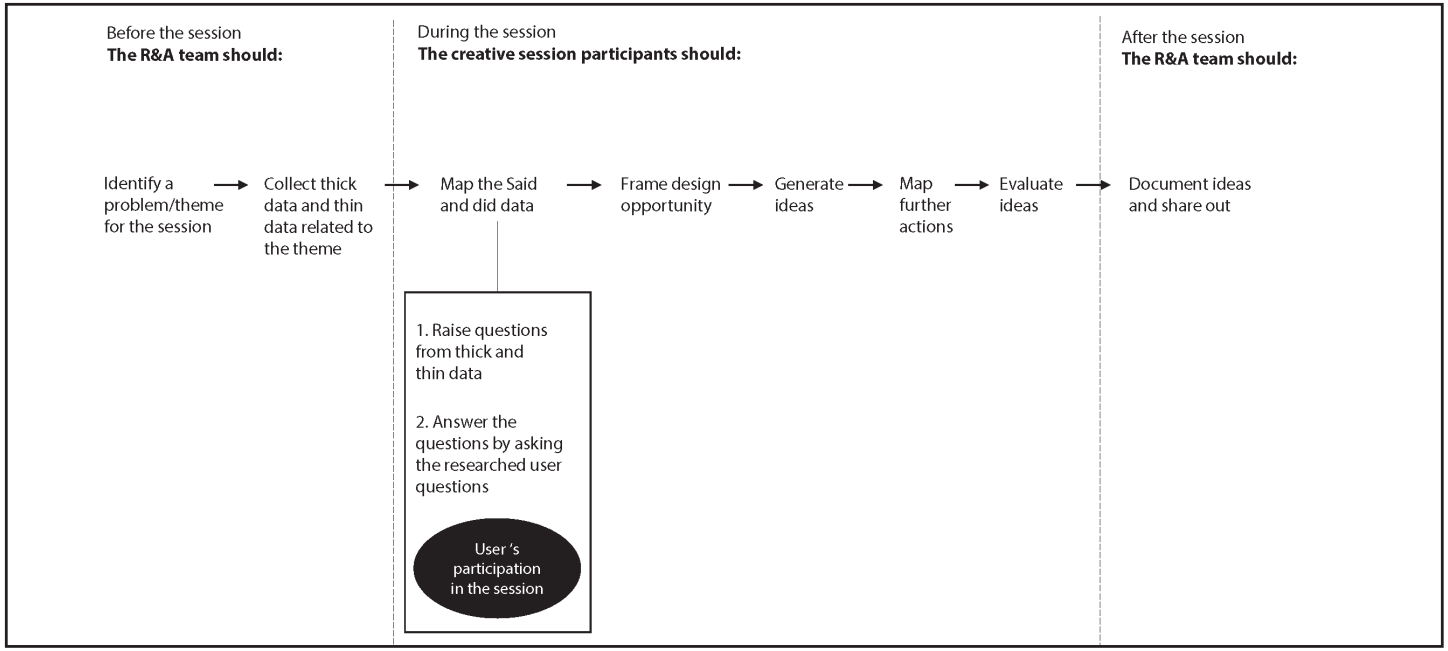


Figure 4.5, the 2nd roadmap that contextualises thin data by the participation of the researched user during the creative session

During the process, the main activities are identified as follows.

Collect thick and thin data related to the theme
This activity should be done by the R&A team since they are in charge of identifying the theme of the design session and preparing materials for ideation sessions. According to their current approach, they collect thick data by self-conducted user research such as interviews, then request for visualized thin data from data specialists.

Map said and did data
This activity should be done by the R&A team in the first roadmap and session participants in the second roadmap. There are two steps for this activity. First, the people should map both thick and thin data on the board and then generate insights and questions from the data. Then they should try to answer the questions by examing existing data or collect more data if needed.

Frame design opportunity
This activity should be done by the participants, who should be guided to frame design opportunities based on the insights generated from data mapping.

Generate ideas
This activity should be done by the participants after framing the design opportunities. The participants should be guided for divergent thinking based on the design opportunities.

Map further actions
This activity should be done by the participants after generating ideas. The participants should be guided to develop their ideas by mapping out further actions and requirements.

Evaluate ideas
This activity should be done by the participants after mapping further actions. The participants should be guided to use convergent thinking to examine the ideas critically and choose the optimal solutions.

3. Role design for facilitating creative thinking: Role switch

Based on the creative technique "Dreamer, realist, critic" (Elmansy, 2015) and "Six thinking hat" (De Bono, 2017), Four roles were designed to engage participants without design background to have different thinking modes during various stages.

Observer
This role is set up for the activity "Map said and did data" and "Frame design opportunity", where the required mindset is being curious and exploratory with any phenomenon or pattern from the data. The rule for this Role is to use the inquiring mind and challenge one's assumptions. As an observer, the participants should write down insights and questions from the data and then communicate with their groupmates to discuss each other's interpretation to avoid misinterpretation.

Dreamer
This role is set up for "Generate ideas", where divergent thinking is needed. The rule for this Role is to think without limitation and hitchhike on each other's ideas. As a dreamer, the participant should work individually and believe that there is no limitation to one's ideas.

Builder
This role is set up for the activity "Map further actions", where reverent thinking is needed. The rule of this Role is to be jointly active in building ideas. As a builder, the participants in a group should help each other write down the actions to develop the ideas.

Critic
This role is set up for the activity "Evaluate ideas", where critical thinking is needed. The rule for this Role is to express opinions with affirmative judgement and protect originality. So the participants should give constructive critics to the ideas and try to give compliments on the good side of the ideas.

4. To deliver the above roadmaps, tools and roles design: The toolbox

Considering that thin data being applied in a creative session is a relatively new path, I believe it is necessary to introduce the proposed process and tools involved. Therefore, I decided to make the design intervention a toolbox including different components, making it easy to be understood and applied by the R&A team.

The toolbox includes:
1. **Introduction of the "Said" and "Did" data and creative problem solving.**
2. **Roadmap of the data enabled design session process for Ford's R&A team.**
3. **Four roles and the rules for each role.**
4. **Design activities and tools for each role.**

4.2 Design detailing

So far, I proposed the design intervention as a toolbox including a roadmap of the process, tools and roles for the creative session participants. Following design detailing contains three main parts to support the development of each component of the toolbox.

Combination with existing creative techniques

Goal
To introduce the four roles and creative activities involved in this process and engage participants in this process by attracting yet convincing visual narratives.

Reference
The book "Road Map for Creative Problem Solving Techniques" (Heijne & van der Meer, 2015) claims to include the most frequently used techniques and most effective ones involved in group sessions in current practice. Therefore, a study on the techniques available in this book was done to see which ones can support the goals of different stages in this concept and fits the participant's level of experience in creative activities. In additionm the book "Creative confidence" offers various activities and tools for practising creative thinking and improving creative confidence, such as "30 circles exercise", "I like / I wish", etc. A study on this book was done to find suitable "creative exercise" for the Ford creative session participants.

Design decision
The goal of applying these techniques is to support participants in completing the activity: generate ideas, map further actions and evaluate ideas. The techniques SCAMPER (Eberle, 1971)(Figure 4.6), 5W1H (Dieter and Kurth, 1968) (Figure 4.7) and idea gallery were selected to support the process.

The technique SCAMPER was chosen to offer inspiration for the role Dreamer, since it fits the experience level of novice participants and offers a set of questions to stimulate the flexibility of options, which corresponds with the goal of the activity "Generate ideas".

The technique 5W1H was expected to help Builder to develop ideas because this method offers a checklist for the participants to gather information in the solution space. Since the builder's goal is to map out all the required actions for developing the ideas, the checklist from this method can be of great help.

The technique Idea galley was selected to support the final evaluation of the ideas since it asks people to focus attention on each option, which fits well with the Critic's goal.

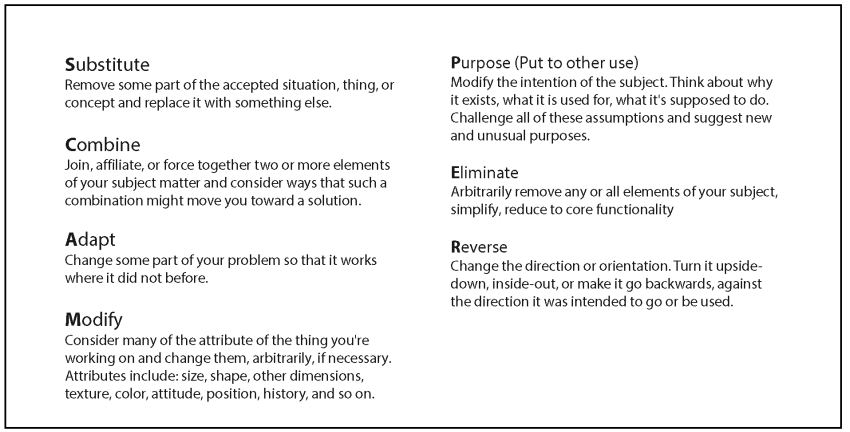


Figure 4.6, the creative technique SCAMPER (Eberle, 1971)

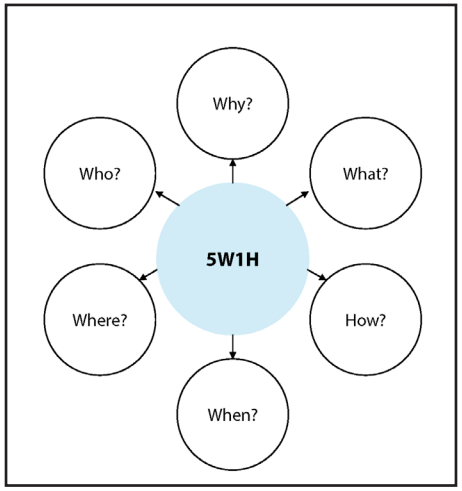


Figure 4.7, the creative technique 5W1H (Dieter and Kurth, 1968)

Visual communication

Goal
To introduce the four roles, roadmap and tools involved in this process and engage participants in this process by attracting yet convincing visual narratives.

Reference
I created a mood board (Figure 4.8) on colour schemes to find a balance in the "attracting" and "convincing" visual style.

Design decision
I designed the illustration for four roles (Figure 4.9) to support the narratives, and applied the colour scheme to develop the visuals of each role.

Presentation

Goal
To deliver the different components of this toolbox in an effective and engaging way.

Design decision
As mentioned before, the components of this toolbox should include an introduction, a roadmap, tools, roles, etc. Therefore, the format booklet was first chosen for delivering the introduction on roadmap, tools and roles since a booklet allows for a relatively immense amount of continuous information. Then, the format template was selected for delivering the "Said and Did map", "Idea development board", and "Idea gallery", because it can offer a specific framework for the participants to fill in. With well-designed guiding questions, a template can lead the participants to reach one's goal by answering the questions.The card set is adapted for presenting "Data combining strategy", "SCAMPER", and "5W1H" because they can offer various options and add more fun thanks to the "random effect".

Before the Covid-19 pandemic, sessions were held offline in Ford, while now they could only hold online creative sessions on online whiteboard Bluescape and expect to hold offline sessions with the pandemic is over. **Therefore, the toolbox is designed in both physical and online versions to support offline and online sessions while the activities remain the same.**

As shown in the following figure 4.10, 4.11 for offline sessions, the booklet, template and cards should be printed out to allow the participants to grab and use. While the

Figure 4.8, a colour scheme mood board with pictures collected from the Internet.

Figure 4.9, the illustration designed for four roles: observer, Dreamer, Builder and Critic.

online version (Figure 4.12) is designed based on the features of online whiteboard, here Miro is used as an example.

Figure 4.10, the effect picture of the physical booklet in the toolbox

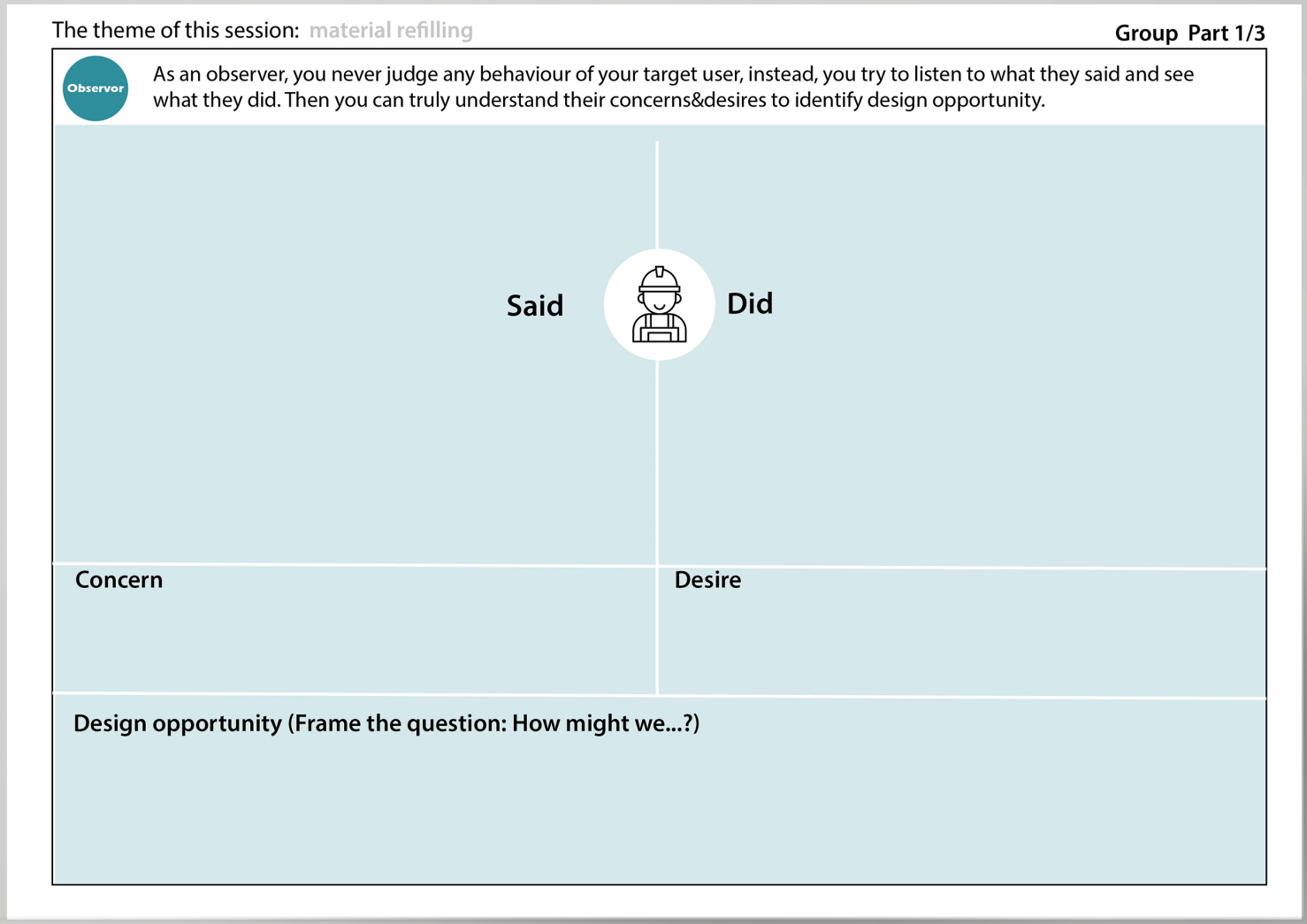


Figure 4.11, the effect picture of the physical Said and did data map template and data combining card set.

