INVESTIGATING HOW TO USE SERVICE DESIGN TO SUPPORT KNOWLEDGE TRANSFER IN PRODUCT DEVELOPMENT PROCESSES

A case study of how Service Design can be used to support knowledge transfer in new product development at B&R Automation

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ABSTRACT

The goal of this thesis is to understand whether service design can be used to support knowledge transfer in a new product development process at a company.

The research revolves around the case conducted at B&R Automation in Odense, from start January to end May 2018.

B&R is an automation company, which has its R&D and production headquarters in Austria and a global presence in 75 countries. They produce everything from automated laundry machines to full-fledged factory belts. They strive for perfection in automation and strive to develop innovative automation products.

B&R's engineers, who are all equipped with a different set of experts skills are in different product development process phases from each other, which creates the problem of insufficient knowledge transfer when creating an automation machine from scratch. Therefore they are having a hard time due to them not being a part of the entire process but rather only a small piece of it. This leads to information loss between each product development process phase.

B&R wants to solve this problem preferably by creating a visual tool, mode or game. Their idea is touching the fundamentals of knowledge translation, however, further investigation shows that the main problem occurs when knowledge is transferred between each of the product development process phases.

The thesis used user journeys, workshops and interviews to develop a prototype which aims to assist B&R with a set of instructions on how to implement the chosen final product.

Key Concept:
Knowledge Transfer

CONTENT

LEARNING GOALS

The thesis is based on two sets of learning goals, the Service system design's study guide and our own personal goals.

Study guide goals

The study guide (The Technical Faculty of IT and Design The Study Board of Media Technology, 2012) explain the students who complete the module (thesis) will obtain the following qualifications:

Knowledge

- Must have knowledge about the possibilities to apply appropriate methodological approaches to specific study areas.
- Must have knowledge about design theories and methods that focus on the design of advanced and complex product-service systems.

Skills

- Must be able to work independently, to identify major problem areas (analysis) and adequately address problems and opportunities (synthesis).
- Must demonstrate the capability of analysing, designing and representing innovative solutions.
- Must demonstrate the ability to evaluate and address (synthesis) major organisational and business issues emerging in the design of a product-service system.

Competences

- Must be able to master design and development work in situations that are complex, unpredictable and require new solutions (synthesis).
- Must be able to independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility (synthesis).
- Must have the capability to independently take responsibility for own professional development and specialisation (synthesis)

PERSONAL GOALS

Personal goals

This thesis will help improve our understanding and knowledge regarding service design and how to use it in a practical setting. Addtionally by having a “real“ case with some specific problems will challenge our way of thinking about service design.

Therefore our personal goals are:

- Get a better understanding of service design
- Understand how to use the service design tools most efficient
- Knowledge on how a company works and how service design can help
- Give something new to the service system design community

1 INTRODUCTION
... SO FAR

The theme of the report revolves around the infrastructure and optimization within businesses and companies. How well the infrastructure is designed is an important factor for the company, especially when it comes to communication and knowledge sharing. The communication is the backbone of any company from top down, thus it is vital to keep a high standard and consistent across the entire company. Senapati (2018) states that "Communication plays a fundamental role in all facets of business." (Senapati, 2018: p 2).

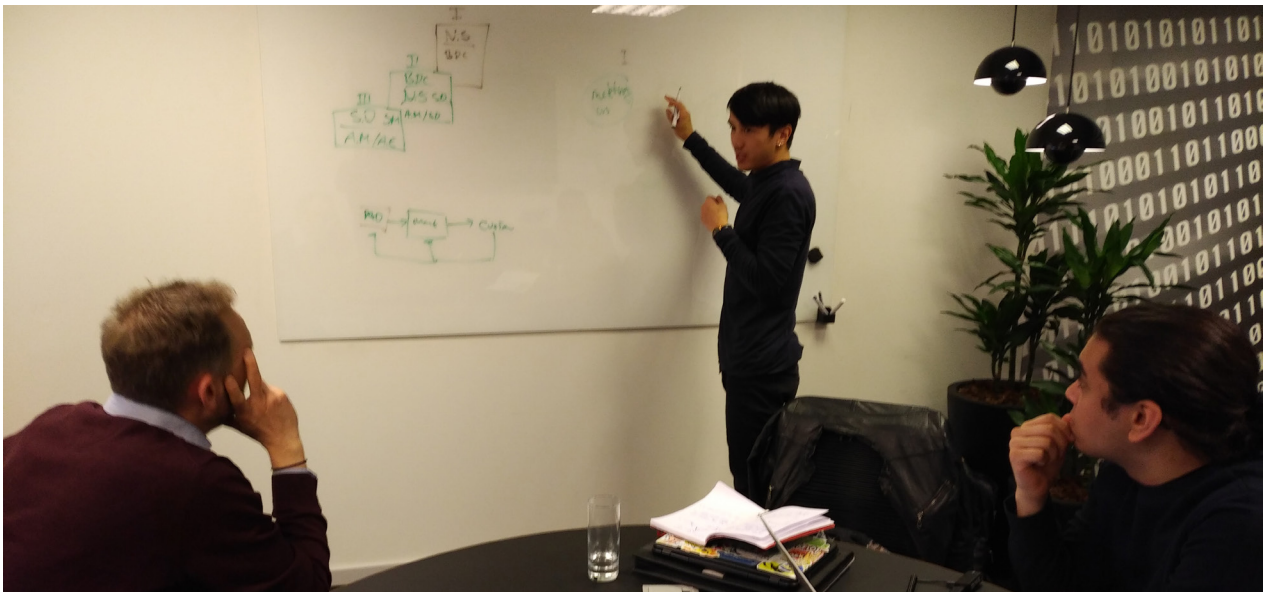
Communication strengthens how a company interacts with each individual part within itself, this is one of the factors that affects the work time of different projects, by increasing or decreasing the time spent on said project. Additionally by doing it correctly gives the company a competitive edge against its competitors by creating an increased optimized workflow and reducing work time and knowledge sharing attempts (Argote & Ingram, 2000).

Service design is known for helping solve important challenges (Stickdorn, M. et al, 2018) and this quote from Moritz elaborates further "Service design helps innovate (create new) or improve (existing) services to make them more useful, usable, desirable for clients and efficient as well as effective for organizations. It is a new holistic, multidisciplinary, integrative field." (Moritz, 2005: p. 6-7). Therefore will be the backbone of this thesis.

1.1 CASE STUDY

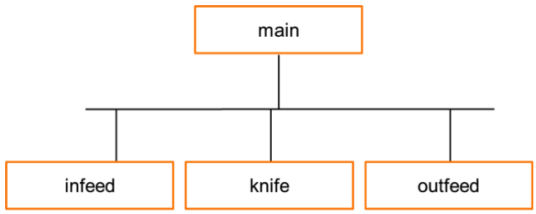
This case was discovered through a 3rd party web service called “Match my Thesis”. The service requires the user to fill out a form, which includes information regarding what a relevant thesis or case could be. When the form is filled different cases from various companies are found that match the written criteria and fields of interest.

A case from B&R was found (Appendix A part 1 - 3), that required a solution to optimize their internal communication, as well as optimize current design and development processes, as miscommunication and data loss is common between the different engineers and stakeholders. They describe their workprocess as a “whiteboard sketch based interview” and that personal notes are usually the way data is stored instead of having a shared place to save it. This is where data is commonly lost. Their design and development process for their machines are separted into three steps (Appendix A);



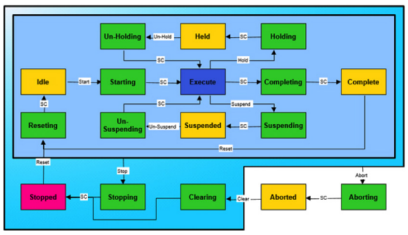
THE FIRST STEP

During this step the machine is divided into their mechatronic objects or modules.



THE SECOND STEP

When the different objects of the machine is identified they each need to be programmed.



THE THIRD STEP

The last step is the implementation and development of the machine.

The engineers behind the machinery is in most cases mechanical engineers with little to no knowledge of programming. Therefor the communication between the software and mechanical engineers can be problematic as the mechanical engineer thinks in processes and functionality and the software engineer thinks in generic modules and programming sequences. Before continuing they want to make sure that everyone understands their vision which is:

"As experts in automation, we believe there is a better way of doing things. We imagine that with a help of right tools, much of the process of creating good software architecture and programming a machine can be automated. The vision for the future is that we after each meeting have captures of the latest machine processes and can generate an updated version of the underlying software architecture." - B&R Automation

This is the initial information gathered and this will help guide the project in a direction where everyone is content with the results. The quote above from B&R will be a guide as the project proceeds.

1.1.1 B&R AUTOMATION

B&R is an automation company that specializes in combining state of the art technology and automation to provide customers in almost every industry a complete automatic solution for factory automation, motion control, HMI (Human Machine Interface) and integrated safety technology (B&R Automation, 2018). They have offices in 68 countries and cooperating partnerships ranging to over 75 countries worldwide.

Their success is due to their company's philosophy; "Relationships that endure" meaning that they are not looking for customers that are going to partner with them short-term. But are looking for creating partnerships that are based on loyalty, trust and a high levels of expertise. On top of that the company strives for perfection in automation, as they put all their knowledge and creativity into developing products that are innovative, which have won them three Børsen GAZELLE awards (Danish innovation award) (B&R Automation, 2018).

Despite all their success the company is still lacking in regards to communication, infrastructure and how they can best utilize their resources within the firm.

1.2 DESIGN BRIEF

Before the project started two physical meetings with B&R were held to get a more in-depth explanation of their problems and thoughts, that were not explained in the case description (Appendix A). This chapter will explain additional information regarding the initial interview with B&R.

1.2.1 INITIAL PROBLEM

From the two initial interviews the main issue was found. The main issue was the communication difficulties that B&R experiences internally between their engineers. B&R is having issues with good communication and data storing which results in information loss. The following gantt chart is a simplyfied visualization of how their engineers work together within the company and when the different engineers get included in the project.

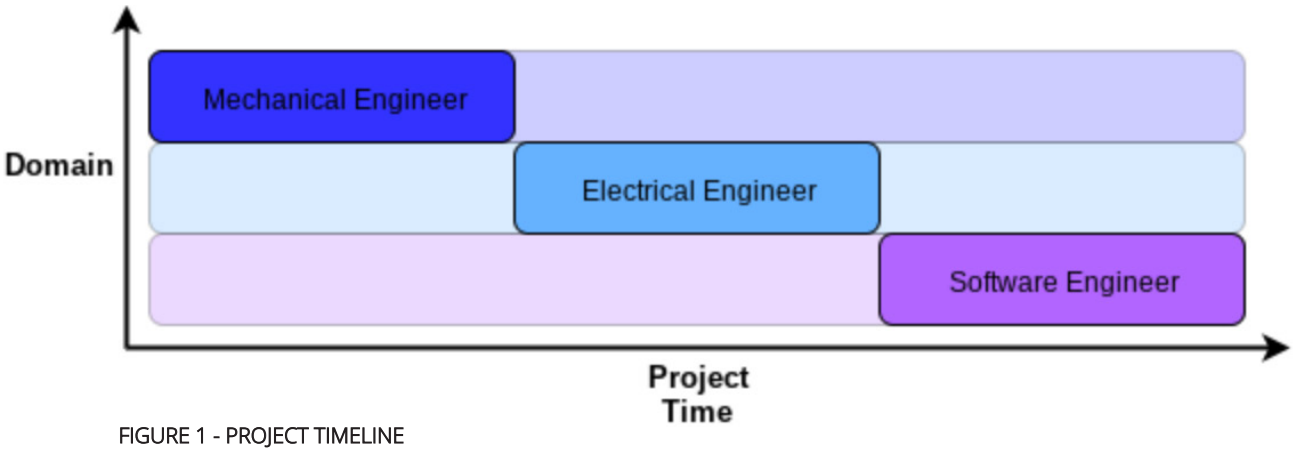


FIGURE 1 - PROJECT TIMELINE

As seen above (figure 1) there is no overlapping areas where the different engineers can work together. As one engineer finishes their task they move on to another project. This means that all the experience and knowledge that the engineer has accumulated through the project is lost due to the lack of documentation and communication.

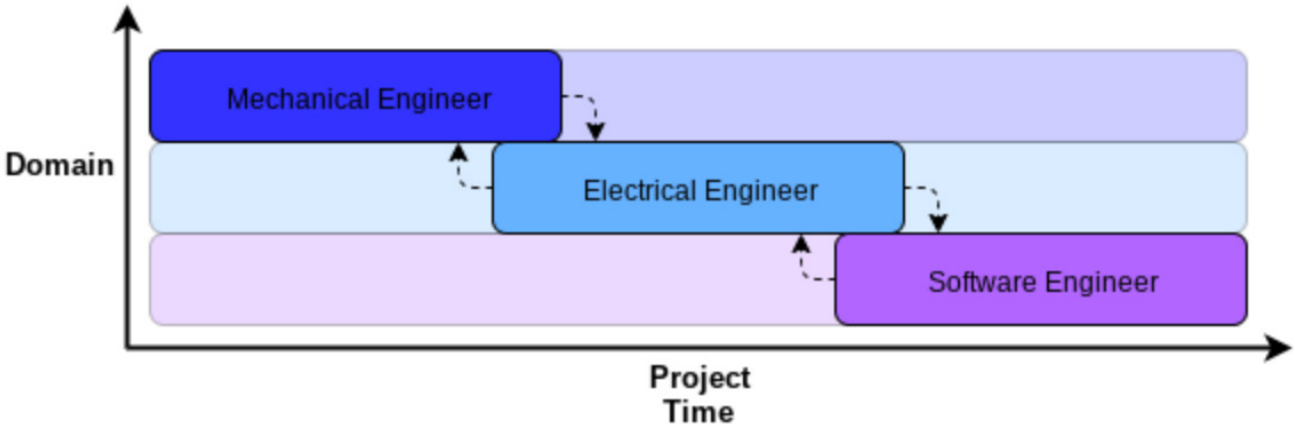


FIGURE 2 - IDEAL PROJECT TIMELINE

In the figure above (figure 2) an alternative solution can be seen. The figure shows a "handshake" approach by having the different engineer's processes overlap, this enables an improved way to handover documents and other important knowledge to the next engineer. This will result in less information loss making the process run smoother.