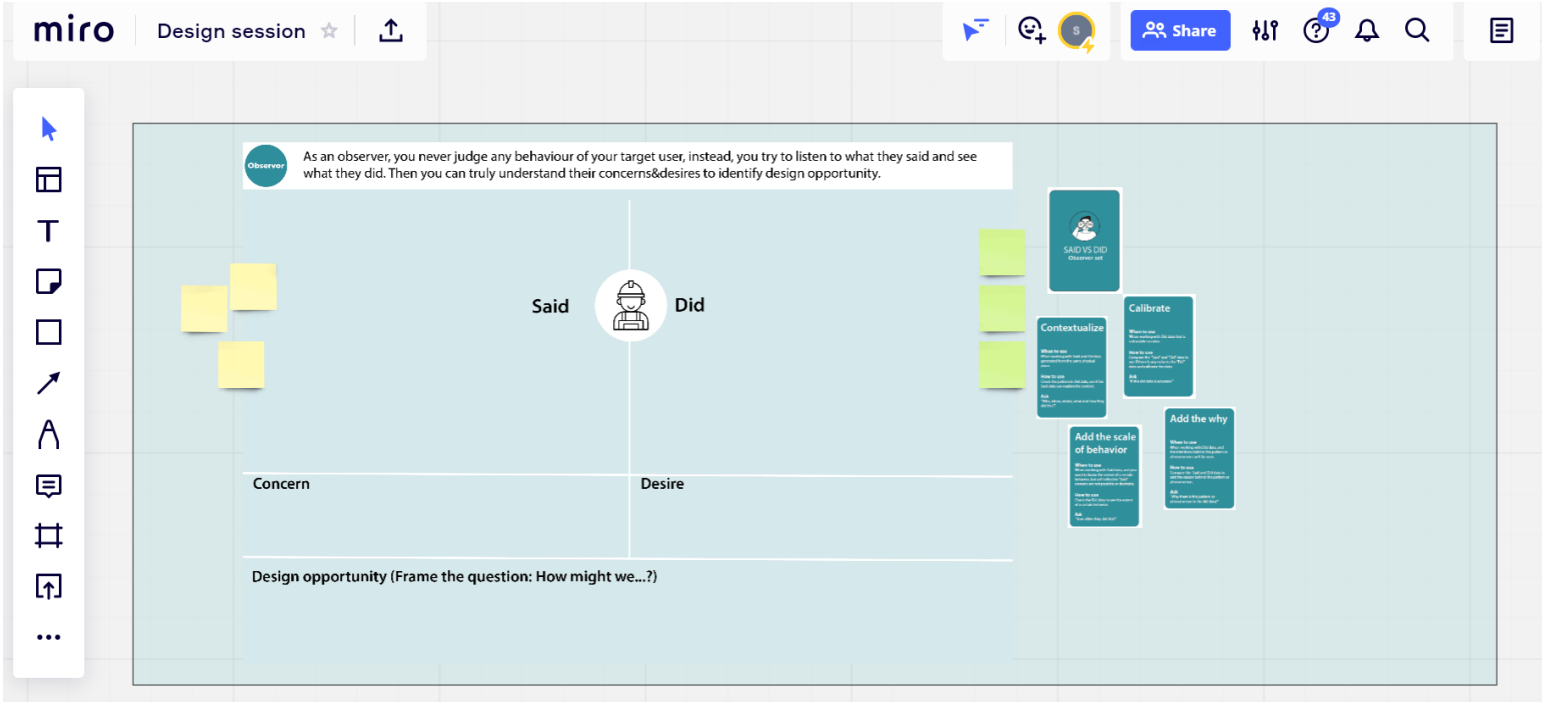


Figure 4.12, the online version of Said and did data map template and card set in online whiteboard (Miro)

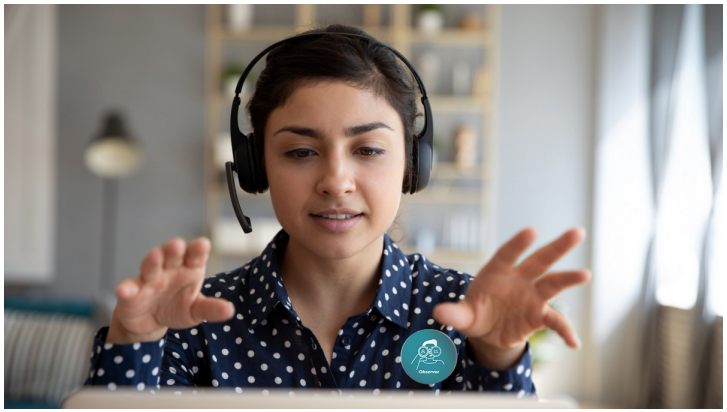


Figure 4.13, the effect picture of a participant wearing the badge during an online meeting.

Moreover, I chose the badge as a prop in this toolbox for its portable and presentable feature. The badge is presentable even when only the upper body of participants is visible during an online session so it can be used for both online and offline sessions. As shown in figure 4.13, the role badges were designed to remind the wearer of their Role at the time. Therefore, the facilitator can keep the discipline and timing during the session by asking the participants to wear different badges.

4.3 The toolbox

The main presentations of the toolbox include a booklet, three templates, three card sets, and role badges, supporting the introduction and conduction of the intended design activities for the creative session participants.

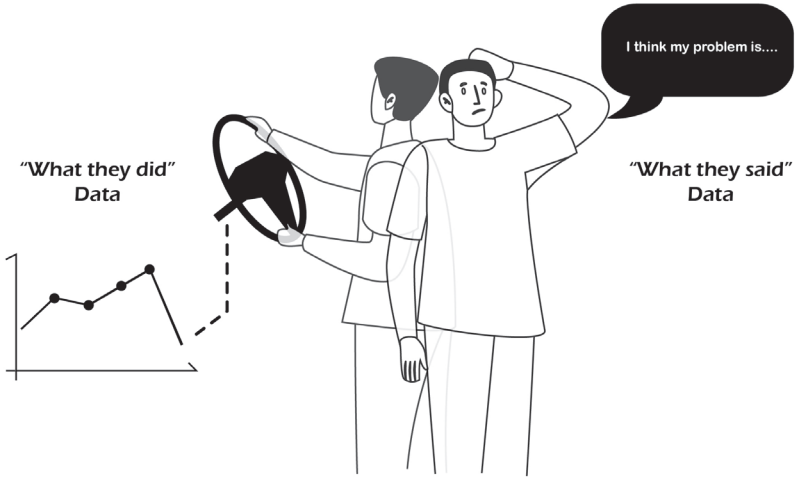
The booklet

This booklet introduces the toolbox and explain the specific steps of the roadmap, tools and roles. However, considering that it should not take too much effort to read the booklet, the introduction is designed to be concise, while the facilitator should give more instructions during the session.

First, there was an introduction of the concept "data-enabled design" (Figure 4.14)

Why do we need data?

Before the emergence of IoT, we could only understand our target user by interviews and observations, listening to "what the user said," and interpreting their values, problems and needs. Now, it is time to bring the sensor data from our connected devices into the game, for it tells us "What the user did" honestly and accurately. Therefore, this new data perspective can empower us to see user's behavior and understand the target user's subconcious desires.



Why do we need creative problem-solving?

Nowadays, we face more open, complex, dynamic, and even networked problems, which conventional thinking does not work. That is why more and more companies think of creative problem solving(CPS) a vital ability, a way to find new perspectives and come up with innovation solutions. The key principle of CPS is allowing different thinking at different stage. to generate ideas from different perspectives as shown in the CPS model.

What is great is that creative problem solving is like all other things: practice makes perfect. Follwing you will see a roadmap of the process of the session and four roles designed for you to practice the different thinking at different stages of this session.

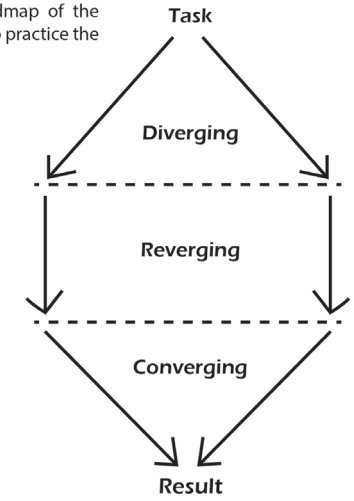


Figure 4.14, introduction of the concept "said and did data" and "creative problem solving" from the booklet

that was introduced in the toolbox, replacing data terms with "said data" and "did data." Then there is an introduction of the CPS model and the purpose of role-playing. I also designed visuals to explain the concept of "said and did data" and "creative problem solving" since that the participants can be not familiar with these terms.

After the introduction, it is the roadmap (Figure 4.15) for the entire process, including the preparation and follow-up work required by the R&A team before and after the session, making it more complete, transparent and convincing. In these two pages, I first divded the stage "Before the session", "During the session" and "After the session", and then add the activities connected with arrows to show the participants what has been done, and what they should do during the session. Meanwhile, I put the roles' visualisation to connect activities with the roles. Therefore, the viewer can see that they are about to act in four roles during the session, though they are not clear about the meaning of each role at this point.

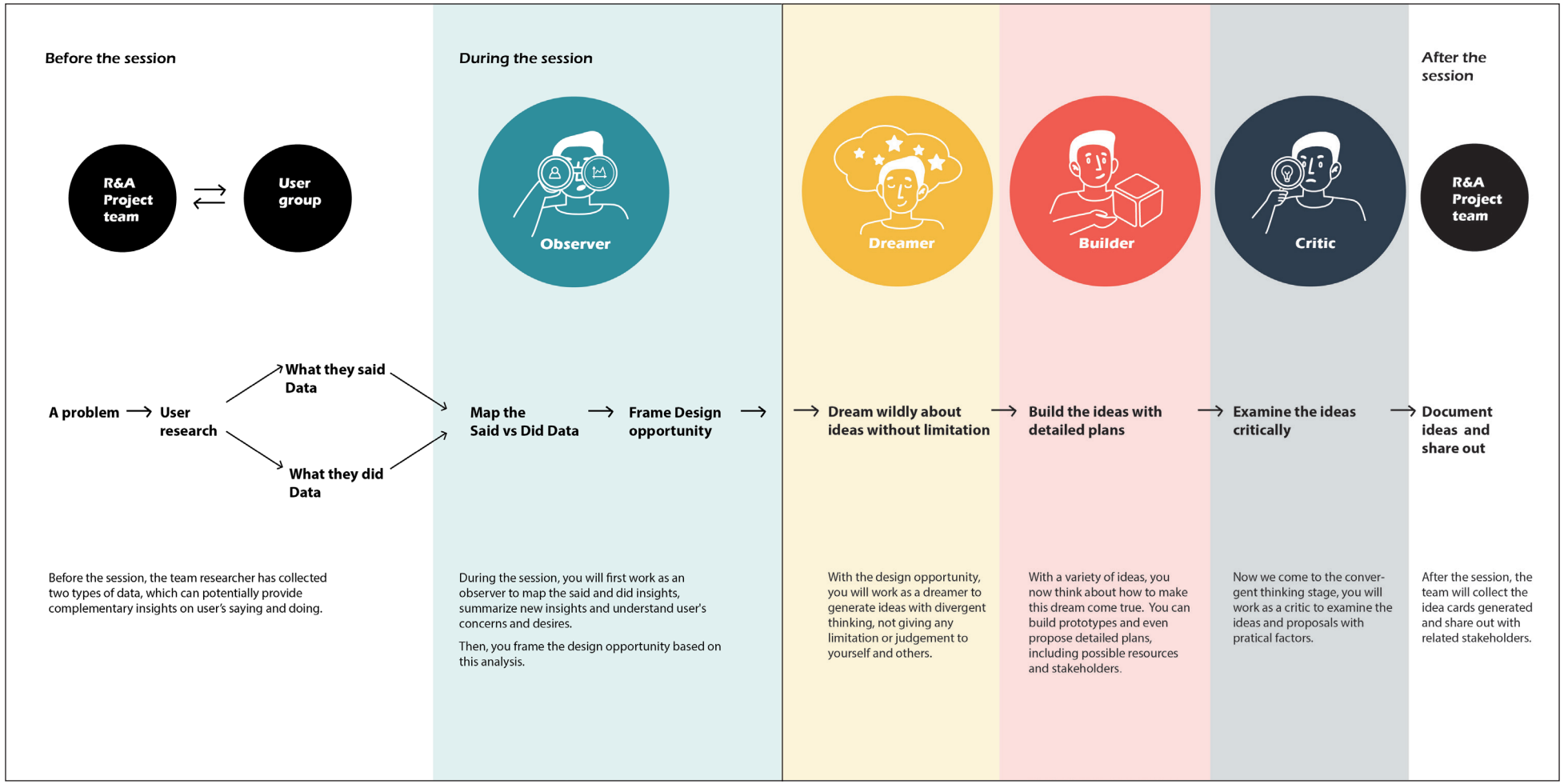


Figure 4.15, roadmap of the data enabled design in Ford from the booklet

Finally, the rules and available tools of the four roles are explained in the following four pages, as shown in figure 4.16. Each page includes the name of the role, then the rules for the role and a paragraph describing what they should do. The tools for the observer is the "Said and did data map", including the template and data combining strategy card set. While Dreamer, Builder and Critic's tools are developed based on the chosen technique (in the design detailing stage) SCAMPER, 5W1H and Idea gallery. I used a substantial visual difference in colours to help the viewer to distinguish different roles. Moreover, the switch of roles should be directed by the facilitator during the session.

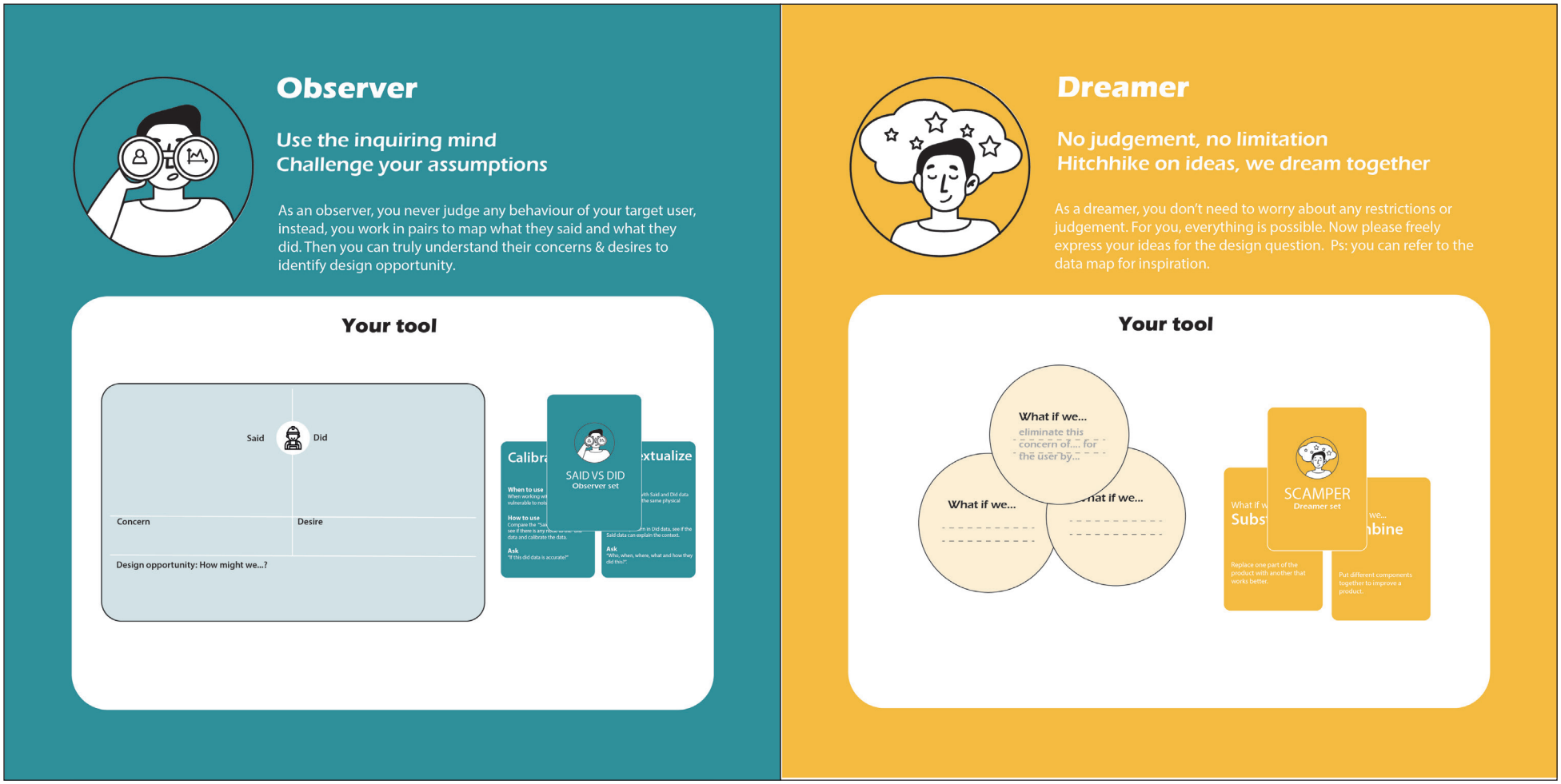


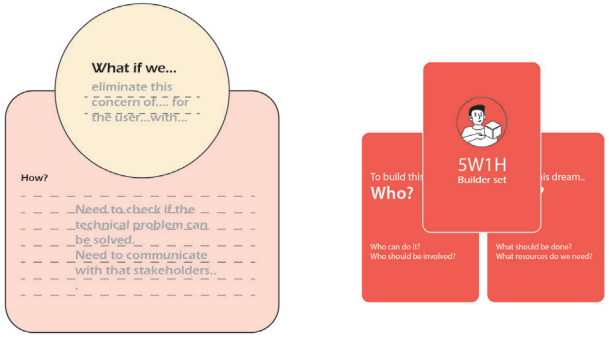
Figure 4.16, instructions, rules and tools for each role from the booklet

Builder

Be jointly active
Move circularly

As a critic, you now have the chance to express your gut feelings and comments to any ideas. Now please critically consider each idea and post your comments under the idea.

Your tool

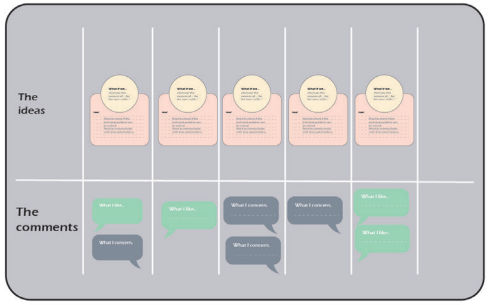


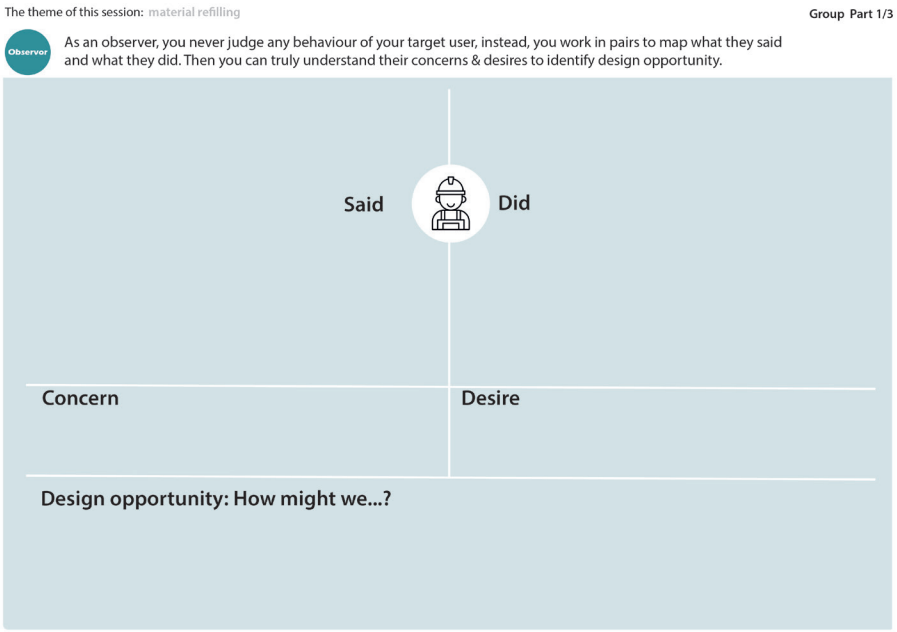
Critic

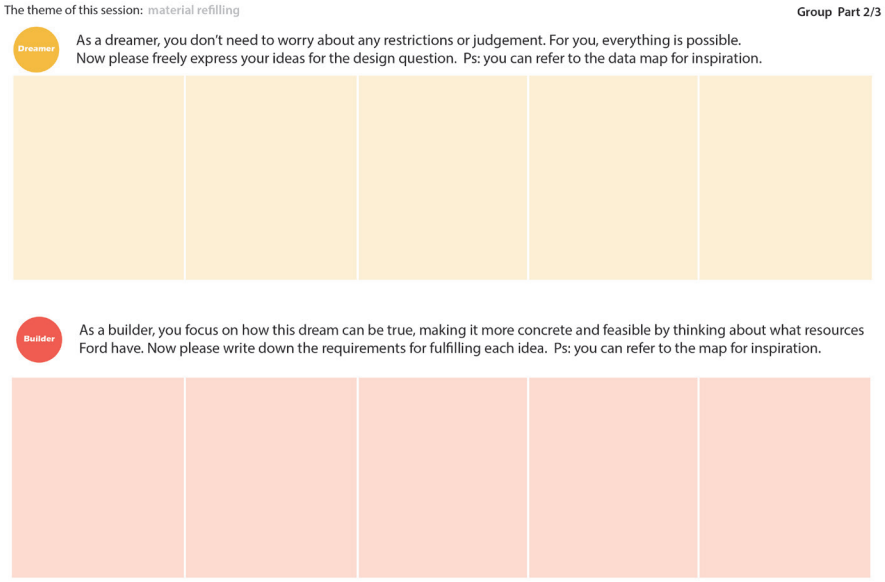
Express with affirmative judgement
Protect originality

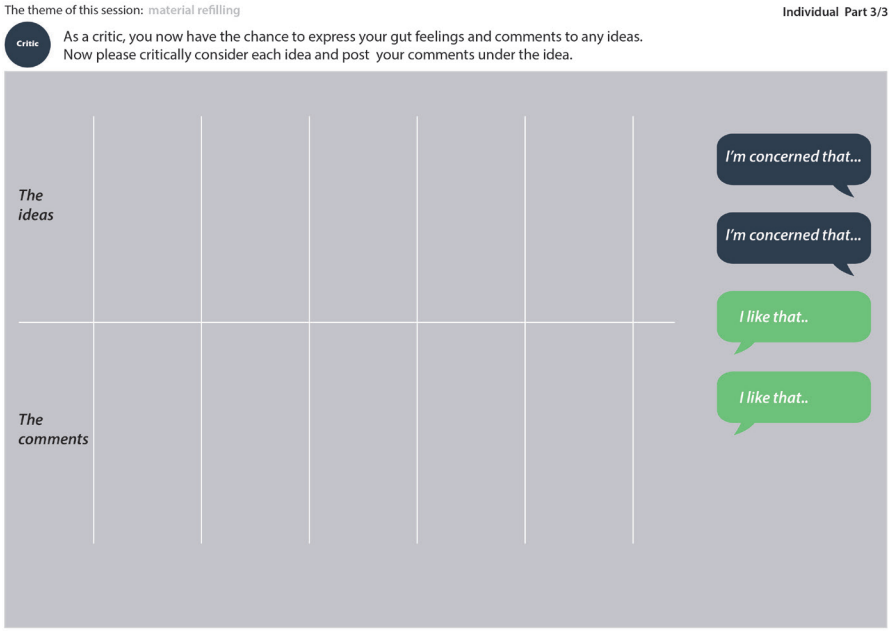
As a critic, you now have the chance to express your gut feelings and comments to any ideas. Now please critically consider each idea and post your comments under the idea.

Your tool









The template

As mentioned in design detailing, I selected the format template to deliver the "Said and Did map", "Idea development board", and "Idea gallery" because it can offer a framework, guiding questions and instructions to lead the participants to reach one's goals. As shown in the three templates (Figure 4.17), I desiigned the instructions and questions to guide the participants to reach the goal of each role: firstly, map said and did data, then generate ideas, map out more actions and finally evaluate ideas. It is worth noticing that the size of the template should be made as big as possible in both physical and online versions to encourage the number of insights and ideas.

Figure 4.17, the three templates as the workspace for the session participants to conduct design activities.

The card set

I designed the card sets to deliver the data combining strategies, creative techniques 5W1H, and SCAMPER since it can offer various options and add more fun thanks to the "random effect". I enlarged the keywords for the readers to understand the information efficiently and unified the visual style and colours for roles, as in the booklet.

For the data combining card set (Figure 4.18), the "when to use", "How to use", and "How to ask" are introduced with text for facilitating the participants to raise questions on data.

For the SCAMPER card set (Figure 4.19), I enlarged the keywords and kept the explanation in smaller font to simulate the participants to generate various ideas by trying to complete the questions on each card.

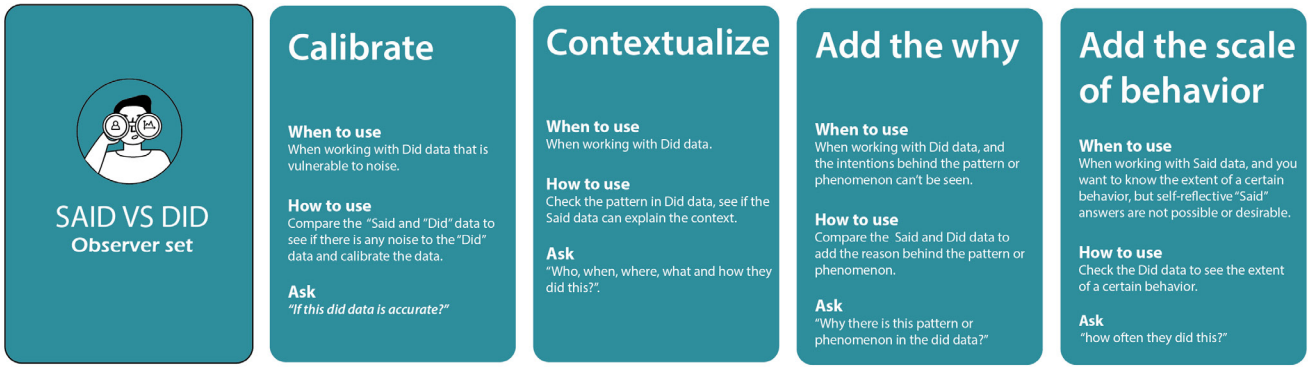


Figure 4.18, the data combining card set.

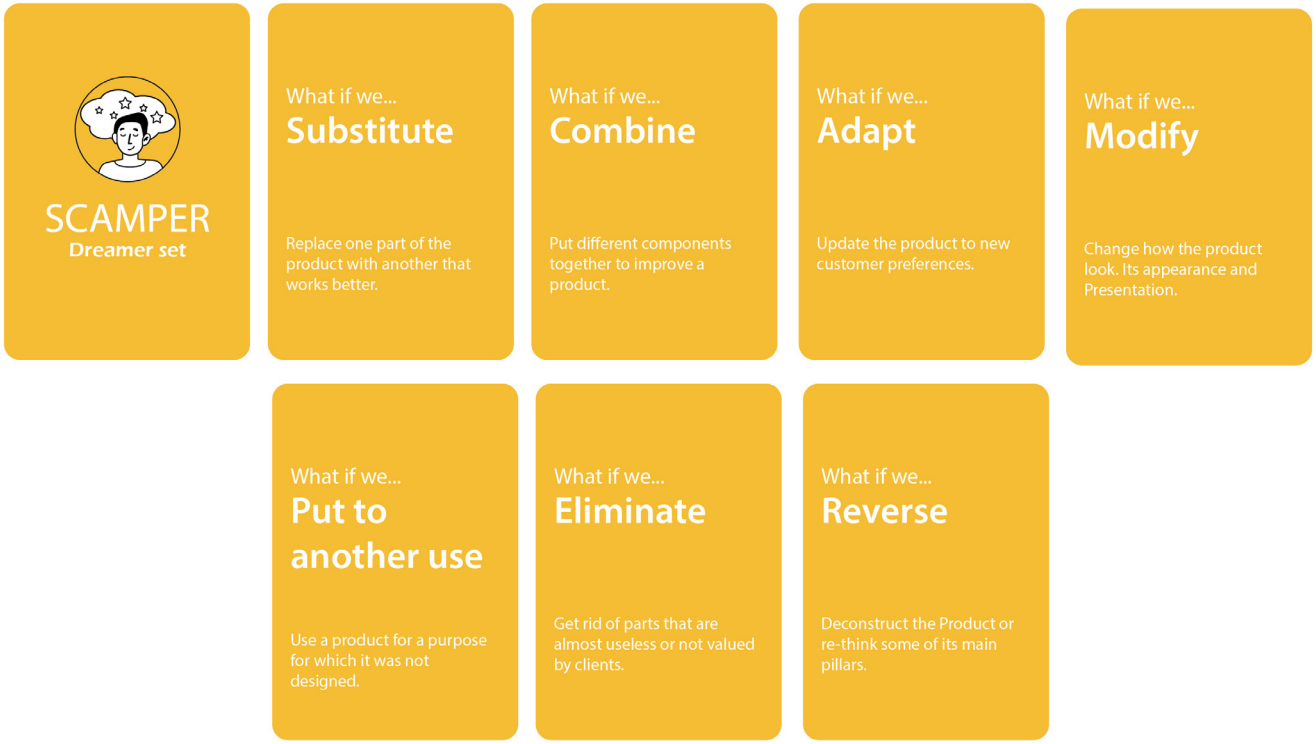


Figure 4.19, the SCAMPER card set.

I put the trigger questions straightforwardly for the 5W1H card set (Figure 4.20) since they are easier to understand than the data combining card set. So the participants can read the questions on these two card sets to reflect on the solutions.

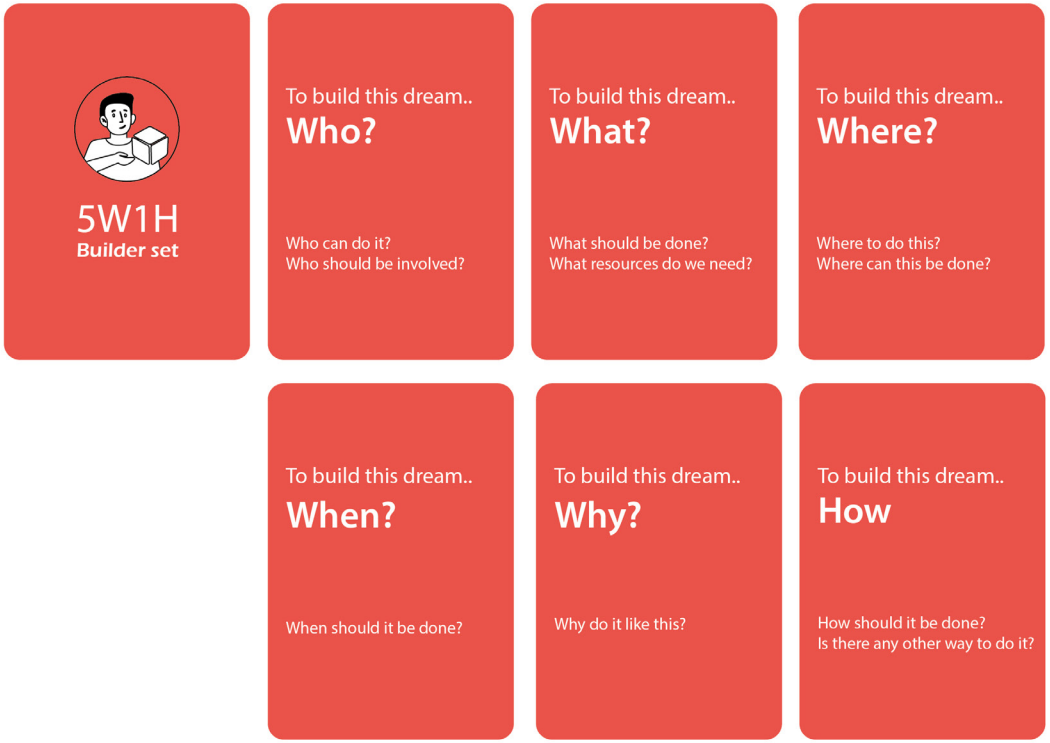


Figure 4.20, the 5W1H card set.

4.3 First-round evaluation on the toolbox

1. Evaluation plan

With previous concept design and design detailing, I proposed the toolbox, which aims to facilitate the creative session participants to generate insights from thick and thin data, and use the insights for creative problem solving process with creative thinking. More specifically, the toolbox aims to improve creativity on the outcome – the insights and ideas generated from the session, and on the process- the participant's interaction with data and application of creative thinking during the session. Therefore, I decided to run the first-round evaluation to examine and reflect on the toolbox.

The goal of the first-round evaluation:
To assess the impact of the toolbox on the creative session's outcome - insights and ideas generated from the session, and on the session's process - the participant's interaction with data and application of creative thinking during the session.

The basic setup and test goal are shown in figure 4.21. To test the toolbox's impact on the session outcome, I decided to minimize the effects of variables other than the independent variable-with toolbox or without the toolbox. Therefore, I decided to use a control test where two groups were given the same design brief, materials, time, and other variables, but different in the given approach - the toolbox or a basic design thinking guidance. I decided to conduct this test with design students with similar design experience to minimize the effect from participants themselves. Then, for the test on participants' interaction with data and creative thinking during the process, it is vital to test with the actual target group- the current Ford creative session participants-since the target group are with specific professional backgrounds and mindsets. Therefore, I invited the Ford creative session participants for the second test. A more detailed description of the two tests and results are presented in the following subchapters.