The initial problem definition and alternate "solution" is an accumulation of key findings from the initial interviews with B&R as well as observation of their employees. It is important to note that this case was not intended for service designers, but for a software engineer. This is because B&R wanted a software solution (see 1.1 Case Study), but the contact person at Match my thesis figured that having service design students work together with a software engineer student would be more optimal as they can give additional insights to the case.

Therefore, a team of three was formed. Two service designers and a software engineer from Finland. As the project was still new it was uncertain whether the solution B&R were hoping should be implemented. They describe it as:

"A canvas or plug and play "puzzle pieces" prototype that would allow for a transparent and tangible approach."

1.2.2 INITIAL PROBLEM STATEMENT

As service designer a critical approach to their process and solution will be taken. Therefore, further research was needed as a foundation to move forward. From this conclusion an initial problem statement was decided:

"How can we use service design to optimize the communication between B&R's engineers to minimizing the information loss between each?"

1.2.3 SCOPE & CONSTRAINITS

As the project was still in its initial stages it was hard to scope the thesis. Therefore a few basic concerns and constraints were written below:

1. Time

Limited time can be spent at B&R.

Tight deadline limits the time spent on each phase.

2. Dependency on external factors (B&R)

Their willingness to cooperate.

Their schedule and time for this project.

3. Finding the right approach

4. Utilizing the relationship with the software student

Whether the he is willing to work together.

What he can provide.

1.3 THEORY & METHODOLOGY

Before proceeding a proper framework needs to be set for the project, this would decide how to handle different situations as well as guide the project in the right direction. Therefore, this chapter will explain the different methodologies and theories used for this thesis. This will give better insights and understand to how and why they are used.

1.3.1 SERVICE DESIGN

Service Design is an interdisciplinary approach that combines different methods and tools from various disciplines (Lazier, 2018). It is still an evolving approach and has therefore no clear definition and language. This can be said to be one of service designs greatest strengths, as "fields in which definition is now settled matter tend to be lethargic, dying, or dead fields, where inquiry no longer provides challenges to what is accepted as truth" (Stickdorn and Schneider, 2010). This gives freedom to designers as there are no boundaries allowing this thesis to work on the problem from various angles (The Interaction Design Foundation, 2018).

However, there are a few concepts and elements to service design that are followed for every project, which are the five design principles by Stickdorn and Schneider. These are key principles when improving and re-thinking a service (Stickdorn and Schneider, 2010);

1. USER-CENTERED

"Services should be experienced through the customer's eyes."

It is important to see the service as a connection of different stakeholders with individual mindsets, skills, backgrounds and experiences. It is crucial to understand and utilize this for the improvement/development of a service (Lazier, 2018).

2. CO-CREATIVE

"All stakeholders should be included in the service design" process"

Each stakeholder have their own idea/expectation towards the service, therefore it is important to have all the involved stakeholders to be a part of the design process. With co-creation the designer and the stakeholders can set boundaries and set a common language, allowing everyone to actively participate in designing the service (Lazier, 2018).

3. SEQUENCING

"The service should be visualized as a sequence of interrelated "actions"

Services consists of many service moments and is a part of a dynamic design process. It is the designers job to keep the pace steady in order to make the front- and backstage to work together, by preparing the backstage processes for the frontstage processes (Lazier, 2018).

4. EVIDENCING

"Intangible services should be visualized in terms of physical "W"artifacts"

Services are intangible, but by using physical artifacts/evidences the service process or touch points can become tangible. By prolonging the intangible service period can increase the appreciation of the experience (Lazier, 2018).

5. HOLISTIC

"The entire environment of a service should be considered"

Services consists of many stakeholders e.g. Users, customers, organisations etc. that together contribute to the whole of a service. Service design aims to create a holistic view based on the various building blocks (Lazier, 2018).

As service design students a need to understand and explore how service design can be used to improve the communication and documentation within B&R will be the top priority. Specifically, the service design principles mentioned above will be followed as closely as deemed necessary. Additionally, using service design to explore the problem will help generate new ideas and contribute to the service system design community.

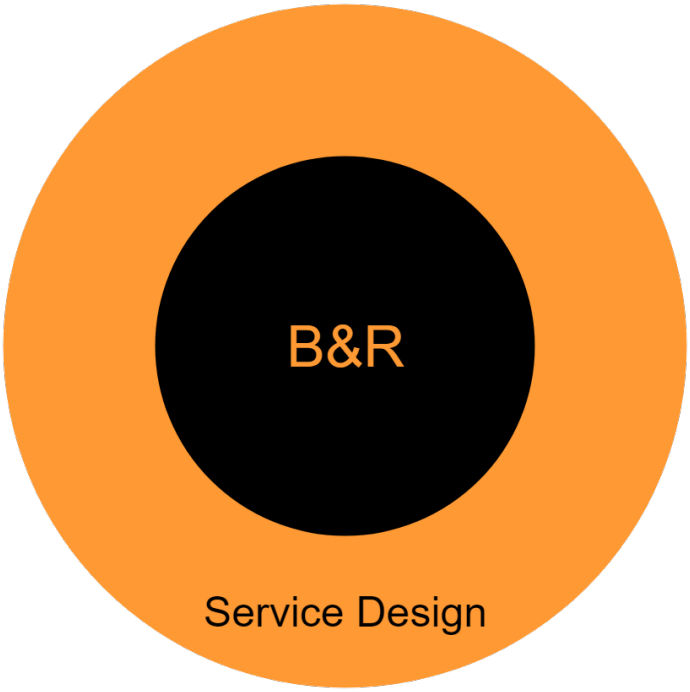
1.3.2 SETUP

As mentioned earlier this case was meant for a software student, therefore Match my thesis set up a collaboration with another masters' student from Finland studying software engineering. The case will revolve around B&R's headquarters in Odense. The company had a few requirements and ideas to what they wanted to get out of this thesis:

"We envision a visual tool, model or a game where clients in a user friendly manner can describe their machines and processes while B&R representative could understand what it is required from their side. We see this tool as a visual language for describing machines and processes in a simple and systematic way that makes sense for the domain the customer works in."

As researchers and designers further research is needed in exploring their problem further. This will be done through interviews, shadowing, user journeys etc. to figure out whether this could be a viable solution for them.

The thesis was decided to have two layers, using the micro and macro level approach.



The first layer is the Double Diamond methodology used to encapsulate the inner core of the project involving B&R providing the micro environment, and the second layer is the service design layer, looking at how the thesis has involved service design and the characteristics of which provides the macro environment.

We will use this setup to understand whether B&R truly understands what they need contrary to what they think they want, by looking at it as a service designer overall. This will allow us to differentiate between our information and our findings. As we dig into uncovering the problem at hand, we will use the service design tools that we find most suitable to facilitate a proper identification of the problem.

1.3.3 DOUBLE DIAMOND

The double diamond was used in this thesis as it gave a good overview and a visual guideline for the design process. Additionally, the double diamond was very flexible as iterations between each phase were common. It separates a complex problem-solving process into four distinct stages: Discover, define, develop and deliver (Design Council, 2015)

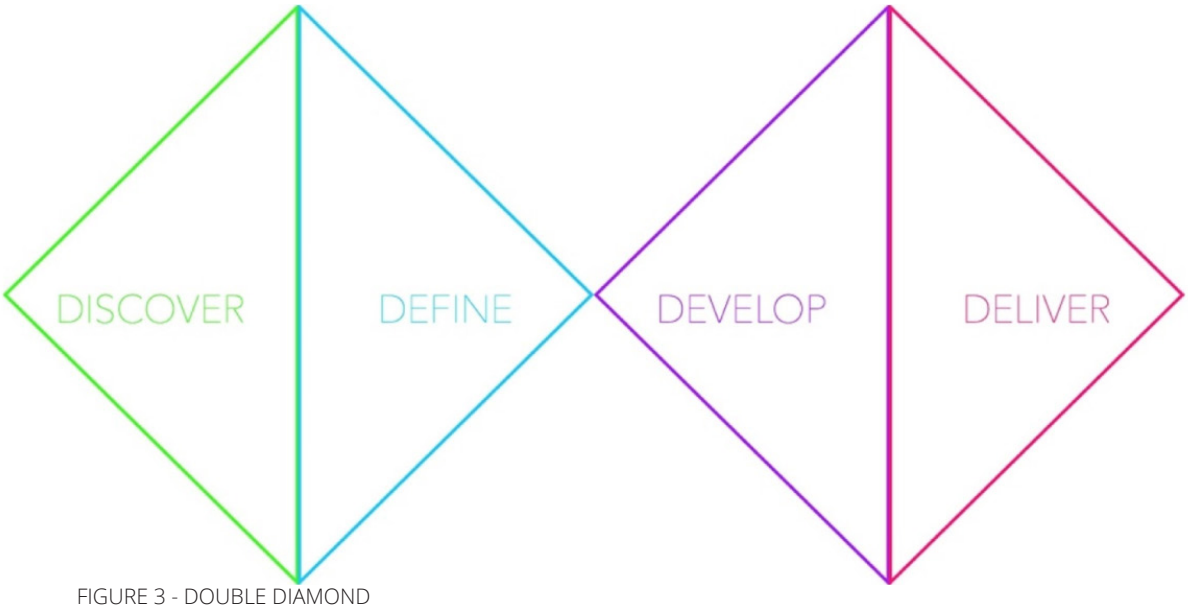


FIGURE 3 - DOUBLE DIAMOND

As design processes are creative, there will be a wider range of ideas and information to gather (divergent thinking). When all the information is gathered, and a rougher idea have been acquired it needs to be refined and narrowed down to a more concrete idea (convergent thinking), this can be seen in the figure above (figure 3). This process happens twice giving the figure a double diamond shape, hence the name double diamond (Design Council, 2014). The double diamond filters out weaker ideas through an iterative process between each stage (Schneider, 2018).

The double diamond model fits the needs of this thesis as it gives freedom and flexibility by allowing iterations between each phase by going back and forth between them. Working and cooperating with not only B&R but an additional masters' student would require more planning as there would be a limited amount of time with B&R.

1.4 LITTERATURE REVIEW

The academic terminology for information traveling from a sender to a receiver is called knowledge transfer, whereas using infographics to translate a larger amount of information in a database is called knowledge translation. For this thesis the focus will be the former.

The large amount of research that surrounds knowledge transfer is evident, however it is still lacking in the research and development (R&D) setting as well as knowledge transfer using service design. Therefore, this chapter will explore literature that can be used for said topics that are lacking.

1.4.1 KNOWLEDGE TRANSFER

First, addressing the question of what knowledge transfer is: knowledge transfer is when two or more actors enable one or another to acquire said knowledge of the opposite actor (Albino et al., 1998). Doctor Minshall, a professor in technology transfer at University of Cambridge describes knowledge transfer as "a term used to encompass a very broad range of activities to support mutually beneficial collaborations between universities, businesses and the public sector." (Dr. Minshall, T., 2009). Similarly in the document for International Knowledge Transfer, Investigations of European Practices (2011) knowledge transfer even takes various forms "e.g., licensing, assignment, communication through collaborative research, scientific publications, obtainment and further processing of traditional knowledge."

Karlsen & Gottschalk (2004) and have defined three factors that affect knowledge transfer:

- Information Technology, as an enabler to increase knowledge transfer by extending one's reach beyond formal communication
- Systems and Procedures, which are required to be aligned to successfully manage and transfer knowledge
- Culture, because organizational culture is increasingly recognized as a factor in enabling efficient intellectual assets

Karlsen & Gottschalk (2004) do also provide project success criterias and how to measure success in a given IT project.

Carlile (2002) and his view on "that knowledge in new product development proves both a barrier to and a source of innovation." is slightly different, but similar, he describes three different approaches to knowledge and moving it across the boundaries in product development.

- Syntactic approach, the establishing of a common syntax (language structure)
- Semantic approach, understanding that even if a common syntax is present, people will interpret it differently, which in turn makes communication difficult

Pragmatic approach, Carlile's third suggested approach, is a mixture of the syntactic and semantic approach, highlights the importance of acknowledging that things will be different and dependent on each other; it assumes everything is different, and recognizes the requirements to deal with the positive and negative consequences.

1.4.2 DESIGN, KNOWLEDGE TRANSFER & TRANSLATION

Knowledge translation is a term that involves exchanging and application of knowledge, looking at Graham & Tetroe (2007) knowledge translation implies by its name that "the definition also implies that some thought should be given to what knowledge should be translated (and to which audience) keeping in mind how the knowledge could be used." (Graham & Tetroe, 2007, p 936)

Simeone et al. (2017) provides tangible evidence that design as a means of a knowledge translation mechanism allows to meet the divergent needs and interests of the different stakeholders.