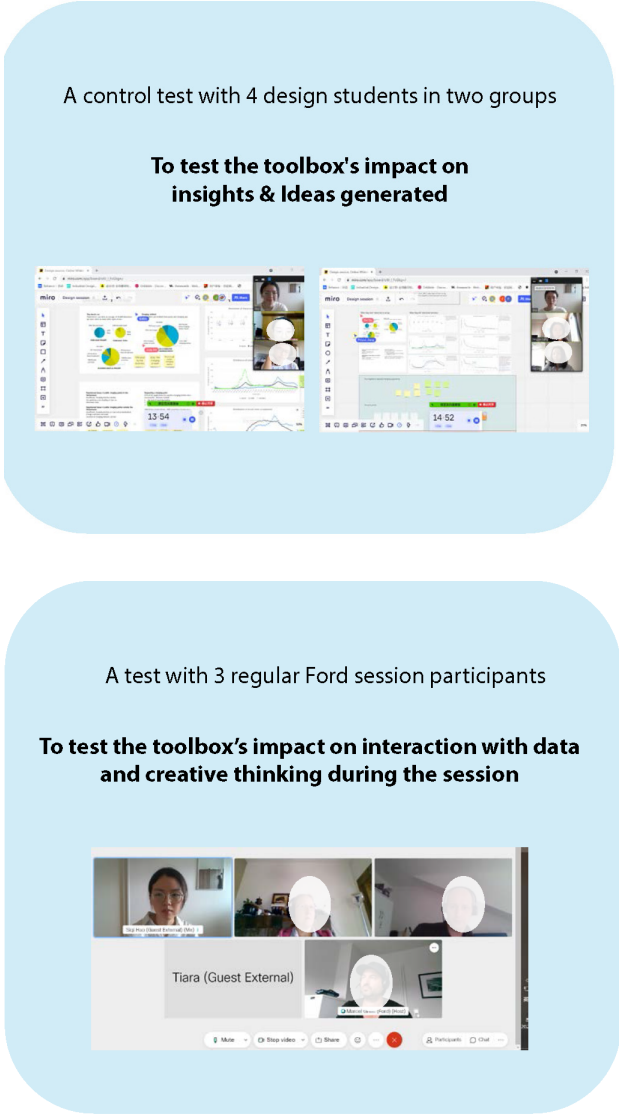


Figure 4.21, the set-up and screenshots of two tests.

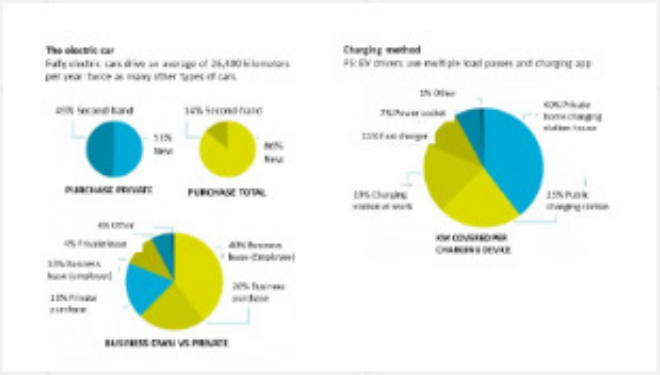
Welcome!

Today's theme: EV car charging experience

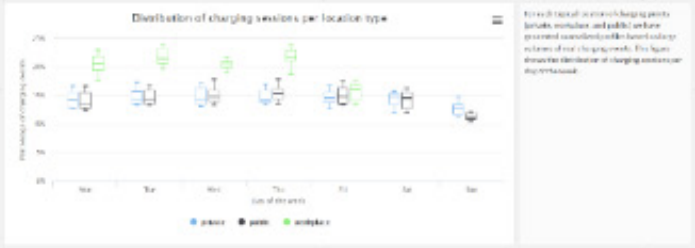
How can the current EV car charging experience in the Netherlands being improved?

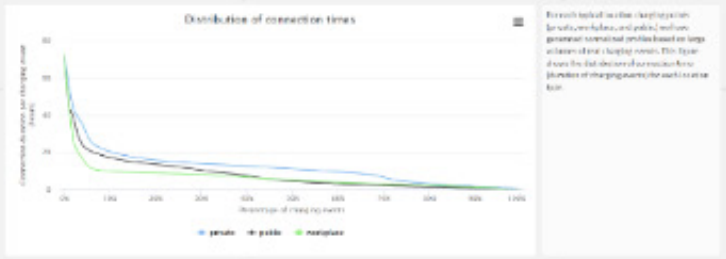
The data source- ElaadNL's research on EV car
Did data: from ElaadNL's historical trend monitors
Said data: from their survey

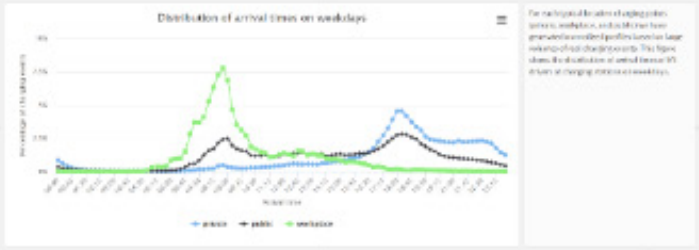
Said data from a survey

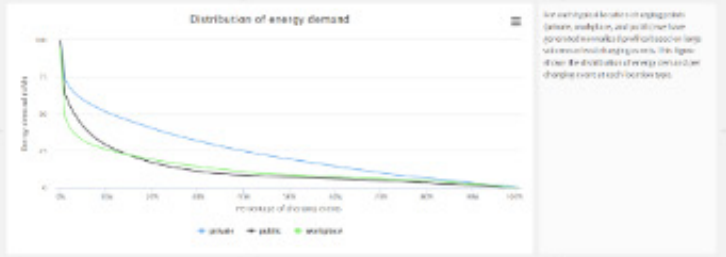


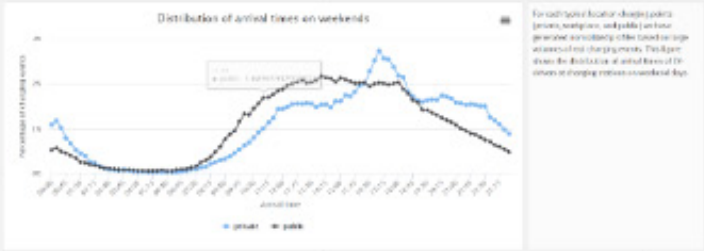
Did data from monitors











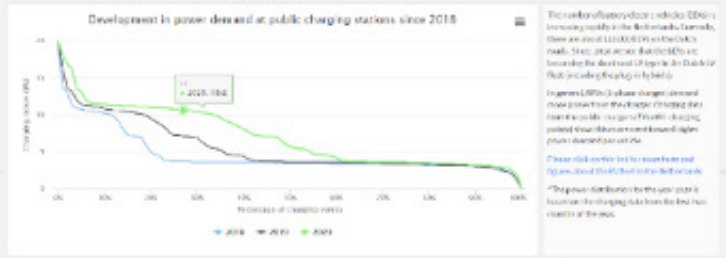


Figure 4.22, the introduction set up for both groups of the first test on Miro board.

2. The test on the toolbox's impact on the outcome of the creative session

Goal
To test the toolbox on its impact on the insights and ideas generated by participants from the session.

Method
I set up a control test to compare the insights and ideas generated with and without the proposed toolbox. Therefore, the two groups got the same time, materials, and guidance from the facilitator during the session. The toolbox group worked with the proposed toolbox, while the control group only got basic guidance in the text on creative problem solving, including the problem finding (problem framing) and idea finding (inspiration process) stage from the CPS model. The time for each stage was the same for the two groups. I facilitated the session and observed the participants' behaviour during the session. **After the session, I sorted the insights and ideas generated from the two sessions to compare the difference.**

Participant
To minimize the effect of the expertise on the design theme and design experience from the test participants, I invited four design students who are similarly experienced in design and inexperienced with data-enabled design and the session topic "E.V. car charging".

Material
Due to confidential issues, I could not use the data from Ford outside Ford, so I used the open data from ElaadNL, who conducted behavioural research within several projects and shared their user data from a survey in the Netherlands(Figure, 4.23) and their historical trend monitors on their website https://www.elaad.nl/research/ (Figure 4.24). Also because that their data is collected from vehicle-related context and corresponds with Ford's usage on thick and thin data. Since part of their research results is in Dutch, a translation by Google translate was done by myself to make all materials in English.

Duration
One and a half hours for each session, followed by a 30-min group interview.

Location
Online video meeting via Zoom and online whiteboard via Miro.

Figure 4.23, thick data translated from the survey result poster from ElaadNL

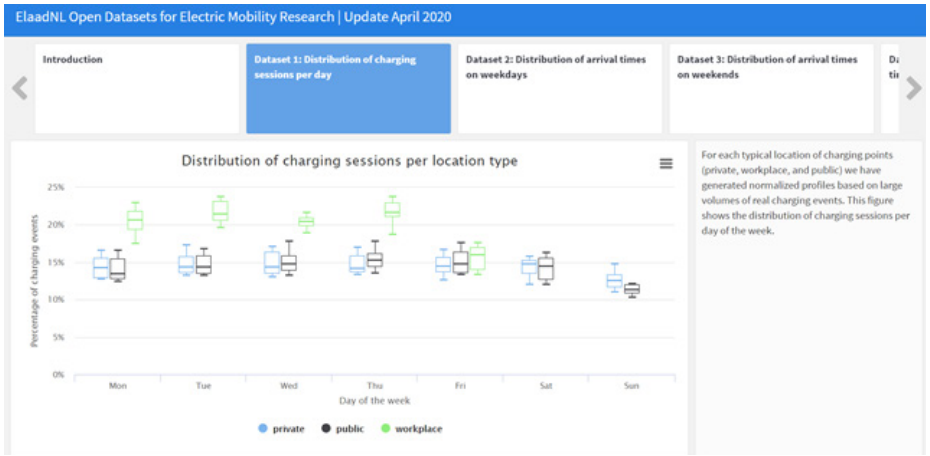


Figure 4.24, visualized thin data diagram from the open dataset of ElaadNL

Process

Two groups were first given a 10-min introduction on the design challenge and set-up (Figure 4.22). Then they were given 30 mins on analysing the same data (Figure 4.23, 4.24) and discussing insights. Then 10 mins were given for framing design opportunities and another 30 mins for ideation and ideas evaluation. The participants were asked to write their insights, questions, and ideas on the online whiteboard throughout the session. Afterwards, I conducted a group interview with the participants to gain feedback on their experience and interaction with data.

Result

Regarding the insights generated from data in the two sessions (Figure 4.25, 4.26), the participants were asked to write down insights from "said" and "did" data on yellow and green post-its separately and then identify further insights on user's concerns and design opportunities. It was observed that the group with the toolbox had more discussions about the intersection of the two data. The two groups produced very similar numbers of Insights and design opportunities. However, the toolbox group made questions that linked both types of data, as shown in figure 4.27. One participant raised the questions "How often do people have this issue of insufficient charge points?" and "What time do people usually charge?" when viewing the "Said" data, then the other participant discussed the insights from the "Did" data to answer these questions. Such discussions did not occur in the control group, where the participants reported "feeling clueless" when viewing the data individually.

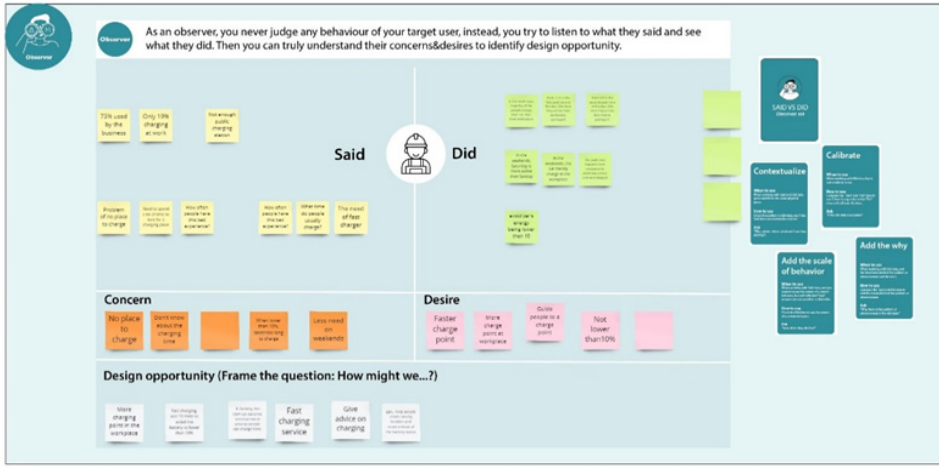


Figure 4.25, the insights generated from data with the toolbox.

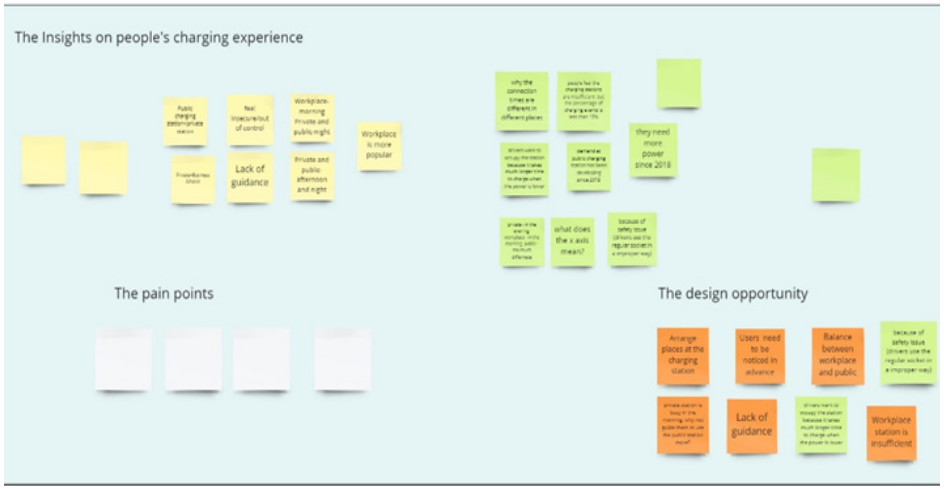


Figure 4.26, the insights generated from data without the toolbox.

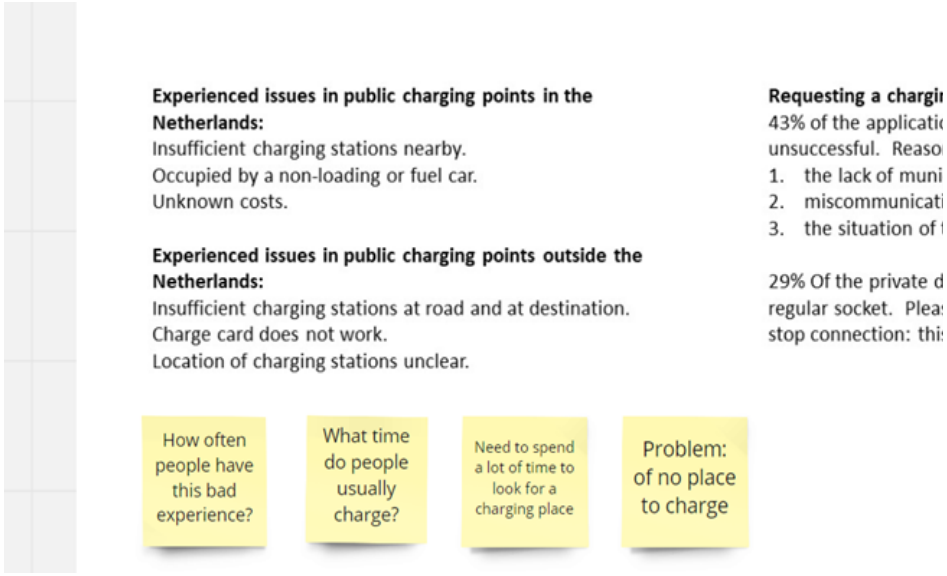


Figure 4.27, a screenshot from the toolbox group's board with questions and insights from participants on post-its.

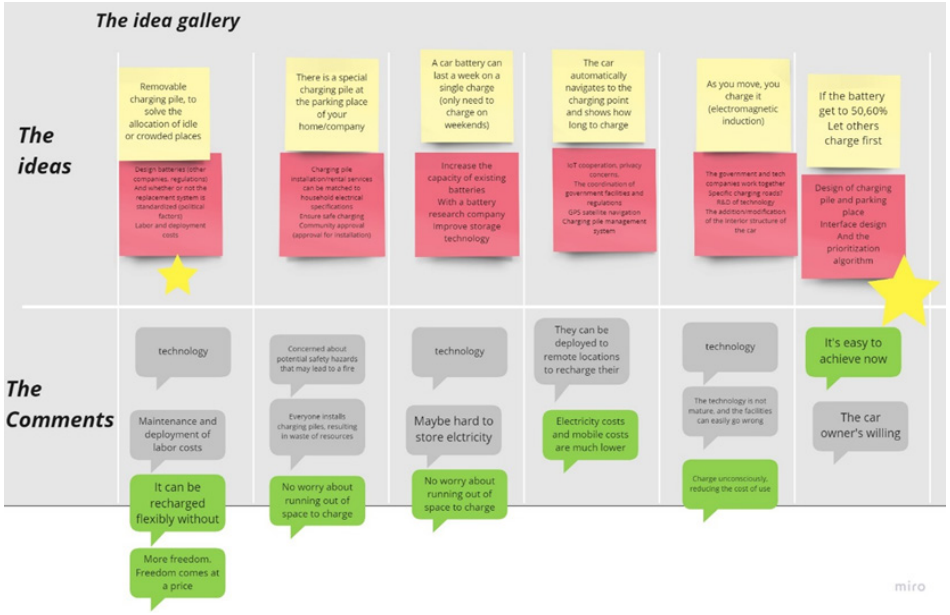


Figure 4.28, the ideas generated from two sessions with the toolbox.