This thesis will also provide even more evidence that using knowledge transfer within design to facilitate a variance of knowledge translation can improve the knowledge transfer rate in a new product development process phases in a R&D setting.

To move forward with the project and provide validity within design, relevant literature was necessary, however, as mentioned earlier knowledge transfer in a R&D setting is hard to come by, but not impossible.

Simeone et al. (2017) wrote an article in the journal of Knowledge Management: "Knowledge translation mechanisms in open innovation: the role of design in R&D projects". It was chosen as our primary design literature due to it being holistic and coincidentally has a similar construction as our thesis due to its contextualised setup. The article seeks to investigate design as a translation mechanism in a R&D setting.

The case study investigates how design functions within open innovation in an R&D project. A project named 3D Tune-In, aims to study gamification mechanisms in healthcare-related processes, was the case context. Following data collection and analysis the article in which 3D Tune-In used various knowledge translation mechanisms that allowed them to visualise and thus translate their scientific knowledge that would otherwise be hard to understand, due to the amount of different stakeholders with various interests and educations.

Ultimately it comes down to the specific stakeholders and which design mechanism (for knowledge translation) would fit the best in that particular context.

This particular thesis does not work with knowledge translation, but rather with knowledge transfer, however, the difference between knowledge transfer and translation is not straight forward differentiate between.

1.5 PROBLEMSTATEMENT

With the information gathered from the design brief, initial interviews as well as research regarding knowledge transfer and translation a newer problem statement was found stating:

"How can we use knowledge transfer to better optimize the communication between B&R's engineers minimizing the loss of information and knowledge throughout each of the product development phase?"

1.6 RESEARCH QUESTION

With the previous research in mind a research question was formed for the thesis stating:

"How can service design be used to support knowledge transfer across the different stages of a product development process?"

From the literature it is clear that knowledge transfer is an important factor when coming to optimization of the communication within a company. However, knowledge transfer supported by service design is a very understudied field, making it harder to find relevant literature to support the thesis. This will allow for more freedom as this was an opportunity to explore new areas of service design providing new research the service system design community.

1.7 APPROACH

In order to answer the problem statement as well as the research question. The collaboration with B&R will help us reflect upon the application of service design methods supporting knowledge transfer. The application of service design methods will help us further our understanding of service design and possibly offer some insights to a less explored area of service design. With this in mind a project plan will be set to better schedule the time that is available to each phase as well as time for our partners (B&R and software student).

1.8 PROJECT PLAN

The creation of the project plan is always a difficult task. Distributing and allocating time on things you have a rough estimate on the amount of work they will take cannot be done in a week or two.

To reach the plan below, we have had 3 versions before it, which were created and superseded by the next one each month. The figure below (figure 4) is based on the double diamond phases, alongside a "pre-project" phase, which covers the first two weeks before we officially started the thesis.

Throughout the report it will be noticeable that we draw a lot information from the interviews we've had, since that is our main source of information.

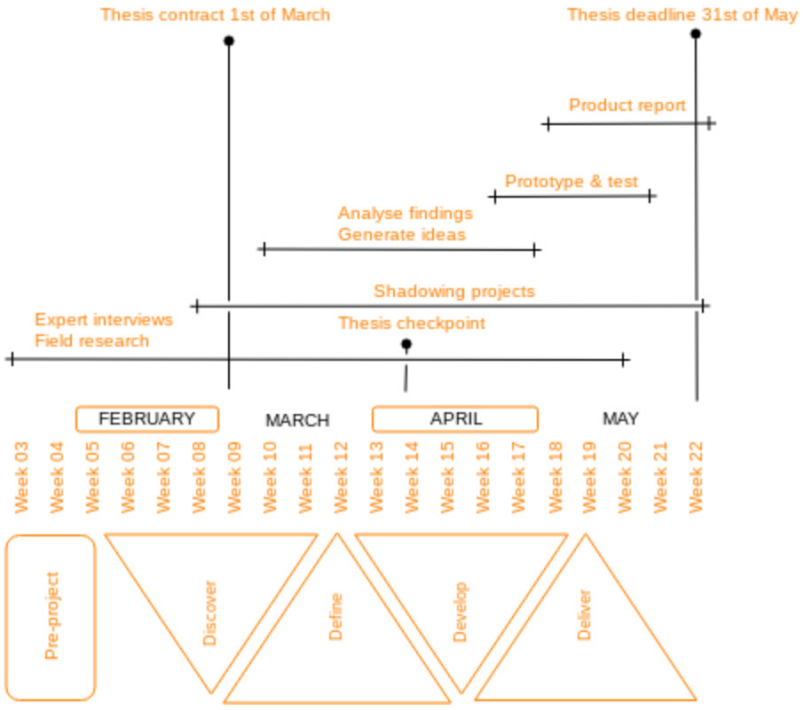


FIGURE 4 - PROJECT TIMELINE

2 | DISCOVER

This chapter will explore the term and value of knowledge transfer and how it can be used in a service design context to help B&R. This was done by understanding what knowledge transfer is as well as in-depth interviews will be done to get a better holistic view of the company and how the different parts of the company is related to the problem.

2.1 WHAT IS COMMUNICATION?

As explained in the Introduction (see 1 introduction) the communication within a company is the entire backbone and gives them a competitive edge in the market (Senapati, 2018).

The terms knowledge transfer and knowledge translation kept showing up when researching communication and how to improve the rate in which information and knowledge is captured through it. Through further research and investigation into each term (see 1.4.2 design, knowledge transfer & translation) knowledge transfer was chosen to be the more interesting and appropriate field to study for this thesis.

2.1.1 KNOWLEDGE TRANSFER TECHNIQUES

Knowledge can be one of the most significant resource within a business/ company if done correctly (Argote & Ingram, 2000). The term knowledge is defined as validated information that have been tested and proven. These are the deciding factors that separates knowledge from opinions, beliefs and other unproven information (Murray & Peyrefitte, 2007).

Knowledge transfer processes are complex and have various deciding factors for whether it succeeds or fails. Therefore this chapter will explore the term knowledge transfer further as well as look at the different factors that affects the success of it.

Knowledge can be separated into two (Argote & Ingram, 2000);

- Information (Explicit knowledge)

Information knowledge is when it is known and can easily be written down ,understood and passed on.

- Know-How (Tacit knowledge)

Know-how knowledge is more complex as it is the accumulation of practical skills and experiences that allow the individual to do a certain tasks more effectively. Additionally it is this unique individual quality, that makes it hard to communicate and transfer to others.

The main focus of this thesis will be on tacit knowledge, as this is generally harder to transfer and it also correlates with the issue B&R are experiencing, as they have to trouble knowledge transfering and communicating with each individual engineer.

Knowledge transfer within an organisation is an important way for the various stakeholders to learn and generate new knowledge together. E.g. by having one unit in the organisation learn from another and vice versa. There are many reasons why knowledge transfer is important the main ones are (Argote & Ingram, 2000):

- Higher resource sharing and knowledge transfer is more cost efficient compared to generating and producing separately.
- Knowledge transfer allows the organisational members to respond and adapt quicker to critical situations.
- It gives the organisational members a better picture of the gained information and make a more informed decision.
- The organisation can generate new knowledge by adding complementary knowledge by all the different individuals within the company.

Based on this article (Murray & Peyrefitte, 2007) the individuals are the primary learning entity within the company, and encourages learning and knowledge transfer which will improve and move the company further. Two of the main factors to consider when knowledge transferring is the contents of the knowledge and the relationship between the source and recipient.

- Depending on the usefulness of the knowledge as well as its value for the company will determine how difficult it will be to transfer.
- The relationship between the knowledge source and recipient is important as an increased level of trust, comfortability and closeness makes it easier to share and obtain new knowledge.

Additionally, when looking at the knowledge recipient there are a few factors to consider:

- Absorptive capacity.
- Ability to exploit outside sources of knowledge.
- Motivation.
- Spatial proximity.

However, the context in which knowledge is transferred can vary. Within an organisational context the formal structure and system can affect the knowledge transfer process. It influences the number of attempts and outcomes of knowledge transfer, ideally once should be enough for everyone understand the knowledge (Murray & Peyrefitte, 2007).

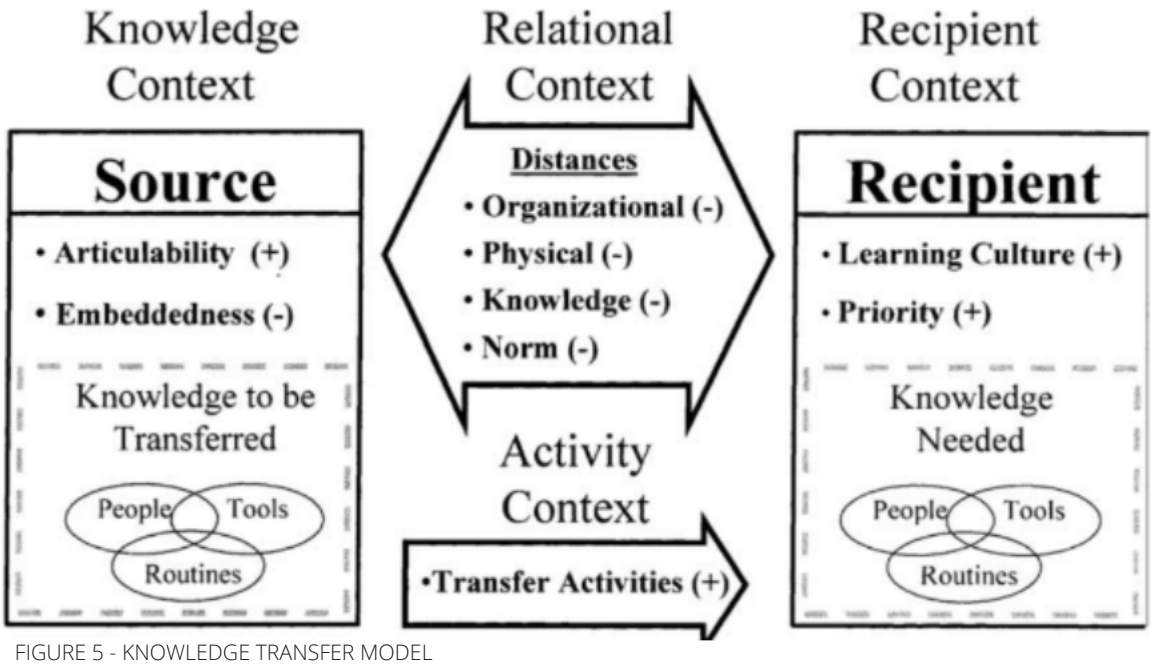


FIGURE 5 - KNOWLEDGE TRANSFER MODEL

The figure above (figure 5) shows a model of knowledge transfer success and including the nine key factors that affect knowledge transfer across the four broad contextual domains.

Knowledge context's basic argument is that the knowledge transfer success requires that both parties understand where the desired knowledge resides within the source and is accessible for both parties.

Relational context suggests that there is a barrier to knowledge transfer across geographical and organizational levels.

Recipient context refers to the degree of knowledge they have as well as how much they priorities the knowledge transfer.

Activity context points to how many knowledge transfer attempts and how great both parties are involved.

This article (Cummings & Teng, 2003) is looking at four different approaches to knowledge transfer;

1. The first approach is to see how many numbers of successful knowledge transfer that was engaged in a certain time frame.

2. The second approach is based on the project management literature, which defines successful knowledge transfer as one that is on time, on budget and produces a satisfied recipient.

3. The third approach is based on the technology and innovation literature. Looks at how well the knowledge can be re-created in the recipient. The knowledge here can be seen as occurring through a dynamic learning process with the organization keeps interacting with the customer and supplier.

4. The fourth and last defines the knowledge transfer success in the way the recipient feels ownership, commitment and satisfaction in the knowledge transferred.

The four approaches have three main aspects in common. To succeed there needs to be:

"the feeling of ownership, commitment and satisfaction"

There are a few ways to make the recipient feel ownership of the knowledge (Cummings & Teng, 2003);

1. Greater discretion over the knowledge will let the recipient invest more of their own ideas, unique knowledge and personal style to the knowledge.

2. The more intense the recipient associate with the knowledge, meaning the more interactions they have with the knowledge can affect it as well.

3. Knowledge ownership relates to the degree in which the individual invests energy, time, effort and attention in the knowledge.

The commitment aspect is greatly enhanced when the recipient understands the value of the knowledge and developing competences using the knowledge. The knowledge needs to make the recipient willing to put in extra effort to work and learn from it by showing that they can get better (Cummings & Teng, 2003).

The third aspect is the satisfaction of the knowledge, this is because the stress level and resistance levels in adapting to use the new knowledge (Cummings & Teng, 2003).

This information will be incorporated into a final solution later in the develop and deliver phase as well as guide the interviews in the next chapter.

2.2 INTERVIEWS

Interviews are important tools as it gives different insights compared to desk research. It allows the designer to get out in the field and talk and learn from relevant people for the thesis. Contextual interviews are used in this chapter to "(...) reveal formal and information networks and hidden agendas of specific actors (useful for system maps) or to understand particular experiences (useful for journey maps)." (Stickdorn et al., 2018: p 120-121). it is also important to note that interviews are a good tool to use when knowledge transferring as well. The recipient will be the interviewer and the sender of the knowledge will be the interviewed.

The interviews were done following the guidelines from Bjørner's book on Qualitative Methods for Consumer Research The value of the qualitative approach in theory and practice (Bjørner, 2016) as well as various knowledge transfer factors. For the initial as well as in-depth interview a semi-structured approach was used. This allows the designer/researcher to make flexible and "on the run" adjustments throughout the interview. A total of 8 interviews were done on the different actors and stakeholders, however only 5 will be described here as they gave the most relevant information.

The interviews were all conducted at B&R's Danish headquarters in Odense. This was done to give the interviewed a natural environment to increase their comfortability, making the interview and knowledge transfer go smoother. Additionally, the increased comfortability enables them to recall specific details that often get lost in traditional focus group settings (Stickdorn and Schneider, 2011).

2.2.1 SHADOWING OF CURRENT PROJECTS

The first goal of the thesis was to shadow a current ongoing project as it gives valuable insights to how B&R runs their projects and pinpoint at what point of the process information is lost as well as when knowledge transfer problems occur. This was not possible as their projects normally span for at least a year, making it harder to follow the entire process from start to finish.

However, a fast-track project started up called, "Icelandic fast-track project". For this project B&R worked for the Icelandic company called Vélfag ehf. B&R describes them as, "is the literal technology leader for fish processing machines".

The fast-track project started early December, initial meetings were held during February and implementation started in March. This meant that not the entire process was followed as parts of the initial meetings were missed. But the observations from this project were very interesting as this was one of the rare cases where the project runs flawlessly. This is due to the larger amount of resources poured into this high-priority project.

Vélfag was an islandic company meaning that they were based in Iceland. Therefore, physical meetings were held there. Making it harder to follow physically, but all documentation as well as digital emails exchanged between the two were shared for this thesis.

Several important findings regarding knowledge transfer success were found from this project:

- The increased number of physical meetings increased the success of knowledge transfer.
- Commitment from both parts helped smoothen out the process.
- The fast track project was a high priority project for both parts.
- The language was a barrier that would decrease the success.

This project is an exception, as B&R do not always have enough resources to allocate so much into one project. Therefore figuring out a way to create another successful project like this without the extra resources is necessary, as the problem is still existent.

2.2.2 APPLICATION MANAGER

Name: Thomas Noerby
Job title: Application Manager (AM)
Duration: Each meeting was scheduled to last 2 hours

This thesis began with interviewing Thomas Noerby who is the main contact person and the internal project supervisor at B&R.

Thomas' job is to supervise the Application Engineers and a handful of Business Development Consultants in every project they work on, he also attends important customer meetings to oversee everything and lays the foundation for how to approach the customer. Mads Olsen is a Business Development Consultant and a later interview with him will describe his role in the company (see 1.2.5 Business Development Consultant).

This design brief (Appendix A) was done by Thomas, and furthermore he was the one who convinced the company that there was a problem with information loss and knowledge transfer. He was the first point of contact when getting through to colleagues and planning interviews for the thesis.

The first meeting done with Thomas and Mads were done on a whiteboard where they were asked to map a user journey of the current product development process phase at B&R.

The key findings were;
B&R's engineers are having a hard time communicating as they are not all a part of the entire process, leading to information loss between each phase.

Currently the process looks like this:

Mechanical → Electrical → Software

Instead of:
Mechanical, who does a changeover to the next engineer
Electrical, who does a changeover to the next engineer
Software, who can go back and see all of the previous information

Thomas and Mads separates the product development phase into four different phases which is different from the three in the design brief (Appendix A);

1. B&R→ Customer

This is where they discuss price on hardware and software.

2. B&R communicates with mechanical, electric and software engineer to understand and generate the requirements.

3. Uses apps and detailed communication with the engineers.

From this they get a UML diagram using Pack ML and starts to define the different modules on the machine. They create a Automation Studio file, which is sent to the fourth phase.

4. Implementation

This phase is where all the previous implementations are gathered into a Automation Studio-file, that in software terms operates the entire machine and all of its functions.

In the figure below (figure 6) a very detailed and messy map can be seen illustrating the four different phases and how the journey is from start to finish. Where the first two phase are diverging and slowly converging in the last two phases. Additionally, Thomas also included when information was lost. This mainly happened between each phase as new people came in as well as there was no documentation on what have been done.

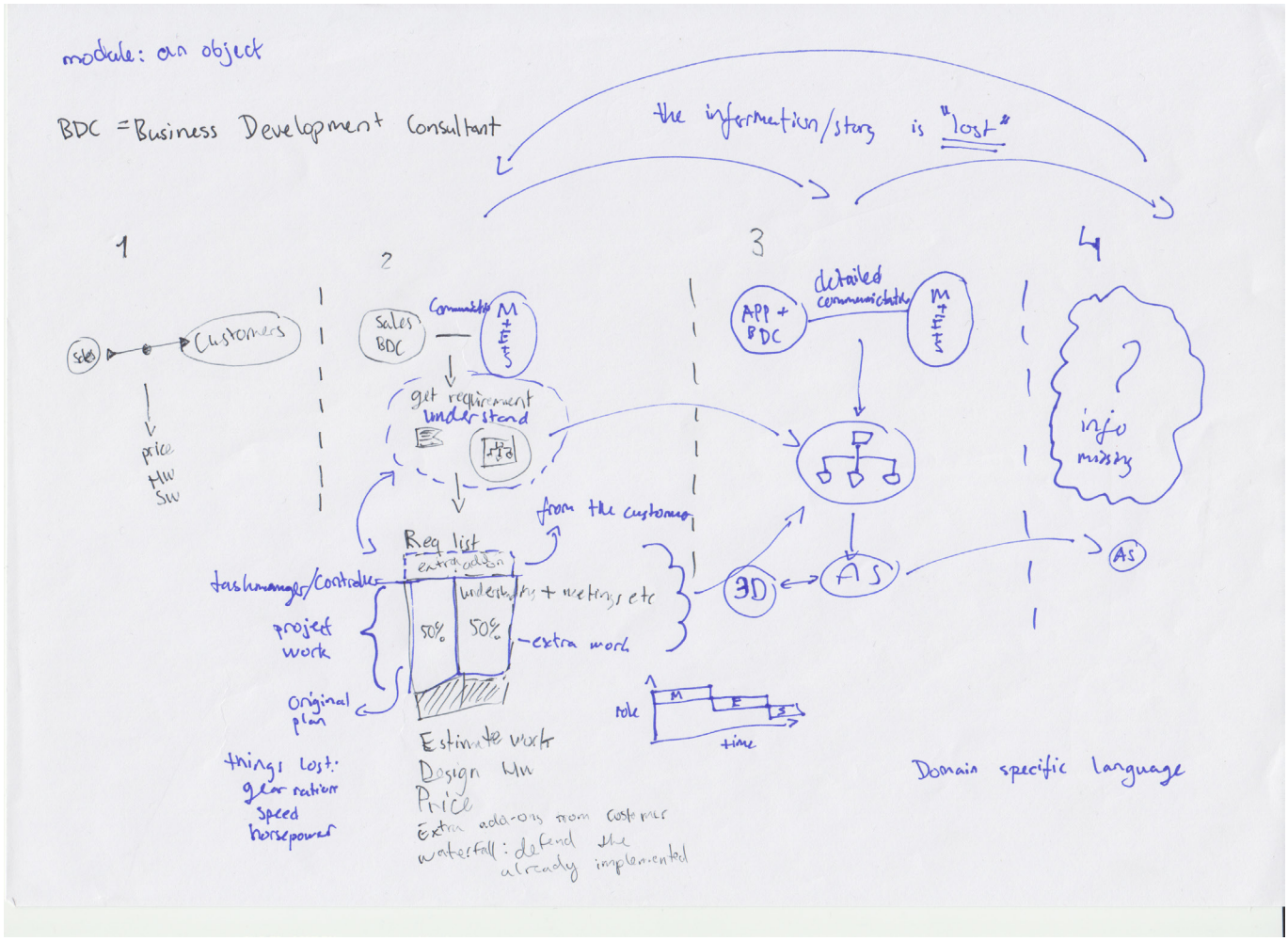


FIGURE 6 - PRODUCT DEVELOPMENT PHASES

The figure below (figure 7) shows how the time spent on the project in divided. According to Thomas and Mads the largest issue is that the actual time spent on the working on the problem is about 40% whereas understanding requires an additional 40% due to information loss and knowledge transfer failures. Additionally, some work that have been done will be unusable as customer needs change and they want to add extra work and implementations to the project. Therefore, a project that should only require 3 months will take 6.

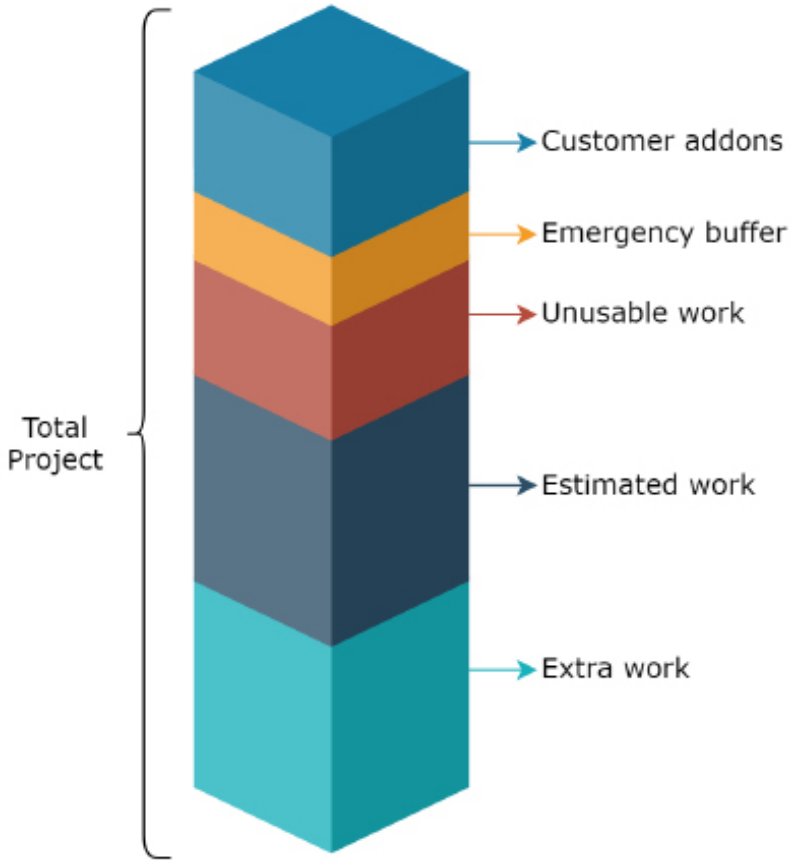


FIGURE 7 - TIME SPENT

From this interview a general idea of the problem was given, there were not any real problems in this project. Therefore a new project will be followed where knowledge transfer is a more apparent problem.

2.2.3 APPLICATION ENGINEER

Name: Frank Kjaerhus
Job title: Application Engineer (AE)
Duration: 2 hours

The second interview was done with Frank Kjaehus. He has a background in software development and has been a part of B&R for over 10 years. He holds the position of Application Engineer and his main job is to design software for the machines in their projects using a proprietary software called Automation Studio.

Automation Studio is a software development environment that creates a digital representation of the machine and construct all the phases of a machine (B&R: Automation Studio, 2018).

Frank was quick to acknowledge where his role was in the product development process and frequently mentioned the amount of work he has to do when going into a project, specifically the amount of extra work; the lack of information when progressing in the project and the re-iterations he has to do because of misunderstandings/miscommunications between him and the customer.

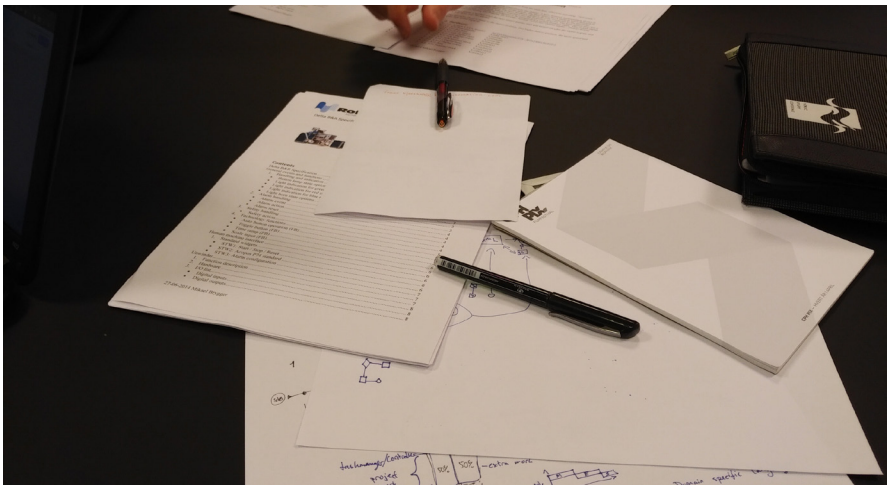
Below is a list of issues mentioned by Frank (in no particular order):

- One of the largest issues is getting the correct information out of the customer.
- What information is relevant to the project.
- The response rate of the customer (sometimes it can take weeks to get an answer).
- Lack of documentation (phone calls, emails and face to face meetings).
- Insufficient qualifications (the customer cannot answer specific questions).
- Language and knowledge barriers (education) is an additional issue.