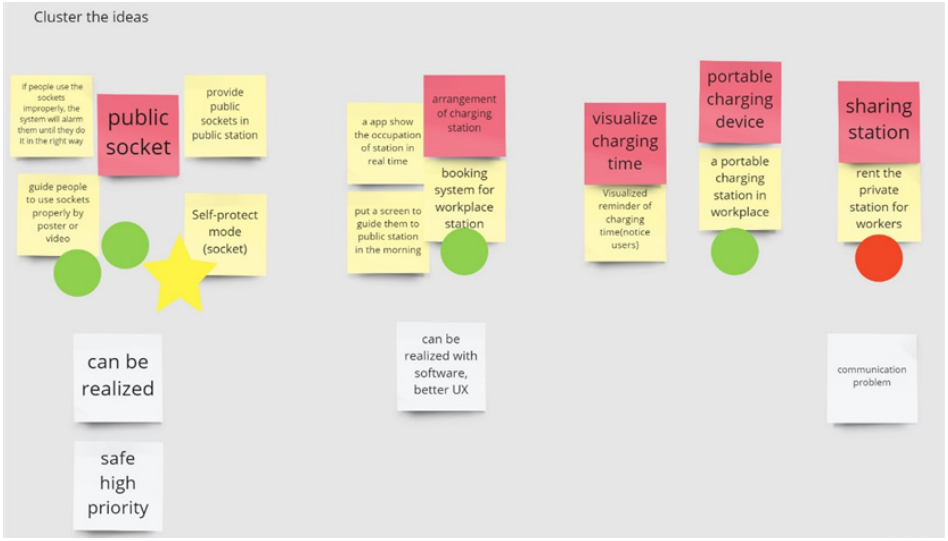


Figure 4.29, the ideas generated from two sessions without the toolbox.

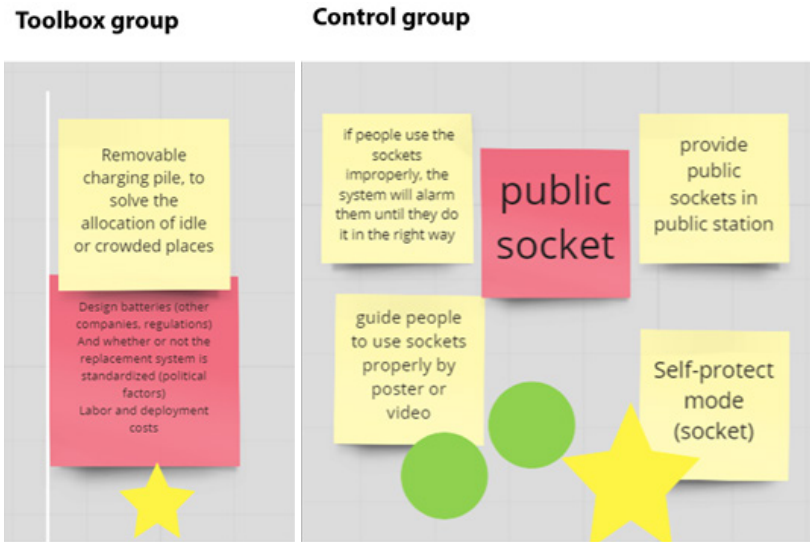


Figure 4.30, the single idea generated from two groups.

The ideas generated from the two groups are shown in Figure 4.28, 4.29. It can be seen that the two groups had generated a similar number of ideas. By comparing the ideas from two groups (Figure 4.30), it can be seen that the ideas from the toolbox group contain more detailed further actions and considerations such as "labour cost", "political factors", and " other company's regulations". In contrast, the ideas from the control group focused on the interaction between user and product.

Comparing the flexibility of the ideas generated (Figure 4.31), it can be seen that both groups had developed ideas about the management of charging stations, removable charging-pile, and navigation & reminders for the driver. At the same time, the toolbox group presents two new perspectives over the control group: performance improvements on the battery itself and a new charging method ("charging from the road").

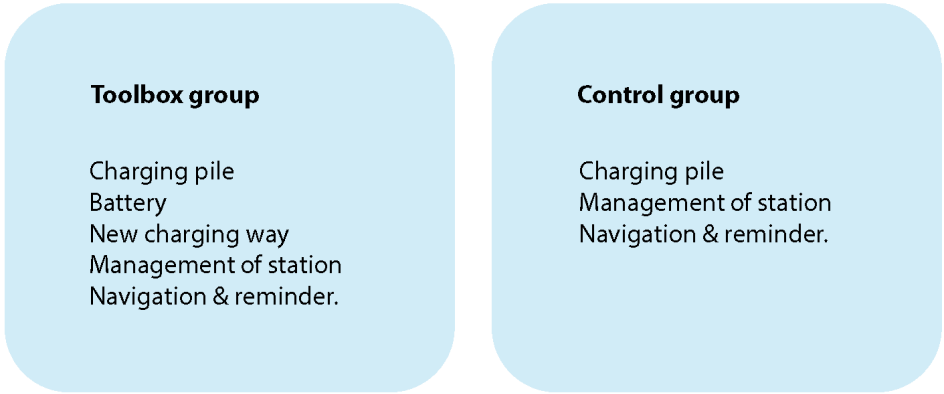


Figure 4.31, the perspectives of ideas from two groups

Conclusion
The toolbox had no significant effect on the number of insights and ideas generated during a session. The toolbox triggered questions and discussions on the intersection of the two data types, thus facilitating the participants to combine thick and thin data and generate insights for problem framing. Therefore, the interaction in design goal was sufficiently achieved in this test. Besides, the toolbox improved the flexibility of the ideas generated.

Limitation & Reflection
First, the boards for the control group was set up with guidance written by myself based on a design thinking approach and were quite different from the toolbox group, which might affect the reliability of the results since they add the variables to the control test. Then, the sample group is relatively small due to my limited capability in conducting tests, which might affect the precision and interpretation of the results.

Then, since all the participants are master students who majored in design, they are familiar with the creative problem-solving process and are very active in summarising insights and ideate. Therefore, it is impossible to tell whether the toolbox can engage participants without a design background. In addition, the given dataset from ElaadNL should have been sorted to be related to user behaviour and visualized with notes, so it could not be examined whether the toolbox is helpful to the preparation of the data before the session. However, these two issues can be examined in future tests with Ford's team and project.

3. Test on the toolbox's impact on the process of the creative session

Goal
To test the proposed toolbox on its impact on the human-data interaction and creative thinking during the session.

Method
A test with regular creative session participants on a design challenge from their ongoing project ("T project" as a code name for confidential consideration) was set up, where the participants were facilitated with the proposed toolbox. After the session, the participants were asked to reflect on their creative session experience and rate their experience. Then I conducted a group interview with three participants to collect their feedback on their interaction with data and the session. The rating questionnaire and interview questions are included in Appendix C. I analysed the rating result and their feedback from the interview to summarize the test result.

Participants
Three regular creative session participants from Ford with various professional backgrounds.

Materials
Sensor data and qualitative insights from the field research of the T project (Digital version) and the design challenge brief from the T project. The two types of data are from their existing research results and are not linked with each other. **Since the materials are confidential, I could not include the screenshots of the boards from the session.**

Duration
One-and-a-half-hour design session, ten-minute following individual rating on their experience with the toolbox and half-an-hour group interview

Location
Online video meeting via Zoom and online whiteboard via Miro.

Process
First, they were given a 10-min introduction on the theme and toolbox. Then, they were asked to work with the second roadmap, where the project manager &

researcher Marcel acted as the target user because they have limited capability to connect with the user due to Covid. Therefore, two participants first came up with questions from said and did data separately during the observer stage and wrote them down on post-its. Meanwhile, Marcel tried to answer the questions by writing down answers on post-its. After such 20-min Q&A, they were asked to discuss their insights from the data and Q&A for another 20 mins.

In later stages, Marcel turned back to a R&A team member and joined the ideation work. They came up with several ideas and gave their comments on each idea. Afterwards, they were given the questionnaire for rating their experience, and the following was the group interview.

Result
From my observations regarding the interaction with data, the participants tended to raise questions rather than summarise insights when looking at data, but such Q&A with data helped them summarise "concerns" and "desires" of the craftsman on the map. However, some raised questions were answered by Marcel, yet many remained unsolved. Besides, the participants were not active in coming back to the cards after they read them once.

From the rating result from the participants, they rated that the card set helped them combine thick and thin data and gave the feedback that they thought of as “an innovative method to combine two types of data”.

Regarding the creative thinking during the process, in the rating result, all participants rated the Role switch in the session "very helpful" in supporting divergent thinking. Moreover, they rated the session as very engaging and insightful. The complete rating result is included in Appendix D.

Conclusion
The “Said and did data map” facilitated the participants to combine thick and thin data by raising questions from one data and seeking answers. Also, the interaction with data is believed to be insightful and engaging. However, many questions could not be answered by given data since they were not complementary, which caused confusion among participants. Besides, role switch worked well in facilitating creative problem-solving and creative thinking. However, the badges were considered unnecessary by the participants.

Limitation & Reflection
The sample group is relatively small due to my limited capability in conducting tests, which might affect the precision and interpretation of the results. Then, I did not give clear instructions on the data preparation for the R&A team, which resulted in the lack of data preparation and complementary data collection. The complementary data is essential for generating insights on user behaviour, so the preparation stage should be better designed for getting complementary data.

4. Conclusion

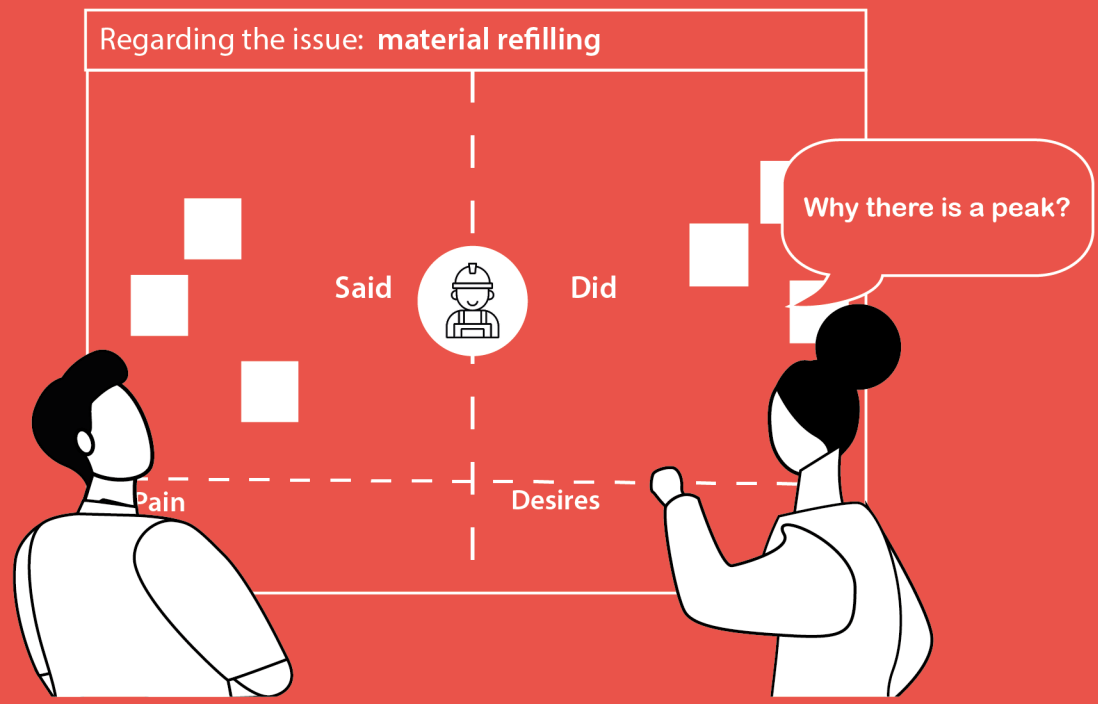
To sum up the two tests, the Role switch part of the toolbox supported creative thinking at different stages, and the "Said" and "Did" data map helped the participants raise questions and combine two types of data, but not sufficiently enough due to the lack of complementary insights to answer the questions raised by participants.

Moreover, the toolbox improved the number of insights from data combinations and the flexibility of ideas generated from the session. Besides, the badges were considered unnecessary since all participants could enter the roles without them; thus, they were removed from the toolbox.

The lack of complementary data greatly affected the data combination process. Therefore, to achieve the design goal and interaction vision, the participants’ interaction with data should be improved by overcoming the following main challenge: How to get complementary thin and thick data for data mapping?

Chapter 5

Design intervention



Frame Research Question

"How to facilitate the Ford R&A team to apply user data to enhance creativity for the ideation process?"

Conduct Literature research & Interviews

The research results were summarized in three perspectives.

Frame Design Goal & State List of requirements

"To facilitate the R&A team to contextualize thin data by combining thin with thick data and support the creative session participants to use data combinations for creative problem solving.."

Propose Design Directions

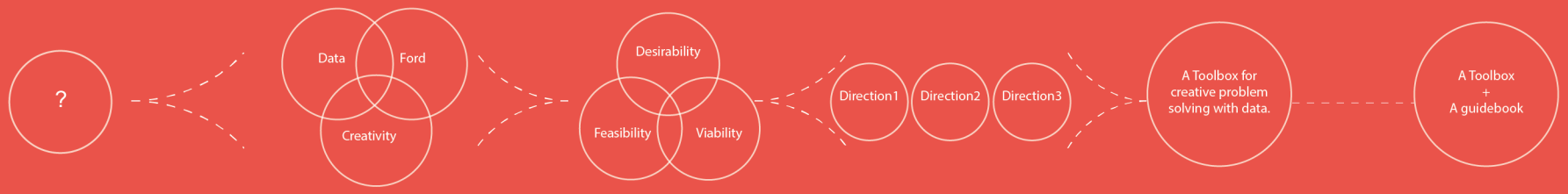
Three design directions were proposed and assessed according to the list of requirements.

Develop the concept by detailing and user test

The chosen concept "Toolbox" was developed with design detailing and tested with target user.

Revise the design based on evaluation results

Based on the evaluation, the final design intervention is delivered as a toolbox and a guidebook.



5.1 The design intervention

From the interviews with Ford R&A team members who participated in the previous toolbox test, I summarised that they found the data mapping stage of the toolbox most valuable since they believe it helps them combine the two types of data and ideate on product development. However, the biggest challenge they mentioned is that the current toolbox gives no clear instructions on obtaining the complementary data that can help them answer the questions raised from data mapping. This problem resulted in unanswered questions and uncombined data from the session in the first-round evaluation. Figure 5.1 shows a screenshot from the first evaluation as an unanswered question that requires more research to answer.

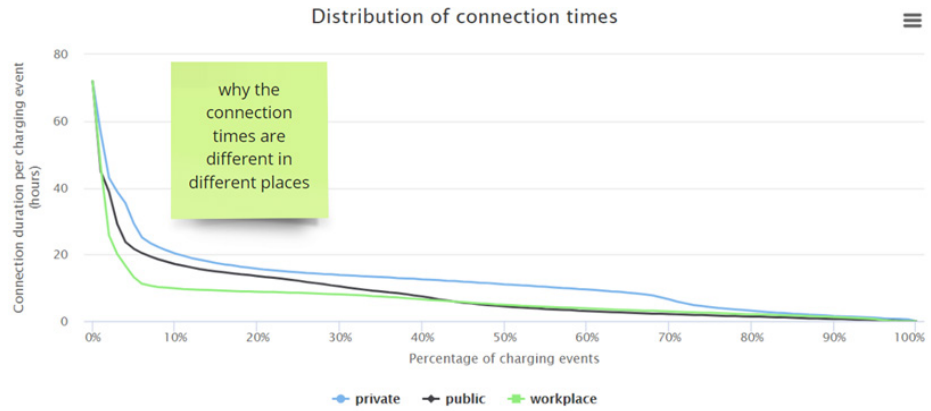


Figure 5.1, an example of an unanswered question from the session in the first-round evaluation.

To deal with this challenge, I decided to divide the data mapping stage into three steps. (Figure 5.2) The hypothesis for this decision is that the second step can support the R&A team to combine thick and thin data by the R&A team answering the questions with existing data or newly collected data.

First, the R&A team should dive into the "Said" and "did" data and raise questions by holding a session with R&A team members. Then to answer these questions, the R&A team should first try to find related information from available data. If they can not answer with existing data, they need to conduct more research to collect the required information to answer the questions. Afterwards, the R&A team can initiate ideation sessions with more participants with different expertise to ideate with the data combination. The revised concept aims to help the team collect complementary data and combine said and did data in this three-step way.

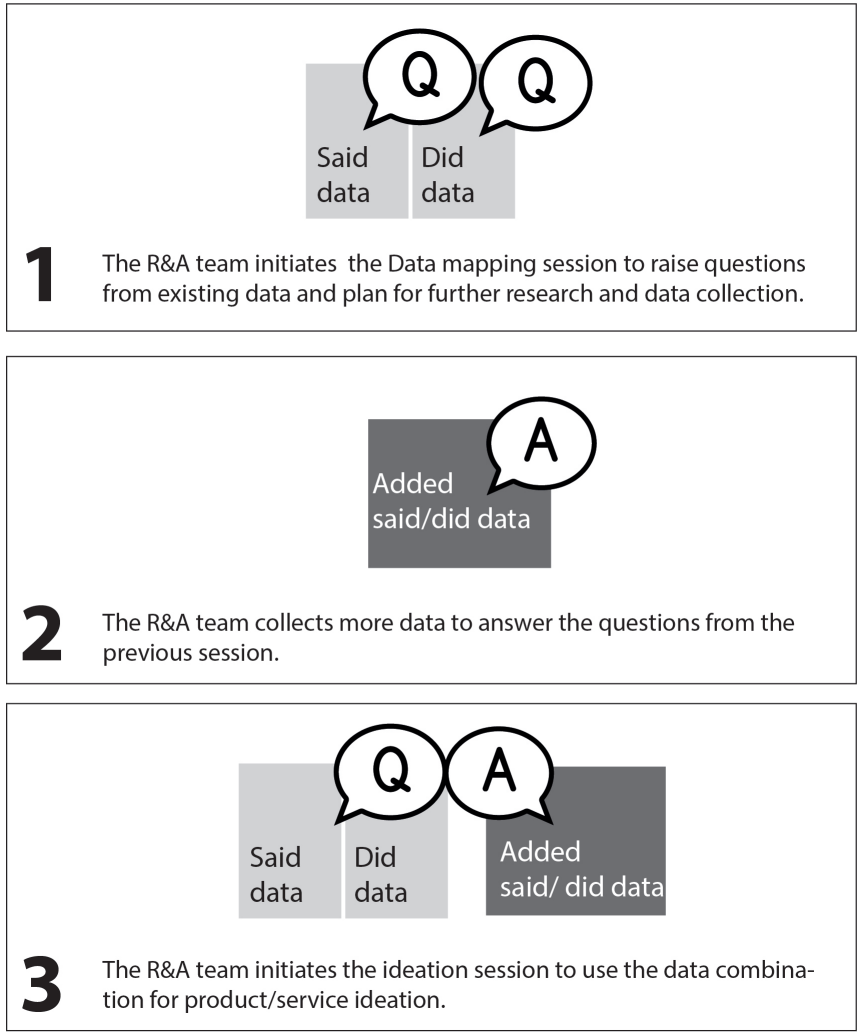


Figure 5.2, the three steps to get data combination for Ford R&A team.

This three-step process is linear, but there is also the possibility that new problems may arise in the third step. In this case, the problem should be retained first to complete the ideation of the third step. After that, the R&A team should decide whether to go back to the second step to answer the question based on the existing insights and ideas and the importance of the new questions. Since the ultimate goal is to generate insights and ideas for product development, the workload of data collection and implementing the three steps should be determined by the R&A team according to the results they expect.

Regarding the representation of this revised concept, the discussion with the Ford mentor and project manager Marcel inspired me with the feedback "make it like a recipe", which means that he would like to have very detailed and step-by-step instructions on how to plan and conduct the data combination and ideation.

This analogy coincides with my analogy in the interaction vision, "Make the process like doing a chemical experiment", which means that the "formula" - step-by-step instructions and expected results- should be provided for the R&A team.

With this interaction vision, I chose the form of a guidebook to explain each phase, the required persons, materials, tools and step-by-step directions for the project manager and facilitator. Figure 5.3 shows that this guidebook contains a one-page introduction

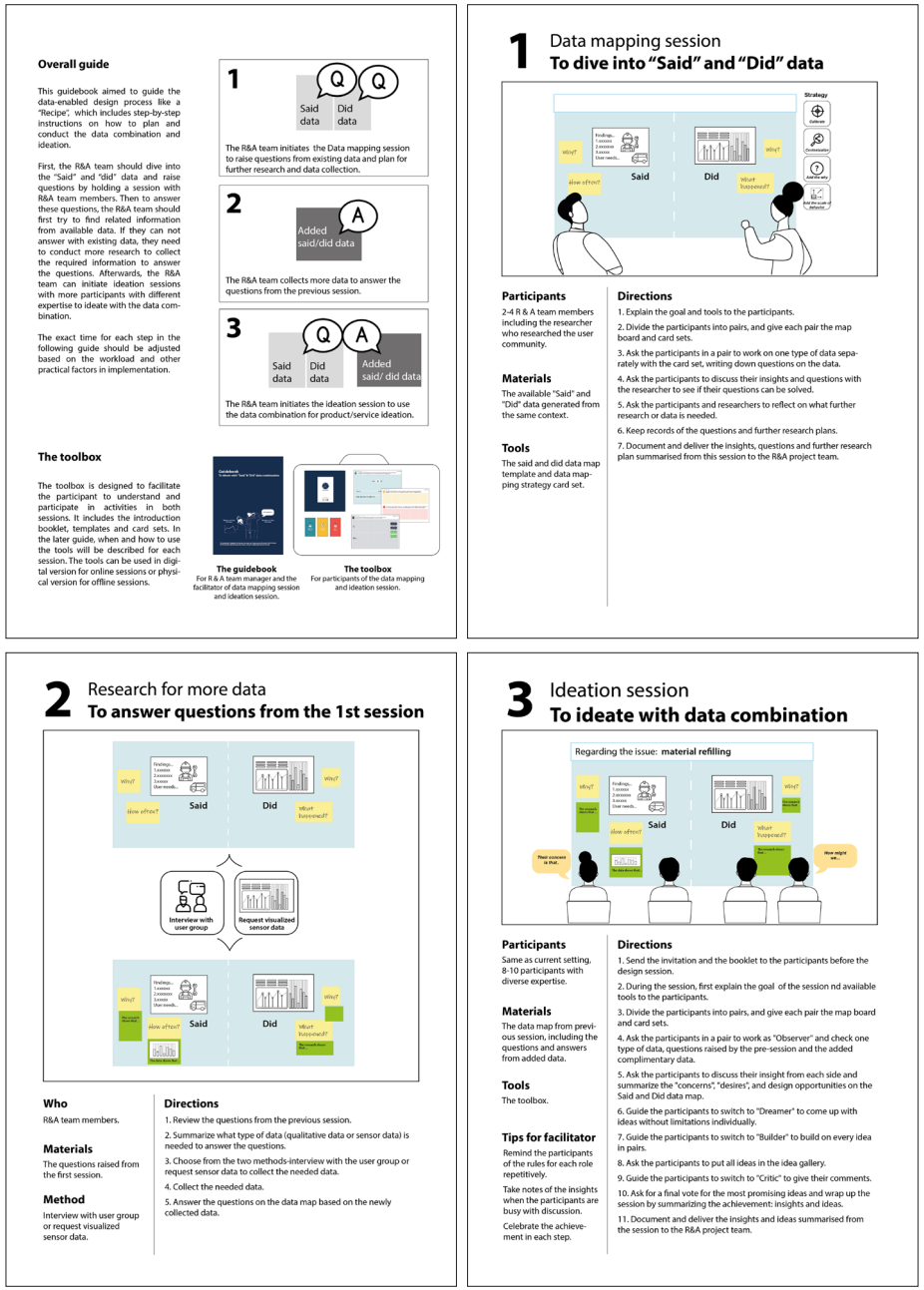


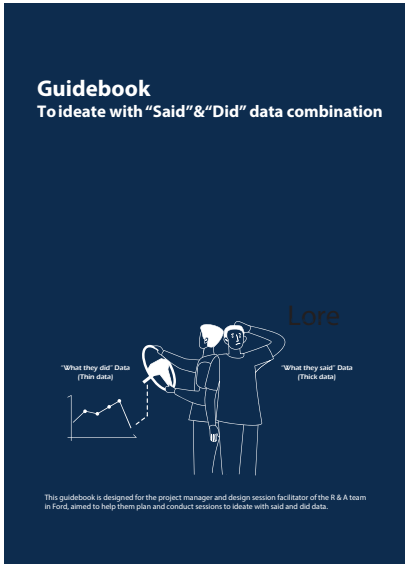
Figure 5.3, a one-page introduction and three subsequent pages of detailed directions on the three continuous phases from the guidebook.

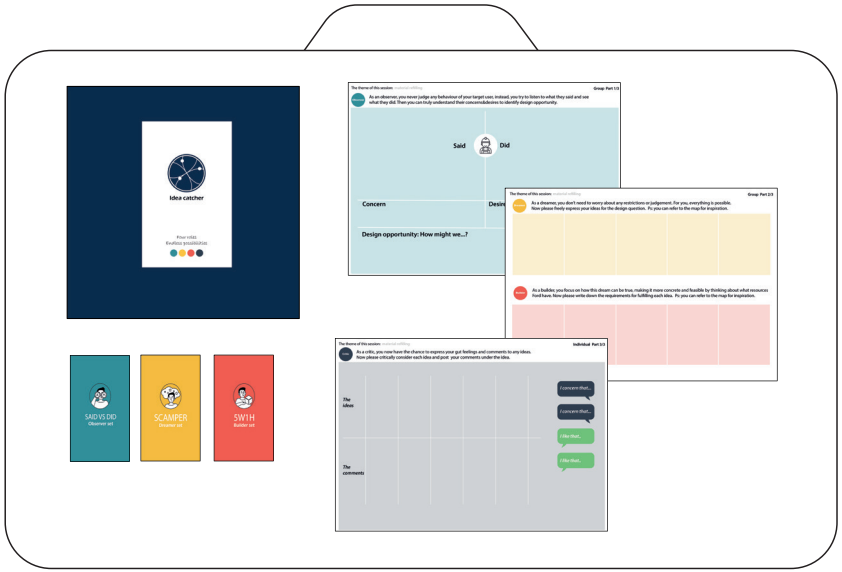
and three subsequent pages of detailed directions on the three continuous phases. The directions are proposed based on the reflections from previous tests and research on the workflow of the R&A team.

To sum up, the design intervention includes two parts: the guidebook and the toolbox. The guidebook is designed for the R&A team manager and facilitator to plan and conduct continuous sessions and research to combine thick and thin data. Meanwhile, the toolbox is designed for the participants of the data mapping session and ideation session to finish the session's goal.

The two parts support each other but target two different groups of people. Therefore, I decided to present them as two components of my final design intervention.

Since the previous tests have evaluated the toolbox's impact on the process and outcome on data combination in the ideation session, the next step is to evaluate the guidebook as the newly added part and the overall final concept.





The guidebook

This guidebook is designed for the R&A team manager, and the facilitator of the data mapping session and ideation session, aiming to support the Ford R&A team to plan and conduct data-enabled design.

The toolbox

This toolbox is designed for the data mapping and ideation session participants, aiming to facilitate the participants to generate insights from data mapping and then ideate with insights from data.

5.2 Second-round evaluation on design intervention

The final design added the guidebook to the toolbox, which is a booklet that introduces the whole process to ideate with data and gives guidelines to the R&A team for implementing each stage.

The goal of the second-round evaluation: To assess the usability and feasibility of the guidebook and then assess the desirability, feasibility and viability of the final concept, including the guidebook and toolbox, by reviewing the list of requirements raised before.

In order to get the feedback from the final target audience of the guidebook, I decided to conduct the final evaluation in the form of an interview with the project Manager because interviews allow me to gather detailed feedback and opinions from the interviewee efficiently. The interview questions were designed first to evaluate the guidebook and then the entire concept, including the guidebook and toolbox. The interview questions are put in Appendix E. I first presented the guidebook to the R&A project manager and then conducted the interview. Afterwards, I sorted the transcript and interpreted the interviewee's answers as follows.

Assessment result of the guidebook
The project manager believes that the three-stage revised concept can help them collect and combine thick and thin data. Regarding the directions in the guidebook, he believes the guidebook offers clear and feasible instruction on the whole approach.

"So I think that's definitely the right route to find a way to connect this to different data already and see if there to be some adjustments in terms of collecting more data or collecting more specific data because things get set up the answer to this first step, we're going with a well-connected database, qualitative and quantitative database to the ideation later... And it's good to give us clear guidelines, I think it make sense and the instructions are understandable!"

The project manager believes that the first session and second research stage are even more critical for the later ideation, and he thinks they would like to try later in their practice.

"Maybe even the pre-session is maybe more important than the ideation itself. Because you do the groundwork here for the later ideation. I think that it's an important step. So I think really, that let's say get this to know is re-evaluated if this will work in our work environment, I think we would have to try it."

Assessment result of the toolbox
Regarding the tools in the toolbox, the project manager believes that the data map and data map card set are of the most value for them from this project since it offers an innovative way for them to interact with different types of data. While for other tools, he believes they are replaceable and thus not that critical for this data-enabled design process.

"...But I think it's open for anyone to use the ideation things itself. Later on, the idea gallery, it's the same. So there are many different ways of visualising the ideas and structured and organised. And I think it's always a good thing to try out new ways. However, the first thing the data map. I think this is in your thesis the most critical work and this is also the thing that I don't have a solution yet, where you really give an innovative way."

The project manager believes that the roles designed in the toolbox are of great value for the session participants to think differently and ideate with divergent thinking,

"I think that this is a very valuable thing in general because different roads always trigger your new beliefs and new ideas. So, it's always good with work in different roles."

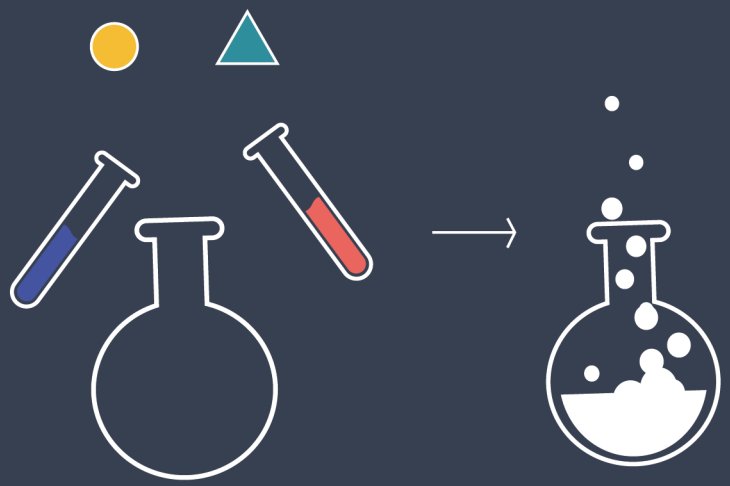
Assessment result of the overall concept

The project manager believes that the final design achieves well on their requirements in the disability aspect: to bring data into the ideation

session in an innovative way, which he believes is the most crucial aspect in the innovation model for this project. At the same time, he believes the concept to be feasible and viable, which they could only evaluate and give more feedback through their future practice with actual project.

Reflection on the second-round evaluation

Even though the project manager of the Ford R&A team gave very positive feedback to the final design intervention, I should also reflect on the limitations of this evaluation. First, the evaluation was conducted with only one project manager, which makes it limited to the practice of one Ford R&A team and hard to speculate the feasibility of the design intervention for the other Ford R&A teams. Then, as mentioned by the interviewee, the final design intervention can only be tested in the actual practice, so there are chances of unforeseeable problems with this design intervention. Finally, this evaluation is only limited to Ford's context, so whether the design method I have proposed is usable for other design teams or organisations can not be evaluated through this evaluation. I believe the generalization of this design intervention requires more assessment with other design or research teams by interviews or tests.



Chapter 6
Conclusion & Recommendation

Frame Research Question

"How to facilitate the Ford R&A team to apply user data to enhance creativity for the ideation process?"

Conduct Literature research & Interviews

The research results were summarized in three perspectives.

Frame Design Goal & State List of requirements

"To facilitate the R&A team to contextualize thin data by combining thin with thick data and support the creative session participants to use data combinations for creative problem solving. "

Propose Design Directions

Three design directions were proposed and assessed according to the list of requirements.