Frank's take on the current project situation is that he is able to extract 50% of the necessary information from the customer and the remaining 50% are created by drawing on his personal professional experience.

His suggestion for a solution is to create standardized set of questions the customer can try to answer, in some sort of checklist. Preferably using a process diagram to visualize what the machine should be able to do sequence by sequence.

Lastly Frank shared a specification list a customer sent, which is used to describe the machine they wanted B&R to make, however, the 20 page document has close to no relevant information for a software engineer (Appendix D).



It became clear that the customer simply provides what they have available, unfortunately mechanical engineering specifications and setups cannot be converted to software specifications. This particular situation, which according to Frank is a frequent thing, requires a lot of communication back and forth before one is able to extract specific information.

Frank stressed that the field B&R works in is dominated by the mechanical engineers, however, the sheer demand for mechanical engineers is falling, and the demand for software engineers is increasing, and he thinks that the reason that the customers are unable to understand B&R is that they are still stuck in the 90's where the mechanical engineers were in demand.

The key findings from this interview is that the knowledge transfer is failing as the sender and receiver are from different knowledge domains. One is thinking software while the other mechanical. Additionally, the commitment and priority from both are apparent. B&R are more invested in this project than the people at Roll-o-matic are, resulting in a longer delay between emails.

With Frank's insights to the current problems as well as potential solutions gave a better understanding of the problem at hand. The next interview will start looking at all the relevant stakeholders and actors in the product development process.

2.2.4 NEW SALES MANAGER

Name: Mike Gornizka
Job title: New Sales Manager, previously Business Development Consultant
Duration: 2 hours

The third interview was conducted with Mike, he has a background in the military as an industrial electrician and holds the position as New Sales Manager at B&R.

The goal of this interview was to get a more in-depth understanding of the workings of the company and where he fits in the process and whether he had other insights to where the other stakeholders fit in as well.

Mike is responsible for the strategy, organisation design, HR work, marketing for the automation academy and all of the student workers. He is working parallel with Martin Larsen (see 2.2.6 Scandinavian sales manager) and is currently mentored by him, as Martin was the previous New Sales Manager.

He believes that the product development phases should only be divided into three parts in contrary to what was told in the first meeting (see 2.2.2 Application manager). Frank divides the process into these three phases:

First phase; Meeting with client

This phase encapsulates the very first meeting with their client where their main goal is to get information from their potential customer.

In this phase the following people are involved:

New Sales (NS)	Business Developer Consultant (BDC)

Second phase; Meeting with engineers

This phase is where the engineers are getting involved in the project and starts idea generating and gathering a team.

In this phase the following people are involved:

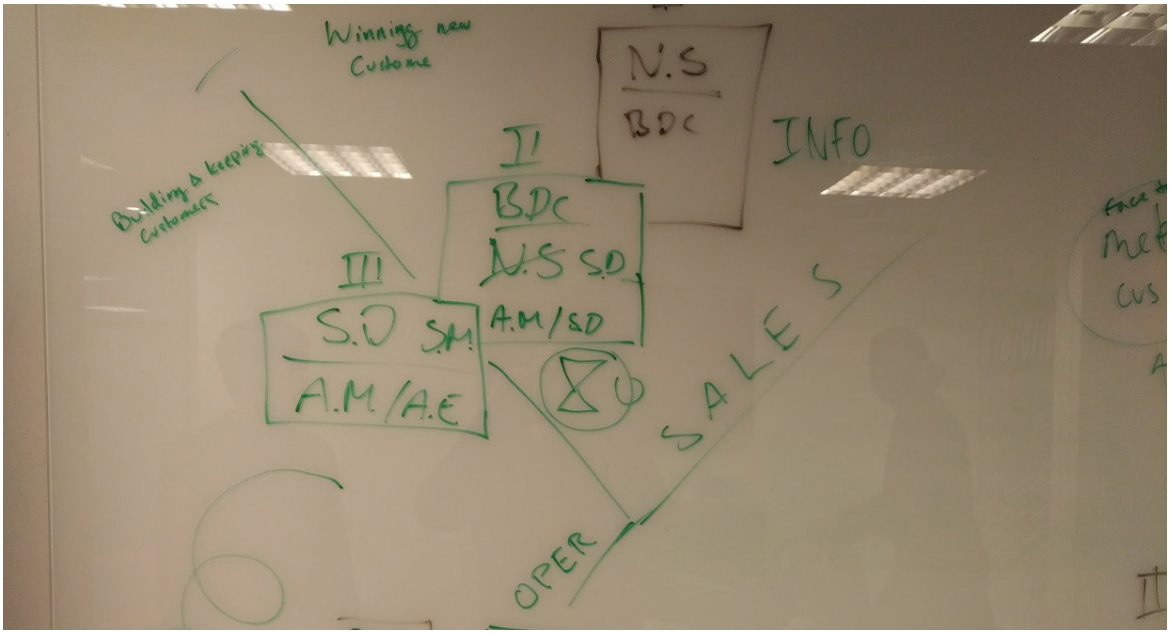
Business Developer Consultant	Solution Developer (SD)
Application Manager (AM)	

Third phase; Implementation

This phase is when the customer decides to become B&R's customer and starts implementing the ideas and increase their relationship.

In this phase the following people are involved:

Solution Developer	Solution Manager (SM)
Application Manager	Application Engineer (AE)



The photo above shows the diagram drawn during the interview. Mike categorizes phase one and two as trying to win new customer and phase three as operations. Meaning that they first start partner up with their customer between phase two and three.

His role in the product development phase is to bring in new customers. He attends the initial meetings with the customer alongside a business development consultant (as seen in phase one).

The key findings from the interview was that everyone at B&R sees the process differently making it unclear to describe and define the actual phases of the process. Additionally, the brief and Thomas are misunderstanding the smaller details of the case. B&R have close to no machine engineers. They consist of mostly software engineers, making the initial problem different, as the understanding was that B&R are having problems internally with their different engineers. The problem occurs when communicating with their customer's engineers that mostly consists of machine engineers.

2.2.5 | BUSINESS DEVELOPMENT CONSULTANT

Name: Mads Olsen
Job title: Business Development Consultant (BDC)
Duration: 2 hours

The fourth interview was with Mads Olsen, who is a business development consultant at B&R. He has a background in IT and software engineering.

As the business development consultant is part of the majority of the process valuable insights can be gathered. Mads explains that he sees that the biggest issue is working with the different types of engineers as they are working in different domains making knowledge transfer harder. However, Mads explains that the future of B&R lies in the programming, which is why they are not hiring mechanical engineers. The problem is that there are not enough software engineers and the industry is dominated by mechanical engineers.

He explains that in a perfect world the mechanical engineers can understand programming and vise versa, making the knowledge run smoother.

Lastly from his point of view there are a few possible solutions;

- He recommends that a common interface that visualizes everything
  Preferably where everyone can visually see how the machine operates
- Work with mechanical engineers and help them modularize their systems
  Make them more acceptable to change and future proof them
- Create a better understanding of how a mechanical engineers thinks
  Does they think in states like software engineers do?
- Have a software engineer earlier in the process instead of the last part of the process
  Make them attend meetings
- Bring the "A" team, e.g. if they have software engineer bring a software engineer
  Match the customers engineers with B&R's employee educations

The key findings from this interview is that matching the knowledge domain of their customer an increased knowledge transfer success rate can be achieved.

2.2.6 | SCANDINAVIAN SALES MANAGER

Name: Martin Larsen
Job title: Scandinavian Sales Manager, previously New Sales Manager (SSM)
Duration: 2 hours

Martin Larsen is the Sales Manager for B&R Denmark, he works with all transactions in the startup phase with customers and B&R before anything is set in stone. He gave some insights into how the company works in general.

The principles and understanding behind how B&R operates changes in this interview as B&R are not a product supplier, but a service provider and they do not provide this for e.g. Philips, Samsung or any other firms. Their customer are original equipment manufacturer who partners with B&R and creates products for the end customer, who are companies suchas Philips, Sumsung etc.
Therefore B&R do not care about creating relationships with them but rather the original equipment manufacturer.

Additionally B&R only focuses on the Research and Development phase by making sure that their customer's engineers get educated and learns how to use their machines to let them maintain and run everything themselves when the implementation is done.

Martin introduced a source into the interview, that shows what Mads was talking about. The supply and demand of both mechanical and software engineers is turning quickly.

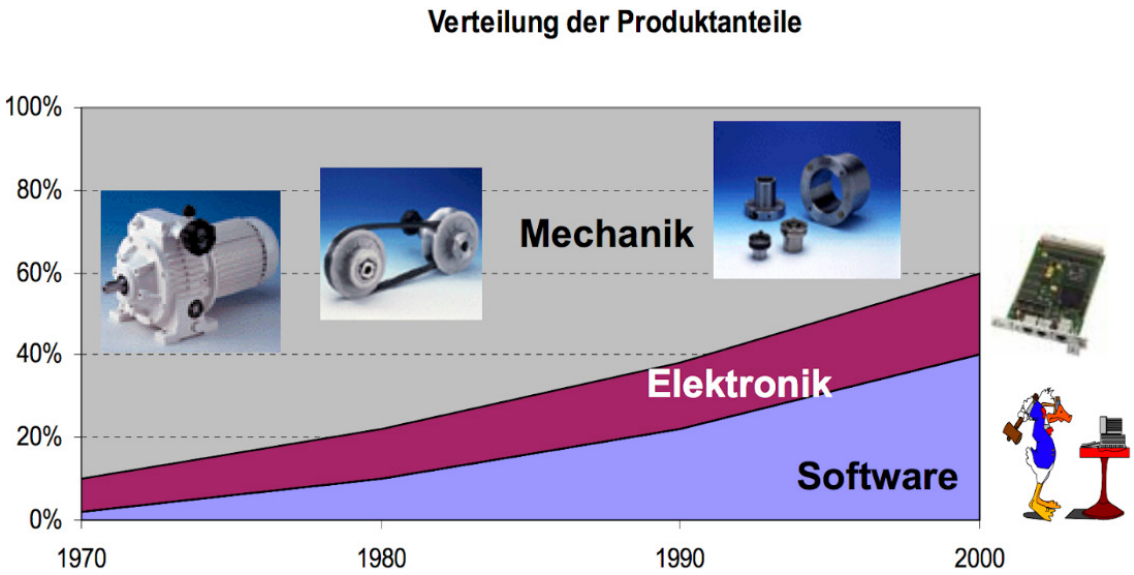


FIGURE 8 - PARADIGM SHIFT (STETTER, 2011)

The figure above (figure 8) is outdated, but according to Martin the demand for software engineers have increased up to 80% within the industry. However, it is still dominated by mechanical engineers as they started many centuries earlier than software engineers.

The findings in this interview gave a clearer picture of who B&R is and what their goals and visions are. Additionally a better understanding of their inner workings were gathered here.

2.3 CURRENT USER JOURNEY

Gathering the key findings from each interview and the monthly meeting with B&R a rough user journey for their customers can be seen below (figure 9).

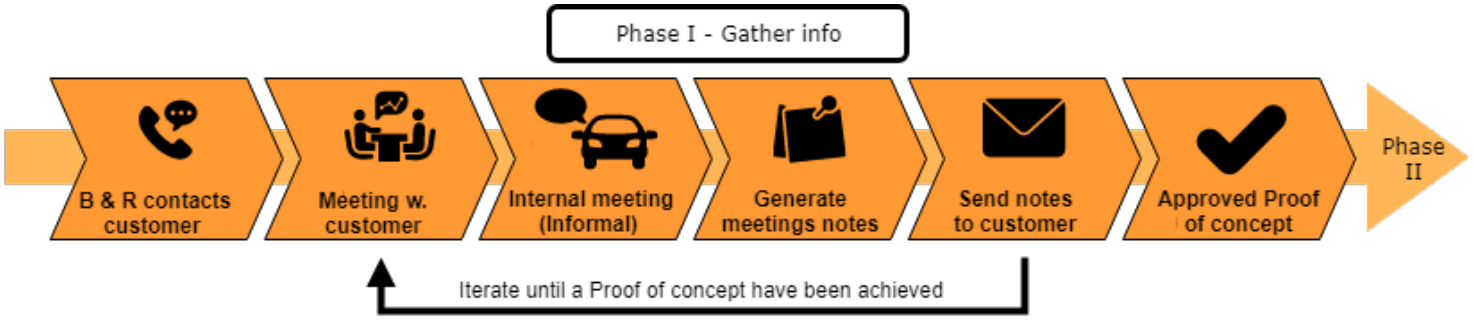


FIGURE 9 - USER JOURNEY, PHASE 1

The first phase of the product development phase is the information gathering phase. In this phase the main goal is to get as much detailed information as possible regarding the product from the customer. In the interview with Martin Larsen 80% of the time B&R contacts the customer and they set up a meeting. The meeting will be held physically at their customers location and on their way back home an internal informal meeting is held where notes will be generated and send to the customer.

This processes will iterate until enough information is gathered and both sides are satisfied with the results, which will move the process to the next phase.