Develop the concept by detailing and user test

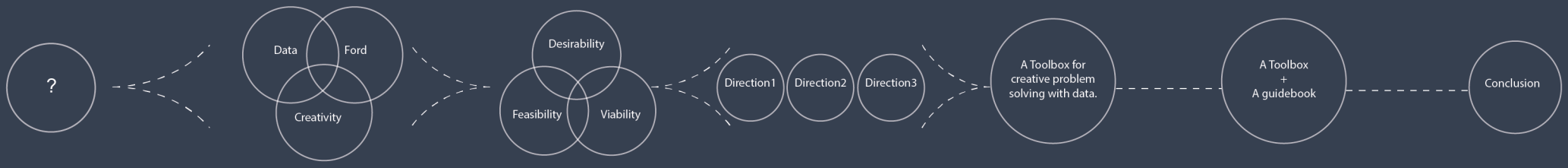
The chosen concept "Toolbox" was developed with design detailing and tested with target user.

Revise the design based on evaluation results

Based on the evaluation, the final design intervention is delivered as a toolbox and a guidebook.

Evaluate & Conclude

The reflections and conclusions were made based on the evaluation.



6.1 Conclusion

Looking back at the process of this project, I first conducted interviews to investigate Ford's internal practice on data and ideation and summarized the challenges and visions of applying data for ideation in Ford. Then, I reviewed the theories and practices related to data-enabled design and creativity, leading to a summary of potential approaches and methods for Ford. Afterwards, in the design stage, the core design concept was to bring thick and thin data into the ideation session through the tool "Said and did data map" in the toolbox, while another main design element-the role switch aims to facilitate the session participants with different thinking modes. Identified from the first round of evaluation with students and the Ford team, the main problem was that the collection of complementary data could not be completed in the middle of the session. Then, I proposed a three-step process for getting data combinations and designed a guidebook containing step by step instructions. With a second round of evaluation by interviewing the Ford project manager, the final concept is assessed on its usability, desirability, feasibility and viability. Now it is time to conclude this project along with critical reflections and future recommendations.

First, regarding the research question of this project:

"How to facilitate the Ford R&A team to apply user data to enhance creativity in their ideation process?"

I disassembled the research questions into three perspective-Ford, Data and Creativity, and proposed sub research questions for each perspective. Then the research on each question was conducted in the research chapter. In conclusion, to facilitate the Ford R&A team to apply data in the ideation process, it is needed to design the process, methods, and tools for the Ford team to generate insights from thick & thin data combinations for the problem framing process, thus enhancing creativity.

Regarding the contribution of this project to data-enabled design, previous studies on data-enabled design only proposed the theory and strategies for combining thick and thin data but did not provide the specific steps, methods, and tools for practical implementation. Besides, the design process was relatively organic and dependent on the designer or researcher's decision in previous studies. In my project, I first proposed three data-enabled design approaches - convergent approach, exploratory approach and explanatory approach, and map out all the people involved in this process and their specific actions. **The "said and did data map" is an original tool to bring thin data into design sessions, thus facilitating researchers and designers to understand data, combine thin and thick data, and in the end, contextualize data to generate insights on user behaviour.**

Moreover, the three-step method for combining thick and thin data also fill the method gap for the implementation of data-enabled design in organizational practice, making the process and available methods explicit for the project team to conduct data-enabled design session.

Then, regarding the design goal and interaction vision of this project:

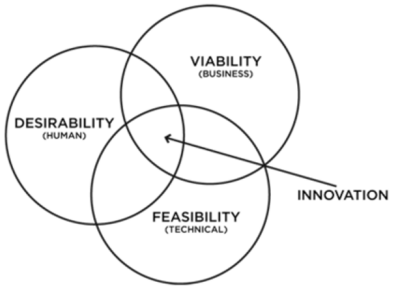
Design goal: To facilitate the R&A team to contextualize thin data by combining thin with thick data and support the creative session participants to use data combinations for creative problem solving.

Interaction vision for R&A team and session participants: Their interaction with data should be instructive, engaging, insightful, convincing and creative, like doing a chemistry experiment.

Based on the evaluation result from the two rounds of evaluation, it can be concluded that the design intervention did offer an innovative way for the Ford team to analyse data, combine thick and thin data and then ideate with data with the creative problem-solving approach, which means that the final design intervention sufficiently fulfils the design goal.

Regarding the interaction vision, it can also be concluded that the interaction vision is sufficiently achieved base on the test with the Ford R & A team, where they gave pretty positive feedback on the data mapping tool.

In the end, with a check on the list of requirements again, I highlighted the requirements that are assessed as achieved based on the previous two rounds of evaluation (Figure 6.1). It can be concluded that the final concept is sufficiently desirable for the target group-Ford R & A team and theoretically meet the requirements to be feasible and viable according to the team manager, which could be tested in their future work practice.



Desirability

• Empower participants and facilitators without design. thinking background to have a creative mindset during the session.

• Engage the participants without data or design background to interact with data and draw insights on user behaviour.

• Enhance the quantity of ideas generated from the session.

• Enhance the flexibility of the ideas (diverse perspectives) generated from the session.

Viability

• Cost-effective to be adapted by the R&A teams.

• Measurable and visible effects ("KPI") from this toolbox, including the feedback from R&A teams and assessments on ideas.

Feasibility

• Feasible to be built and adapted by the facilitator of different R&A teams.

• Fit in with Ford's data and design capability to get the materials prepared for this toolbox.

Figure 6.1, the final assessment by the list of requirements, the requirements in green means to be evaluated as sufficiently achieved.

6.2 Limitation & Recommendation

First, the tests designed in the first-round evaluation were designed to test the impact of the whole toolbox, including a series of tools. However, in the later feedback session, it was pointed out by the Ford R&A team that the "said" and "did" data map tool should be given more focus since this tool is considered as the core contribution to their team. Therefore, further tests of the template and strategy card set included in this tool should be done to improve its usability and feasibility. Since the tool's goal is to facilitate user's interaction with data and the combination of thick and thin data, I should design tests to measure the data combinations and insights generated from the usage of this tool and assess the user's interaction with the tool.

Then, the current evaluation on the final design intervention is only through the feedback from one project manager instead of actual tests, which means that there are chances of unforeseeable problems in the actual practice. The recommendation for this limitation is to test the feasibility and viability of the guidebook in the Ford team's practice within their context. With the feedback from practice, the design intervention can be further adjusted and improved, especially the detailed directions that remain unexamined. Moreover, it is unknown if other design teams or organizations can apply this design intervention for their data-enabled design practice, which requires more assessment by other design/research teams by interviews or tests.

Finally, this project is part of the Ford Data Enabled Design collaboration. As shown from the previous tests, the selection and visualization of data can significantly impact the later mapping and analysis. Therefore, the research results of this project should be delivered to the other graduation students doing related projects so that the design intervention of different projects can be connected and even integrated. First of all, I can initiate a creative session to allow other students to join as participants to apply the proposed toolbox. Then, we can discuss how their project can be connected with my project and whether it can be delivered to Ford and tested in the project practice after integration.

6.3 Reflection

This project was my first attempt at method design, and overall, I think I achieved my learning objectives on gaining knowledge on data-enabled design and creativity, though I had some problems combining the knowledge learned with Ford's workflow in the design stage. I have completed intensive literature research and learned a lot about data-enabled design and creativity in the research stage. However, some design decisions made at the early design stage were not well combined with the Ford team's capability and workflow. I can recall that these design decisions were also questioned by my mentors back then, but I focused too much on limitations from Ford's context and was hesitant to test the concept because I was afraid of failure. However, it was the later tests that gave me confidence and courage to revise the concept. So, the lesson is that the test on the proposed process and tools should be well designed to gain reflections for method design.

I think the subsequent adjustments and guidebook have theoretically solved the problems found in the tests, although there is no actual test on the adjustments due to the time limit and the Ford team's availability. Still, I am personally satisfied with the outcome of this project since it has fulfilled my design goal and has been recognized by Ford Team. Last but not least, I want to deliver my sincere appreciation to the academic and mental support from the supervisory team during the project. It was a long and challenging journey, but they helped me set up a "growth mindset" to face the difficulties and do responsible design!

7 Reference

A

Admin, I. U. (2017, May 25). *How to Prototype a New Business.* IDEO U. https://www.ideou.com/blogs/inspiration/how-to-prototype-a-new-business

B

Bacciotti, D., Borgianni, Y., & Rotini, F. (2016). An original design approach for stimulating the ideation of new product features. *Computers in Industry*, 75, 80-100.

Bachelor, P. A., & Michael, W. B. (1997). The structure of intellect model revisited. In M. A. Runco (Ed.), T*he creativity research handbook: volume 1* (pp. 155–182). New York: Hampton Press.

Brown, R. T. (1989). Creativity. In *Handbook of creativity* (pp. 3-32). Springer, Boston, MA.

C

Cardoso, C., Badke-Schaub, P., & Eris, O. (2016). Inflection moments in design discourse: How questions drive problem framing during idea generation. *Design Studies*, 46, 59-78.

Chan, J., Fu, K., Schunn, C., Cagan, J., Wood, K., & Kotovsky, K. (2011). On the benefits and pitfalls of analogies for innovative design: Ideation performance based on analogical distance, commonness, and modality of examples.

Correll, M. (2019, May). Ethical dimensions of visualisation research. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1-13).

Creswell, J. W., & Clark, V. P. L. (2017). *Designing and Conducting Mixed Methods Research* (3rd ed.). SAGE Publications, Inc.

D

De Bono, E. (2017). *Six thinking hats.* Penguin uk.

De Jong, E. (2020). Ford service innovation: A toolbox for innovators: How to create valuable and meaningful services for real people.

Dorst, K., & Cross, N. (2001). Creativity in the design process: Co-evolution of problem-solution. *Design Studies*, 22(5), 425-437.

Dorst, K. (2011). The core of 'design thinking'and its application. *Design studies,* 32(6), 521-532.

E

Elmansy, R. (2015). Disney's creative strategy: The Dreamer, the realist and the critic. Retrieved on July, 2, 2016.

G

Goldschmidt, G., & Smolkov, M. (2006). Variances in the impact of visual stimuli on design problem solving performance. *Design Studies*, 27(5), 549-569.

Gonçalves, M., Cardoso, C., & Badke-Schaub, P. (2012). Find your inspiration: exploring different levels of abstraction in textual stimuli. In D.S. 73-1 Proceedings of the 2nd International Conference on Design Creativity.

Gorkovenko, K., Burnett, D. J., Thorp, J. K., Richards, D., & Murray-Rust, D. (2020, April). Exploring The Future of Data-Driven Product Design. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems. https://doi.org/10.1145/3313831.337656

Guilford, J. P. (1967). Creativity: yesterday, today and tomorrow. *Journal of Creative Behavior,* 1(1), 3–14. doi:10.1002/j.2162-6057.1967.tb00002.x.

H

Heijne, K., Meer, H., & van der Meer, H. (2019). *Road map for creative problem solving techniques.* Amsterdam University Press.

Herissone, R., & Howard, A. (Eds.). (2013). *Concepts of Creativity in Seventeenth-Century England.* Boydell & Brewer Ltd.

Hidalgo, D. (2020). Exploration of data as a design material for sensemaking and creativity.

Hnatiuk, S. (2016). Ford Service Innovation for micro handymen enterprises.

Hosseini, M. (2009). *The utility of roleplaying methods in design* (Doctoral dissertation, School of Interactive Arts & Technology-Simon Fraser University).

J

Jansen, P. (2021). Implementation strategy of a data enabled service design process at Ford.

K

Kelley, T., & Kelley, D. (2013). *Creative confidence: Unleashing the creative potential within us all.* Currency.

Kittur, A., Yu, L., Hope, T., Chan, J., Lifshitz-Assaf, H., Gilon, K., ... & Shahaf, D. (2019). Scaling up analogical innovation with crowds and AI. *Proceedings of the National Academy of Sciences,* 116(6), 1870-1877.

Klein, G. & Moon, B. (2006a) 'Making sense of sensemaking 1: Alternative perspectives', *IEEE Intelligent Systems*, 21(4), pp. 70–73. doi: 10.1109/MIS.2006.75.

Kun, P., Mulder, I. J., & Kortuem, G. W. (2018). Data Exploration for Generative Design Research.

Kun, P., Mulder, I., & Kortuem, G. (2020). Developing a Design Inquiry Method for Data Exploration. *IxD&A,* 45, 180-206.

L

Lockton, D., Harrison, D., Cain, R., Stanton, N., & Jennings, P. (2013). Exploring problem-framing through behavioral heuristics. *International Journal of Design*, 7(1), 37-53.

M

MacKinnon, D. W. (1970). Creativity: A multi-faceted phenomenon. In. D. Rodlansky (Ed.), Creativity: A discussion at the Nobel conference (pp. 17-32).

Marti, P., Megens, C. and Hummels, C. (2016) 'Data-enabled design for social change: Two case studies', Future Internet, 8(4). doi: 10.3390/fi8040046.

McFadzean, E. (1998). Enhancing creative thinking within organisations. *Management Decision*, 36, 309-315

Mumford, M. D., Marks, M. A., Connelly, M. S., Zaccaro, S. J., & Johnson, J. F. (1998). *Domain-based scoring in divergent-thinking tests: validation evidence in an occupational sample. Creativity Research Journal,* 11(2), 151–163. doi:10.1207/s15326934crj1102_5.

O

Onarheim, B., & Friis-Olivarius, M. (2013). Applying the neuroscience of creativity to creativity training. *Frontiers in human neuroscience*, 7, 656.

P

Pasman, G., Boess, S., & Desmet, P. (2011). Interaction vision: expressing and identifying the qualities of user-product interactions. In *DS 69: Proceedings of E&PDE 2011, the 13th International Conference on Engineering and Product Design Education, London, UK*, 08.-09.09. 2011 (pp. 149-154).

Plucker, J. A., & Renzulli, J. S. (1999). Psychometric approaches to the study of human creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 35–61). Cambridge: Cambridge University Press.

R

Ritter, S. M., & Mostert, N. (2017). Enhancement of creative thinking skills using a cognitive-based creativity training. *Journal of Cognitive Enhancement*, 1(3), 243-253.

S

Smets, A., & Lievens, B. (2018, October). Human Sensemaking in the Smart City: A Research Approach Merging Big and Thick Data. In *Ethnographic Praxis in Industry Conference Proceedings* (Vol. 2018, No. 1, pp. 179-194).

Spierings, K., Eikelenberg, N., Snelders, D., & Visser, F. S. (2018). User-Centered Service Innovation for Commercial Vehicles: Plugging in the Handyman Market. In Customisation 4.0 (pp. 3-17).

Sternberg, R. J., & Kaufman, J. C. (2010). Constraints on creativity. *The Cambridge handbook of creativity,* 467-482.

V

Van Kollenburg, J., & Bogers, S. J. A. (2019). Data-enabled design: a situated design approach that uses data as creative material when designing for intelligent ecosystems.

Vasconcelos, L. A., & Crilly, N. (2016). Inspiration and fixation: Questions, methods, findings, and challenges. *Design Studies*, 42, 1-32.

Visser, F. S., Stappers, P. J., Van der Lugt, R., & Sanders, E. B. (2005). Contextmapping: experiences from practice. *CoDesign,* 1(2), 119-149.

8 Appendix

Appendix A: Interview questions

Questions for R&A project team members
Regarding the preparation for the ideation session
When do you hold a session? Why?
How do you prepare for a session?
What materials do you prepare for the session?

Regarding the team for design session
Can you introduce a bit about the team members for a design session?
How many people are there?
What are their backgrounds and experience?
Are there different roles in the session?
Do you think people in your team have different attitudes or expectations when working together? What are these attitudes?

Regarding the current design process and problems
Can you introduce how a typical design session goes?
Can you maybe give us an example of a recent session?
How does it go?
What do you do to understand the problem? *Ask in a case about methods or materials
Can you refer to any data involved?
What part do you like? Why?
What part do you dislike? Why?
Are there problems occurring in different stages of this process?
Are there any problems with the teamwork? Why?
Do you have any problems working with the methods and materials you mentioned?
How do you deal with them currently?

Regarding the ideal design process
Did you feel not satisfied with the outcome sometimes? If the outcome doesn't go as wanted and you need to redesign a product or service you already worked on, would you have changed something of your first design process?
How will you change the steps be like?
How do you think you would have worked better?
Did you ever reflect as a team after a session?
What would make it a nice team dynamic for ideation?

Regarding dealing with data
How do you usually approach data? Both qualitative and quantitative.
Do you do data analysis? How does that go? What steps are taken?
Do you get support from GDIA? How does that work?