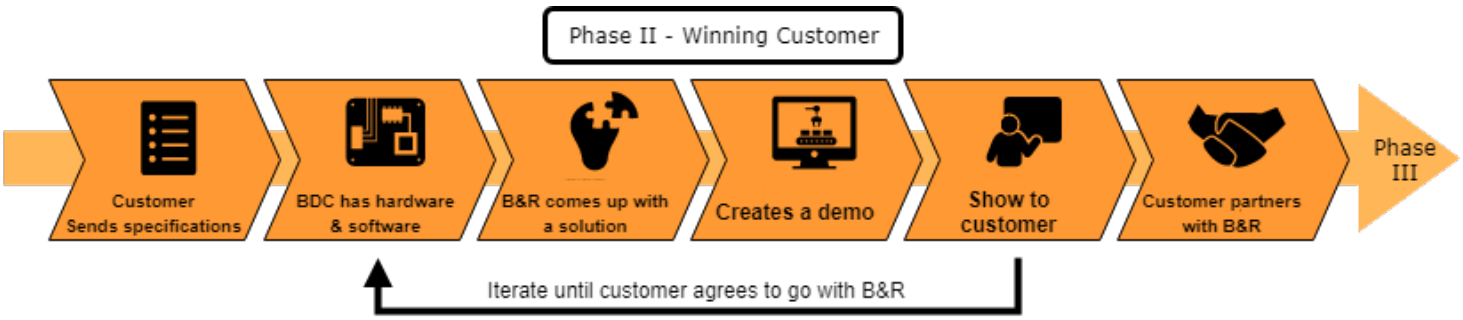


FIGURE 10 - USER JOURNEY, PHASE 2

The second phase (figure 10) is the winning of customers. In this phase the main goal is try to be professional and show the customer how much B&R can do and gain their trust, by showing demos and other visual implications that B&R knows what they are doing.

The proof of concept was approved in the previous phase so the first step in the second phase are various workshops with the customer, generating ideas and start paying more attention to what hardware to use and what kind of software to implement. B&R's team will come up with a solution and have a demo ready for the customer. To save time and resources the demos are mostly very abstract as a tailored demo for each customer is very time consuming. The customer will come with some improvements and adjustments which they will do another workshop on until the customer decides to partner up with B&R for their project.

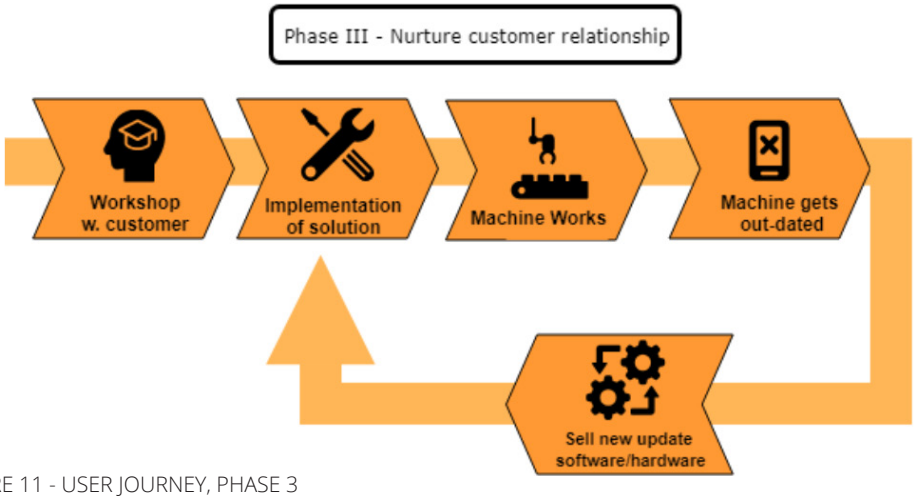


FIGURE 11 - USER JOURNEY, PHASE 3

The third phase (figure 11) the keeping and nurturing the customer relationship. As Martin Larsen stated, the research and development phase is where B&R wants to focus as they are not product providers but service providers. Additionally the cost of replacing an entire machine is a lot more expensive that just having small components and software updated once in a while. Therefore when the partnership is ready and everything in the previous phases are done a workshop with the customer is done again. This is due to the fact that a lot of the previous findings and information is lost as a new team of people is a part of this process and the data collected is not properly stored.

When everything is in place again the implementation of their solution is done and the machine is working. When the machine has run for a few years new technology and software have been developed and B&R will sell these new updates to software and hardware to their current customers, and this is how the current journey proceeds throughout a project.

2.4 KEY FINDINGS

The general understanding of the handling of the thesis was changed as each interview progressed. The preliminary introduction was that B&R had all the three engineers (software, mechanical and electrical) in their company and that the main issue was the communication between their own internal engineers, however, it quickly became evident that B&R consists solely of software engineers with various educational backgrounds. This revelation shifted the thesis focus, but the overall picture didn't move.

Following the interviews, the main problems apparently occur when talking with the customers, the original equipment manufacturers (OEM's). The customer consists mostly of mechanical engineers and this is where the issues start.

The mechanical and software engineers think in different domains and focuses on different parts of the machine. Additionally the communication problems between B&R and their customer is also due to the misunderstanding the customers thinks that B&R is a product supplier and not a service provider. B&R aims to provide a product line of several machines, but with their Automation Studio software, to facilitate a standardized set up across all machines, making them interchangeable, maintain and sell to their end customers.

These interviews gave a still picture of the current situation and the problem was placed into context. As each interview was conducted, it became evident that the issue most likely lies within B&R, and not between the two, as previously assumed.

Each and every employee had an idea of their own on how the product development process runs and is facilitated correctly, and this isn't within the margin of error.

Knowledge transfer success throughout B&R's various projects are mostly due to their ability to adapt to their customers knowledge domain by having the right people at the meetings. Additionally, by making the project a priority adds an increased sense of ownership. This is turn can make the customer more willing to communicate and commit. Lastly B&R tries to win the customer's trust in phase two, which will increase their sense of commitment and share more freely increasing the success of knowledge transfer.
This means that B&R are following the right knowledge transfer criterias, but are doing it unknowingly.

With this information the initial approach will be changed to better fit the case.

2.5 CHANGEOVER

With this new information in mind, the next step will be to better define the problem. The interviews allowed a nuanced understanding of the product development process phases and the issues throughout that process. Through the next chapter, the thesis will converge to define the discovered information.

3 | DEFINE

This chapter will summarize information gained throughout the previous chapter, discover. This will be done by connecting the dots across all of the interviews using visual service design tools.

The following tools will be used:

- Stakeholders Map
- Current User Journey Problems
- System Map

3.1 STAKEHOLDERS MAP

The first part of this chapter will be explained through a stakeholders map, which is a tool that enables a service designer to explore how the different stakeholders are working together, and how B&R's company fit into this process (Stickdorn et al., 2018).

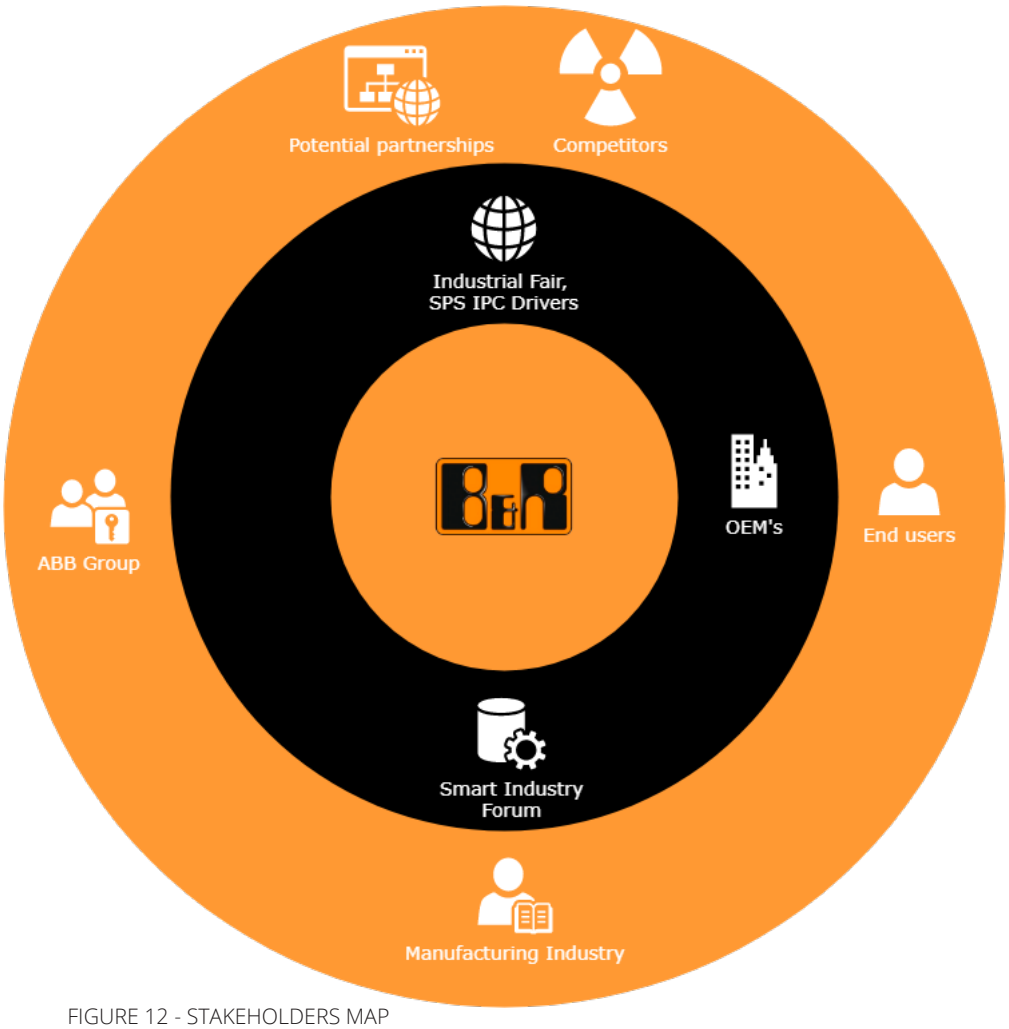


FIGURE 12 - STAKEHOLDERS MAP

The inner circle has direct contact with B&R, the outer circle has indirect contact with B&R.

It was decided to keep the map as simple as possible as B&R does have limited interaction with anyone else but the OEM's, whom are their sole customers.

Inner circle
B&R's customers are solely represented by OEMs (Original Equipment Manufacturer), whose customers are the end users, the personal buyers who shop at resellers, supermarkets or stores.

The Smart Industry Forum, which is a large event about the technology landscape; investigates globalisation, digital transformation and the 4th industrial revolution, which is considered to be the digital age with automation and new innovations. Smart Industry Forum is hosted by WT.SH, B&R and ABB Group (B&R's mother company) as co-hosts (Smart Industry Forum, 2018).

The international industrial fair in Germany, Nuremberg, SPS IPC Drives is B&R's largest medium to reach out to most potential customers. This is also where everyone in the manufacturing industry shows up to show off their current and new gen technologies.

Outer circle
The end users are unbeknownst to them indirectly affected by the choices B&R makes, as the products B&R produces are used in a manufacturing setup by the OEM's which thereby end up in the end users hands.

B&R rarely, and almost never have directly contact with the end users, but can at extraordinary situation do so.

3.2 USER JOURNEY

At another monthly meeting an initial sketch of their current user journey was shown as explained in the discover chapter (see 2.3. Current user journey). During this new meeting problem areas were explored.
Thomas & Mads explained that the problems first occurs in the second and third phase.

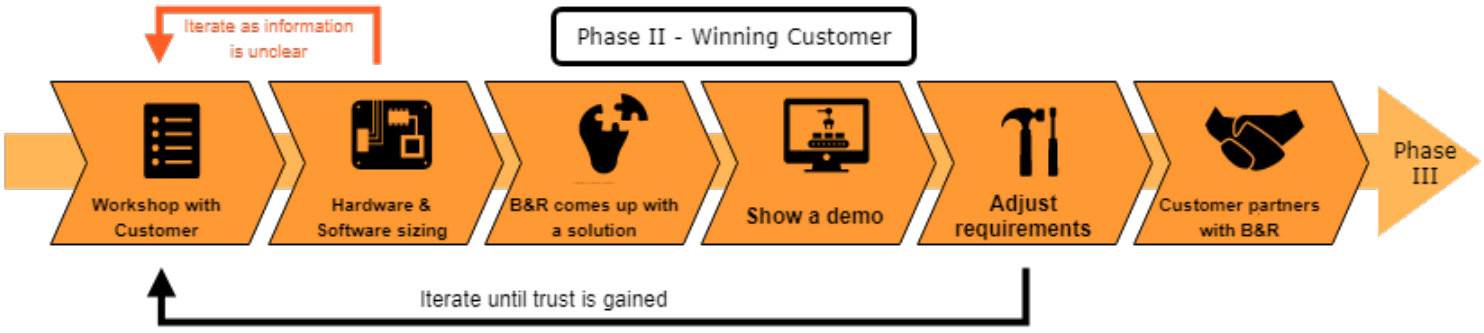


FIGURE 13 - USER JOURNEY PROBLEM AREA

In the figure above (figure 13) the same user journey can be seen as in the previous chapter (see 2.3). The main difference is that the problem already occurs in the beginning of the process. In the first two steps the details and data going forward is still too vague. Therefore a missing iteration should be in place to enable a clearer picture before moving to step three. This can fix a few complications that occurs later on as well. Another missing step is where someone documents the software/hardware sizing as well as a general idea of what is going on in these steps instead of just writing some notes on a post-it and placing it on their monitor screens for later to be lost.

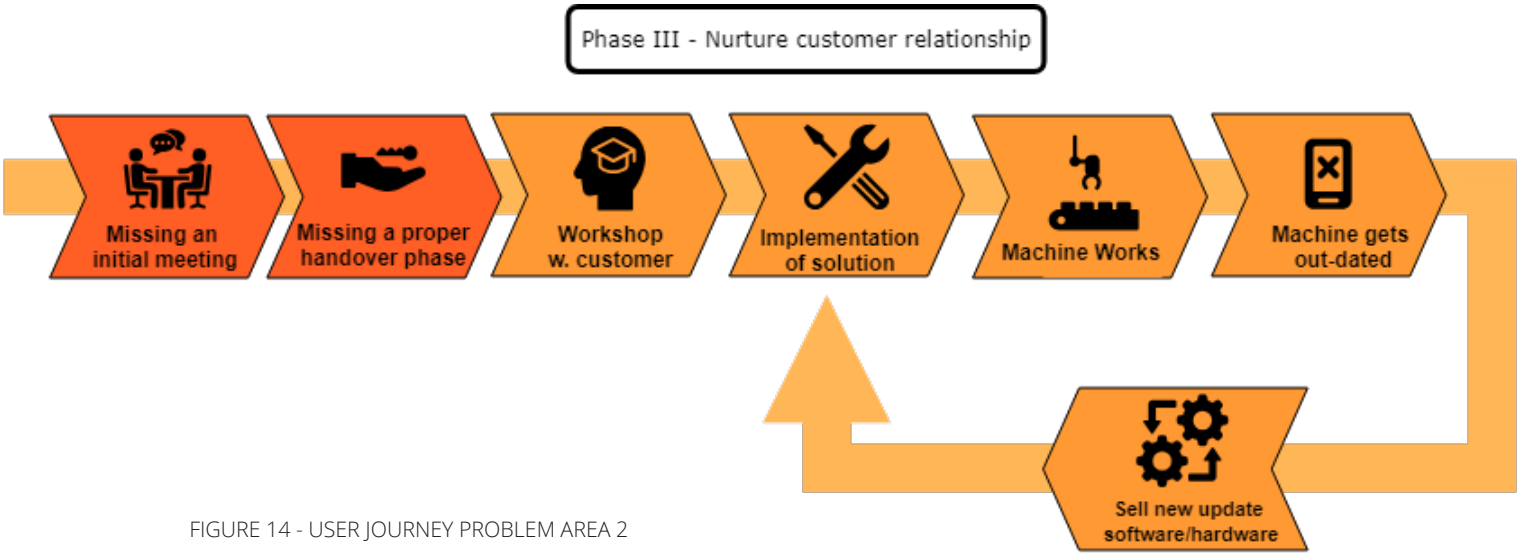


FIGURE 14 - USER JOURNEY PROBLEM AREA 2

In the figure above (figure 14) the third phase of the user journey can be seen. The darker orange colored steps are missing steps necessary for a new team to take over the process which is not happening in the current process. An initial meeting is missing, the ability to get the new team up to date and a proper logbook or documentation to give them a better understanding of what has happened up to this point does not exist as of yet.

From these user journeys it is clear when and where the problems occurs. This will be further explored during the development phase.

3.3 SYSTEM MAP

The System Map for the thesis decided to go with was separated into three phases, as in the user journey, it was important to not make it too detailed and difficult to get an overview, however, that is not completely possible without showcasing the entire knowledge transfer process.

Ultimately, after many trials, a combination of the following system maps were used:

- System Map (Morelli, 2007)
- Value network map (Stickdorn et al., 2018)

The perspective was chosen to be of an observer overlooking the entirety of the project.

It is important to not see the system map as something new (figure 14 or Appendix E), but rather a continuation and zoomed in view of the user journey, as it provides a more holistic view of the entire product development process phases from start to finish (Stickdorn et al., 2018)

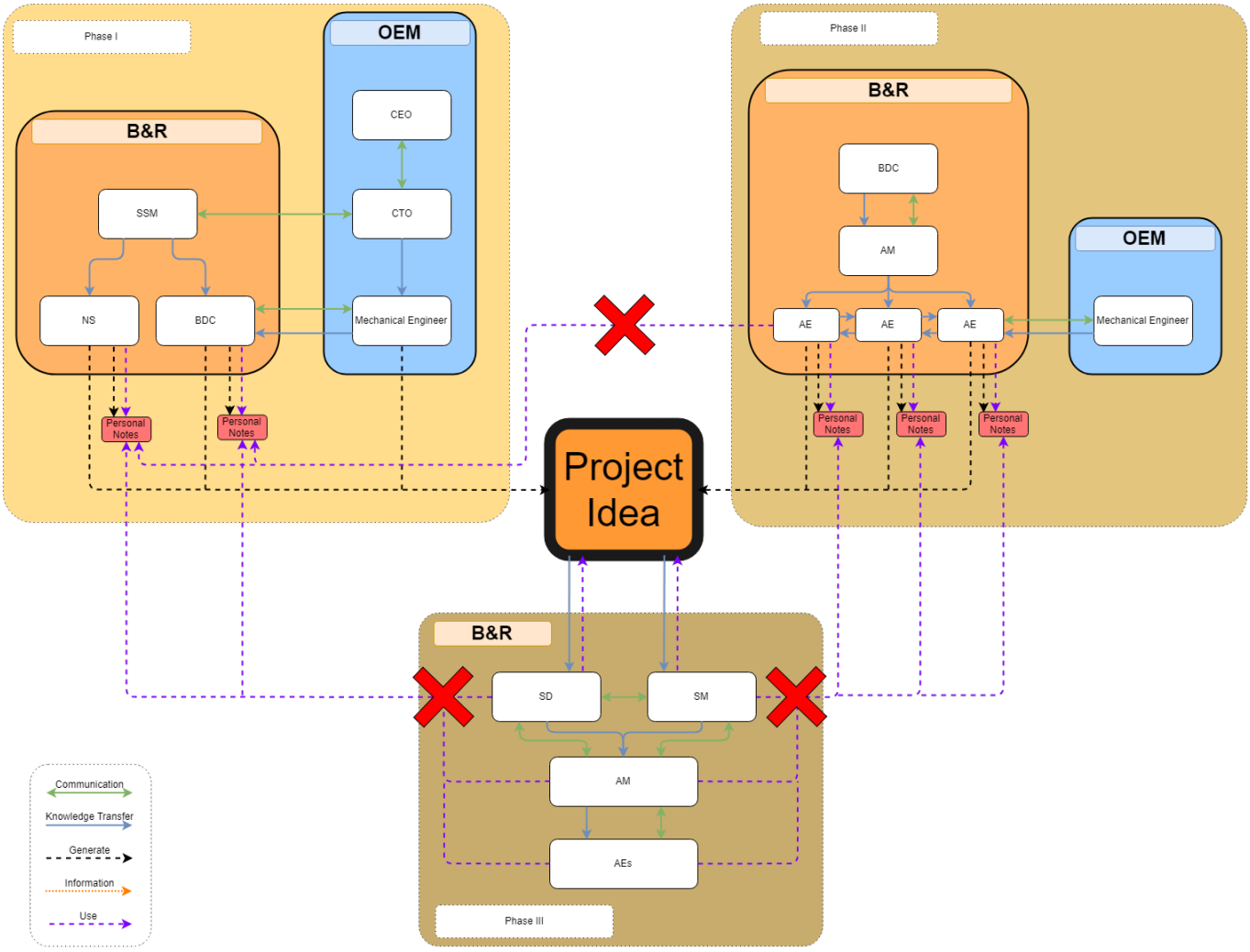


FIGURE 14 - SYSTEM MAP

Phase I

As mentioned in the user journey B&R contacts the customers and tries to convince their chief technology officer to partner with B&R. The chief technology officer tries to convince the chief executive officer to partner with B&R. The CEO agrees and the CTO gathers a team of their mechanical engineers. In turn the customer contacts B&R and starts initiating the project. In this part of the system map it is important to note that areas where the business development consultant and the new sales generates their own personal notes are from interactions with the customer. Additionally there are already many knowledge transfer processes this early in the stage. This is where time is wasted and used inefficiently as stated during the interviews (see 2.2.3), some of this information is documented and is added to the new project that is accessible to everyone.

Phase II

The next phase is when the business development consultant contacts the application manager and assembles a team of application engineers. When they have been briefed they want to accesses some of the previous information that they have gathered from the previous phase, but this information is now lost. They therefore need to contact the customer again to get new knowledge as well as old regarding the project. Again there are many knowledge transfer interactions that are not going smoothly. From these interaction additional personal notes are written down. Again some of this information is saved and documented and put into the project folder.

Phase III

The last phase is when everything is in place and they need to develop and maintain a product for the customer. However everyone only have a vague idea of what the project is about and a majority of previous data and documentations are lost as it is personal notes. Therefore contact with customer is needed again to gather old and new knowledge.

With previous misunderstandings cleared (see 2.4 Key findings) a clear project direction have been found.

3.4 PROJECT DIRECTION

From the user journeys, system maps as well as the stakeholders map a clear project direction have been set. It is clear that knowledge transfer between the customer and B&R are lacking, additionally where this happens have been defined during the user journey. Another point is their lack of documentation. This has been proven to be very problematic and time consuming for them as the system map shows. Therefore, looking into these will be the main focus for the development phase.

3.4.1 DESIGN CONSTRAINTS

The aim of the define phase is to narrow down the problem. With all the material from the discover phase analysed a more organised overview of the problem was found. This leads to the design constraints that will form the foundation and guideline for the future of the project, to ensure that we are developing a proper solution for the user and stakeholders.

The design constraints aim to guide the solution and make it realistic to apply to the product development process phases.

- The knowledge transfer that occurs through the product development process should not hinder the application of the solution, nor should the solution hinder knowledge transfer

- The solution should allow for flexibility across projects, scalability as necessary and allow for a real time update

- Documentation, notes, questions and information should be allowed to co-exist within the solution, without implementing more steps to the product development process

3.5 FINAL PROBLEM FORMULATION

As the project progressed and a more in-depth understanding of the problem was gained, through interviews and service design tools, the various solutions and ways to handle this problem were iterated upon.

Instead of only focusing on the workflow and how B&R communicates with their customer, a greater emphasis and focus on knowledge transfer was deemed important. By looking at how they exactly transfer knowledge and how to increase their success became vital. Therefore a new problem formulation was done.

"How can we increase the knowledge transfer success between B&R and their customers with the use of a standardized system of documenting data through each of the product development process phases?"

With this in mind a clear goal and problem area was defined.

3.6 KEY FINDINGS

During this chapter a more holistic view of the thesis was taken. Seeing the problem from various angles as well as understanding when and where problems arise.
The most important key findings have not changed, there are many processes where knowledge transfer is used incorrectly as well as lack of documentation increasing the project time.

When looking at the system map documentation and backtracking is not an option as the documentation from each are insufficient in the later stages as they cannot be accessed.

From the user journey proper understanding of where possibles solutions can be implemented as well as when the problems occure.

3.7 CHANGEOVER

As this chapter managed to functionally use all of the findings from the discover chapter, it is now a natural step to proceed to the development of the solution.

4 | DEVELOP

The development chapter will explore the ideation, creation and initial testing process of creating a solution for B&R.

4.1 WORKSHOP

A total of two workshops were done. The first one in cooperation with Nilpeter, a customer that has been with B&R for more than 12 years. The second with B&R employees, working at a project with the customer Jensen, a sustainable laundry automation company.

4.1.1 FIRST WORKSHOP

Participants: 4 from B&R, 2 from Nilpeter, 6 in total
Duration: 3 hours on customer meeting, 1 hour on feedback session, 4 hours
Location: Slagelse, Denmark
Tools: Combination of participant observation and contextual interview

The first workshop was at Nilepeter's office in Slagelse. Nilpeter describes themselves as a world-leading manufacturer of different printing solutions (Nilpeter, 2017). They've got a large production of printer assemblies that provide high-quality prints that a customer requests.

The technique used here was the participant observations, which allows to gain insight into the relations of the natural setting that this customer meeting provides (Bjørner, 2016). The workshop was done in two stages, first stage was a customer meeting B&R had with Nilpeter, the second stage was a feedback and discussion session surrounding the first stage. This customer meeting is about a specific model, a offset printer model.

Attending the meeting, from B&R, was a total of four employees:

Thomas Noerby (Application Engineer)
- Frank Kjaerhus (Application Engineer)
- Sverre Faureholm (Business Development Consultant)
- Mads Olsen (Business Development Consultant)

Nilpeter, had two employees attending the meeting:
- Jesper Larsen (Electric and Software Manager)
- Peter Albrechtsen (Development Manager)

Jesper facilitated the meeting and had Peter assisting with the specific technicalities surrounding their product, the offset printer. The offset printer as of now, is mechanically run, with a simple UI monitoring software made by Bosch, who also manufactures the machines in cooperation with Nilpeter.