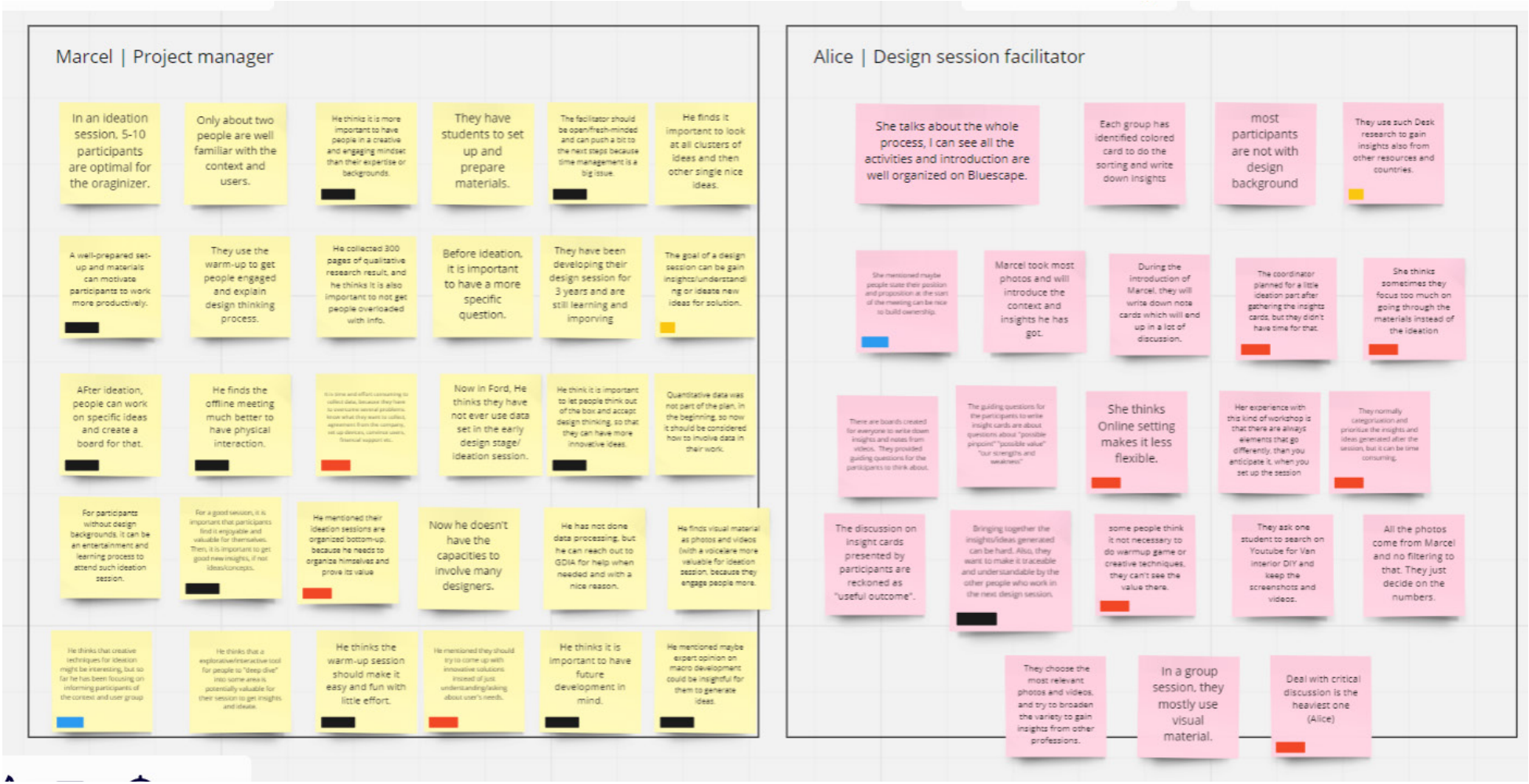
Regarding creativity
What do you think inspires you? Why? What doesn't work?
Do you use any criteria for assessing ideas or concepts from ideation? What matters for you? E.g., originality, novelty, feasibility.

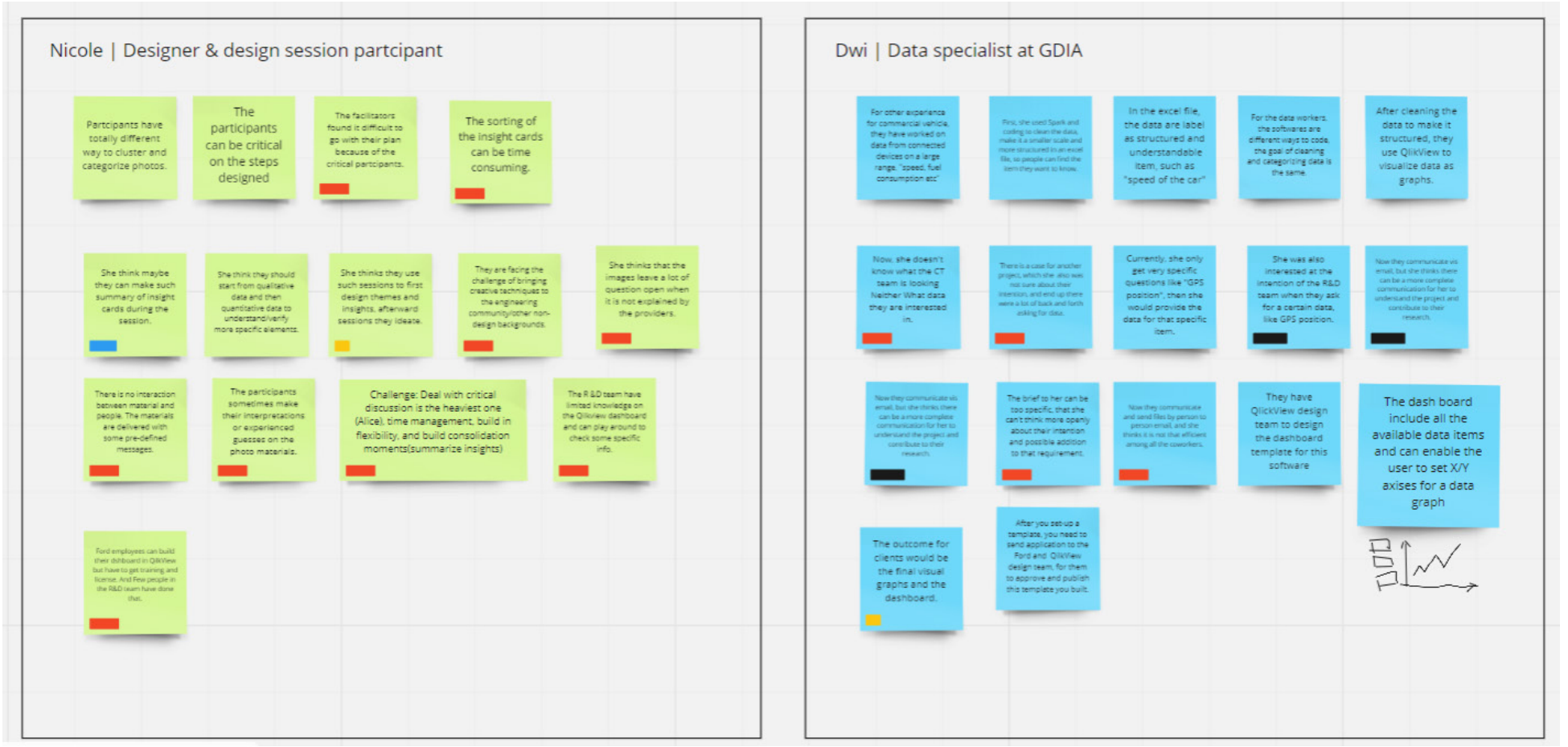
Questions for data specialists from GDIA
Regarding data processing
What are the data resources?
How do you process these raw collected data? Are there any methods or tools?
What is your work flow like with data?
What would the outcome be from your processing?
Do you also work with thick data, or link thick data with thin data?

Regarding collaboration with R&A teams
What is your workflow like with project teams?
What are the challenges and expectations for you on your collaboration?

Regarding Data availability and privacy
How do you deal with data privacy in Ford?
What is the availability of the data source you are handing?

Appendix B: Statement analysis on the interviews with Ford employees




Nicole | Designer & design session partcipant
Partcipants have totally different way to cluster and categorize photos.
The participants can be critical on the steps designed
The facilitators found it difficult to go with their plan because of the critical participants.
The sorting of the insight cards can be time consuming.
She think maybe they can make such summary of insight cards during the session.
She think they should start from qualitative data and then quantitative data to understand/verify more specific elements.
She thinks they use such sessions to first design themes and insights, afterward sessions they ideate.
They are facing the challenge of bringing creative techniques to the engineering community/other non-design backgrounds.
She thinks that the images leave a lot of question open when it is not explained by the providers.
There is no interaction between material and people. The materials are delivered with some pre-defined messages.
The participants sometimes make their interpretations or experienced guesses on the photo materials.
Challenge: Deal with critical discussion is the heaviest one (Alice), time management, build in flexibility, and build consolidation moments(summarize insights)
The R &D team have limited knowledge on the Qlikview dashboard and can play around to check some specific info.
Ford employees can build their dshboard in QlikView but have to get training and license. And Few people in the R&D team have done that.
Dwi | Data specialist at GDIA
For other experience for commercial vehicle, they have worked on data from connected devices on a large range. "speed, fuel consumption etc"
First, she used Spark and coding to clean the data, make it a smaller scale and more structured in an excel file, so people can find the item they want to know.
In the excel file, the data are label as structured and understandable item, such as "speed of the car"
For the data workers, the softwares are different ways to code, the goal of cleaning and categorizing data is the same.
After cleaning the data to make it structured, they use QlikView to visualize data as graphs.
Now, she doesn't know what the CT team is looking Neither What data they are interested in.
There is a case for another project, which she also was not sure about their intension, and end up there were a lot of back and forth asking for data.
Currently, she only get very specific questions like "GPS position", then she would provide the data for that specific item.
She was also interested at the intention of the R&D team when they ask for a certain data, like GPS position.
Now they communicate via email, but she thinks there can be a more complete communication for her to understand the project and contribute to their research.
Now they communicate via email, but she thinks there can be a more complete communication for her to understand the project and contribute to their research.
The brief to her can be too specific, that she can't think more openly about their intention and possible addition to that requirement.
Now they communicate and send files by person to person email, and she thinks it is not that efficient among all the coworkers.
They have QlickView design team to design the dashboard template for this software
The dash board include all the available data items and can enable the user to set X/Y axises for a data graph
The outcome for clients would be the final visual graphs and the dashboard.
After you set up a template, you need to send application to the Ford and QlikView design team, for them to approve and publish this template you built.

Appendix C: The questionnaire and interview questions for the first-round evaluation with students and Ford R&A team

Questionnaire

Rating on the session experience

Thanks for participanting my session, please rate your experience here.

1. Q1 Regarding the whole process, how engaging do you feel about it?

Mark only one oval.

	1	2	3	4	5	6	7	
Not engaging at all	◯	◯	◯	◯	◯	◯	◯	Very enagaging

2. Q2 Regarding the interaction with data, how enagaing do you feel about it?

Mark only one oval.

	1	2	3	4	5	6	7	
Not enagaging at all	◯	◯	◯	◯	◯	◯	◯	Very enagaging

3. Q3 Regarding the interaction with data, how insightful do you feel about it?

Mark only one oval.

	1	2	3	4	5	6	7	
Not insightful at all	◯	◯	◯	◯	◯	◯	◯	Very insightful

4. Q4 Regarding the interaction with data, how much do you think the card set help you to combine "said data" and "did data"?

Mark only one oval.

	1	2	3	4	5	6	7	
Not helpful at all	◯	◯	◯	◯	◯	◯	◯	Very helpful

5. Q5 Regarding the dreamer stage, how much do you think the card set help you to come up with ideas?

Mark only one oval.

	1	2	3	4	5	6	7	
Not helpful at all	◯	◯	◯	◯	◯	◯	◯	Very helpful

6. Q6 Regarding the builder stage, how much do you think the card set help you to deepen the idea?

Mark only one oval.

	1	2	3	4	5	6	7	
Not helpful at all	◯	◯	◯	◯	◯	◯	◯	Very helpful

7. Q7 Regarding the role switch during the process, how much do you think it help you to change your thinking mode?

Mark only one oval.

	1	2	3	4	5	6	7	
Not helpful at all	◯	◯	◯	◯	◯	◯	◯	Very helpful

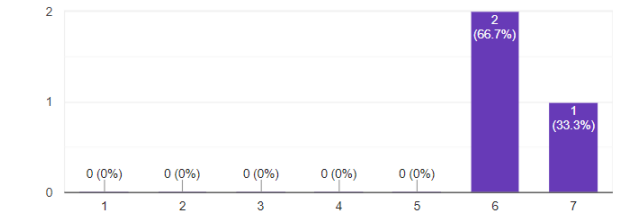
Interview questions

1. How do you feel during the whole process?
2. What do you like and dislike about the process? Why?
3. Is there any problem? Why?
4. How do you feel when dealing with data?
5. How do you feel about the mapping template? Why?
6. Does these strategies help you to map the data? Why?
7. How do you feel about the different card set? Why?
8. How do you feel about the role switch? Why?
9. How do you feel about the booklet? Why?
10. What do you think about the content and visuals of the booklet? Why?

Appendix D: The rating result from the first-round evaluation with Ford R&A team

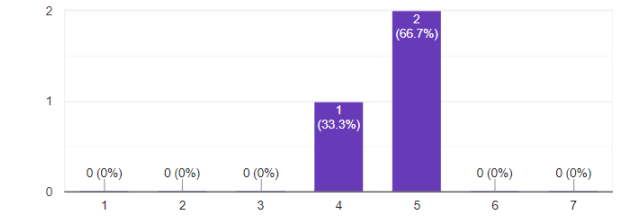
Q1 Regarding the whole process, how engaging do you feel about it?

3 responses



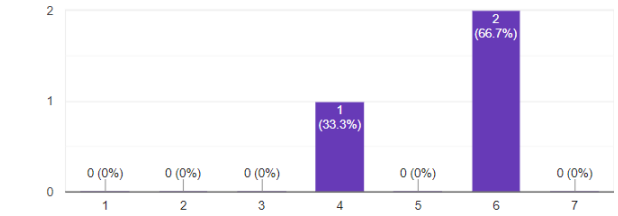
Q2 Regarding the interaction with data, how enagaing do you feel about it?

3 responses



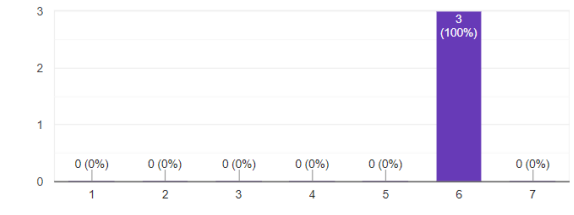
Q3 Regarding the interaction with data, how insightful do you feel about it?

3 responses



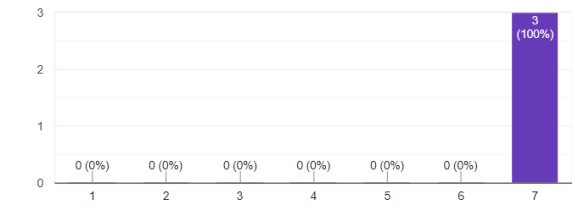
Q4 Regarding the interaction with data, how much do you think the card set help you to combine "said data" and "did data"?

3 responses



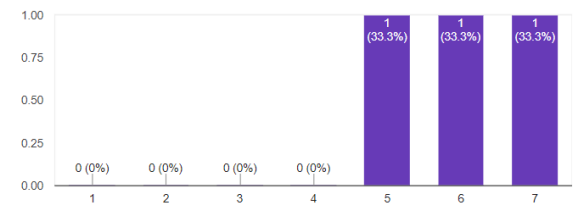
Q5 Regarding the dreamer stage, how much do you think the card set help you to come up with ideas?

3 responses



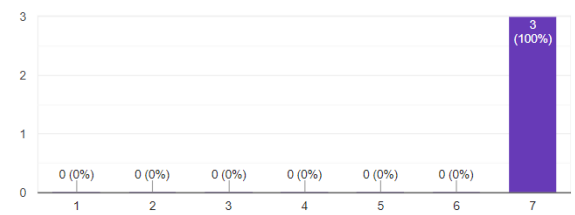
Q6 Regarding the builder stage, how much do you think the card set help you to deepen the idea?

3 responses



Q7 Regarding the role switch during the process, how much do you think it help you to change your thinking mode?

3 responses



Appendix E: Interview questions for the second evaluation

1. How do you think about this separate-step guidebook designed in the final design? Why?
2. How do you think about these directions for you and the facilitator? Why?
3. My design goal is To facilitate the participants in Ford's creative sessions to combine thin and thick data to generate insights and support the participants to use the insights for creative problem-solving. How well do you think this goal is achieved by the final design (guidebook and toolbox)? Which part is still not enough?
4. My interaction vision is that the interaction with data should be engaging, insightful and creative. How well do you think this interaction vision is achieved?
5. The innovation model has desirability, feasibility and viability aspects to evaluate a concept. Also, we have agreed on this list of requirements before, how do you think this final design is with this list of requirements?
6. What do you think is the biggest contribution of this final design? Why?

Thanks for reading!

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