Nilpeters vision for said machine, is to have B&R build it from scratch, with one standardized software solution, while in parallel educating Nilpeters own software engineers in the use of Automation Studio to facilitate their own maintenance and updates of the machine afterwards. A direct quote, that was said by Jesper, was:

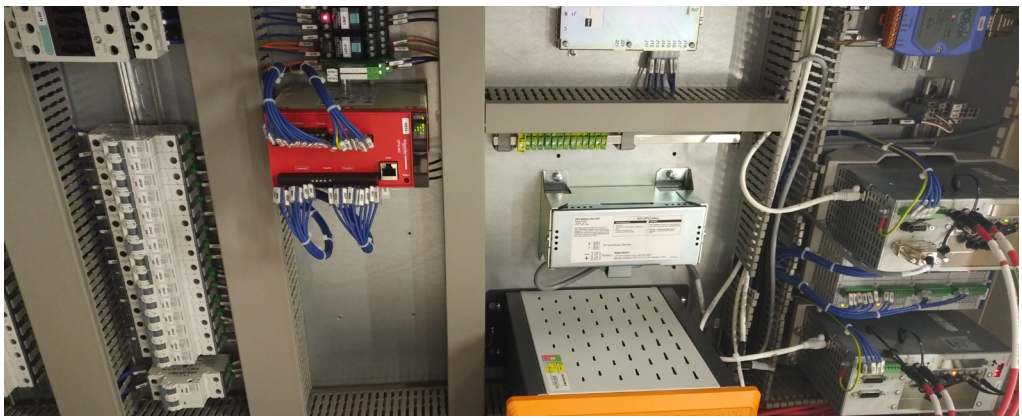
"(...) we need a complete overhaul of the printer service system, and this needs to be done by B&R in a way they haven't done it for us before."

Nilpeter is aware of what B&R offers, what they've done before and have a specific goal that they are confident B&R can successfully help them achieve.

The goal for the day was to gather enough information to make an initial estimate on the work needed to convert the MO from bosch to B&R hardware and software as well as identifying major risks.

1. Background and History (Nilpeter key selling points)
2. The mechanical design
3. Major functions
4. Complex processes
5. Current hardware (I/O,motors,drives)

Customer meetings tend to involve two employees from B&R, this time around it was a total of four employees.



The key findings from the first meeting was:

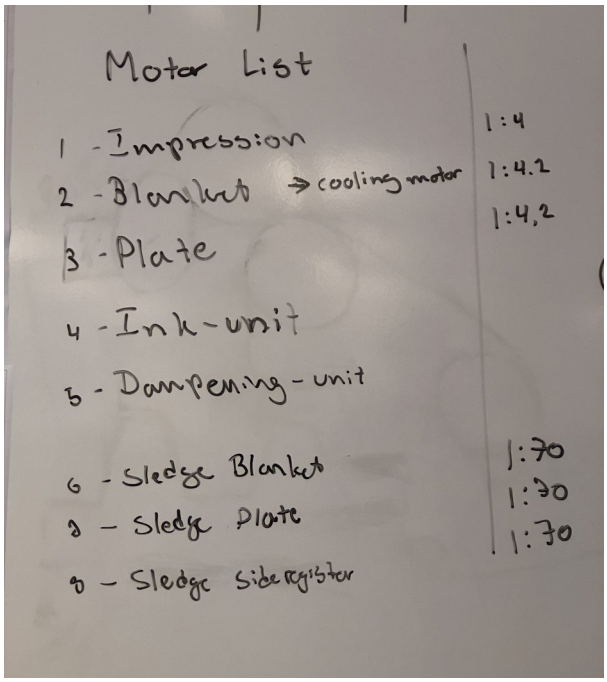
- Having a relationship with Nilpeter, means that B&R is aware of the domain specific language Nilpeter uses when talking about their products
- B&R and Nilpeter are completely polar opposites on which part of the machine that is going to be the most difficult part to program
- Talking past each other occurs frequently, as neither partner understand what the other one is talking about

After the meeting, the discussion workshop was initiated.

Nilpeter had a drawing of the current offset printer in a mechanical 3d format, it did detail certain aspects, but as a software engineer it was difficult to understand, and required a lot of hours to dissect. This was brought up as a potential issue, and Nilpeter talked about a potential workaround for this issue by having a mechanical engineer assigned to help B&R.

As the discussion advanced, the nudging worked, B&R and Nilpeter started to initiate a conversation where they would co-create a motor list (essentially a priority list) of what components in the printer were the first ones to be made.

Furthermore, the discussion led to a simple diagram made by Nilpeter, with comments from B&R, to visualise how the mechanical drawing that Nilpeter had pinned on the whiteboard worked in real terms, this led to a new area knowledge transfer that was earlier unheard of by both B&R and Nilpeter.

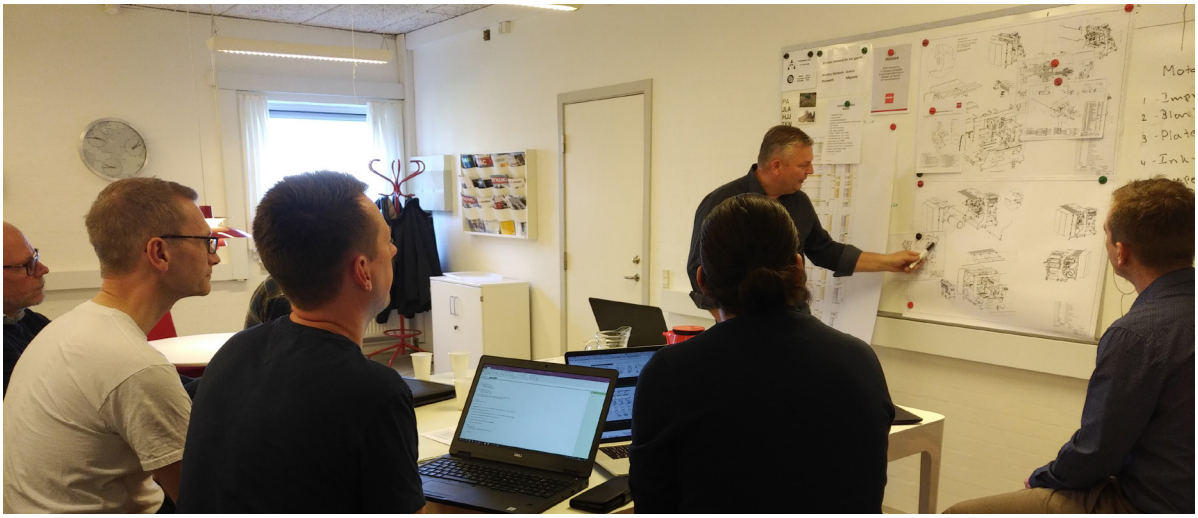


The workshop allowed both partners to have a equal discussion, talking about the things that aren't appropriate to ask, or details that were not identified as issues earlier on.

Having four employees attending the meeting, did help out tremendously, as each employee was responsible for a specific part of machine that they had to focus on, on top of that, they all took notes whenever they weren't asking questions or the conversation wasn't on their specific focus area, this allowed for more concrete questions in the last stage.

The take on this two stage setup allowed for both a planned and relaxed conversation to exist.

One important thing to do is that this workshop was done as a overt observation, which means that the participants were aware of the research for this thesis was being done, and that might have tainted the findings. Having to dissect each and every step of the process whilst having a small attendance in the discussion did create a distraction from the original research purpose, which can be argued to be a well-known pitfall when doing these kinds of observations (Bjørner, 2016).



4.1.2 SECOND WORKSHOP

Participants: 3 employees from B&R
Duration: 3 hours
Location: Odense, Denmark
Tools: Co-creating user journey, system map and mapping the journey; use of preliminary user journey to inspire and showcase what was uncovered through interviews

This particular workshop involved three participants, employees from B&R, that worked in close cooperation with the customer Jensen (Jensen-Group, 2018) who specialize in sustainable laundry automation. Jensen has had a functional relationship with B&R for more than 10 years, and after a few meetings with a business development consultant, Jensen deciding to invest in a new product development project, which prompted B&R to create a new project.

The Jensen project is currently in its last phases, and the employees chosen to participate in the workshop, are and have been a part of it from the very start.

The attendees of this workshop were:

- Uffe Jensen (Solution Developer)
- Mads Pedersen (Application Engineer)
- Henrik Christensen (Application Engineer)

The workshop was done in two stages. The first stage involved a presentation that was meant to showcase the findings up to this moment in time through interviews, and to inspire the attendees to facilitate a user journey of their own based on the Jensen project.

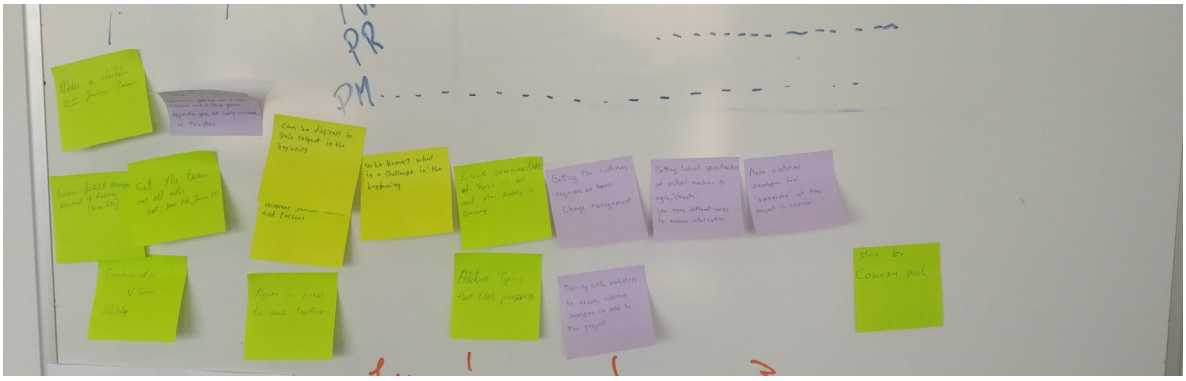


FIGURE 15 - ONE OF THE USER JOURNEYS MADE BY UFFE TO ILLUSTRATE THE BEGINNING OF THE PROJECT

The presentation started by giving a small introduction to the thesis project, to knowledge transfer, to who was interview, the knowledge gained, how the current user journey looks from the interpreted knowledge gained from the interviews and the goal of this workshop.

The second stage of the workshop was split into several steps:

1. Introduction to the Jensen project
2. The drawing of the user journey
3. The distribution of the work between everyone working on the project
4. 5 minute break
5. Recap
6. Pros and cons encountered throughout the project thus far
7. Training Jensen software engineers in Automation Studio
8. Things they would have done differently
9. 10 minutes writing their most important observations, good, bad, important and neutral

As step 9 concluded, the results of said experiences were the following:

- Make a proper schedule together

  Use the Kanban board to create transparency and see each others progress
- Ensure the proper management direction

  Have the executive management team onboard the project
- Align both the customers vision and B&R's vision

  Internally and externally
- Set an agreement with all teams within the customers company globally on the project
- Agree on a transparent workflow that makes sense to all partners involved
- Preparation on a project level instead of a management level

  Make sure the management approves and doesn't interfere
- Ensure real overview of everything when moving forward w/ the project

  so nothing is missed or anyone has the wrong expectations
- Make the customer feel a real "ownership" is project crucial

  B&R is creating a service for the customer, it is up to the customer to maintain it
- Who knows what is the challenge in the beginning

  "This question can be mitigated by gaining trust/respect from the customer by working in close quarters on the project for a period of time" said at the workshop by one of the employees
- Address problems/topic that block progress ASAP to move forward quickly

  Preferably have a meeting and discuss the issues at hand
- Strive for a common goal and make that clear for everyone
- No one knows what the challenge is in the beginning both personally and professionally

  Discuss possible scenarios from previous projects to minimize risk

Ultimately, this workshop provided the inspiration ground to create the first prototype, or at least motivate towards the correct preliminary service system for B&R to use in, not only for their communication between the engineers, but for the entirety of the product development process.

The last few minutes of the workshop was initiated by the employees themselves, as they felt they wanted to express the ideas they have been thinking of to potentially solve the knowledge transfer issue that is present at the vast majority of B&R projects.

Uffe, Mads and Henrik, were adamantly agreeing on a number of things:

A unified, real time platform that would allow for everyone to document their information
Share the comments, worklog and backlog with the customer
E.g. just like with the Kanban board
Make a project wide platform to facilitate each step of the product development process

The points above were formed from the gist of the 1 hour feedback session, and with this it is time to transcend into the first prototype.

4.2 PRETOTYPE

The clever term "pretotype" was coined by Alberto Savoia in 2009, it came due to the lack of a low-fidelity test phase before investing time and money on a prototype.

Savoia sees prototypes as a useful tool to answer a many questions that one might have, but pretotyping focuses on answering "Is this the right thing to build?" question, and he says:

> "Once that question is answered positively, then it makes sense to move from pretotyping to prototyping." (Savoia, 2011, p. 23)

To decide on a pretotype, it is necessary to understand the thought process that has led the thesis to this step. The experience from both workshops, allowed to converge and ideate on what kind of solution would allow for most freedom and flexibility, without forcing any extra activities onto B&R.

The initial interviews gave a deeper insight into the new product development process at B&R, but the workshops provided priceless data that would have been, under normal circumstances, difficult to extract and rationalize, although some hints and comments on the matter were made.

The design brief; the largest portion of this thesis was only about the engineers at B&R and the engineers at the customer's side, having bad communication, but on the contrary, the real life situation is that there's many steps before any kind of specific engineer steps in to the new product development process. The actual situation is that there's four phases of the new product development process and the engineer can be anywhere, depending on the type of project and customer.

With the total sum of all of the interviews and the two workshops, it is not incorrect to say that the final product development process looks true to Figure 16.

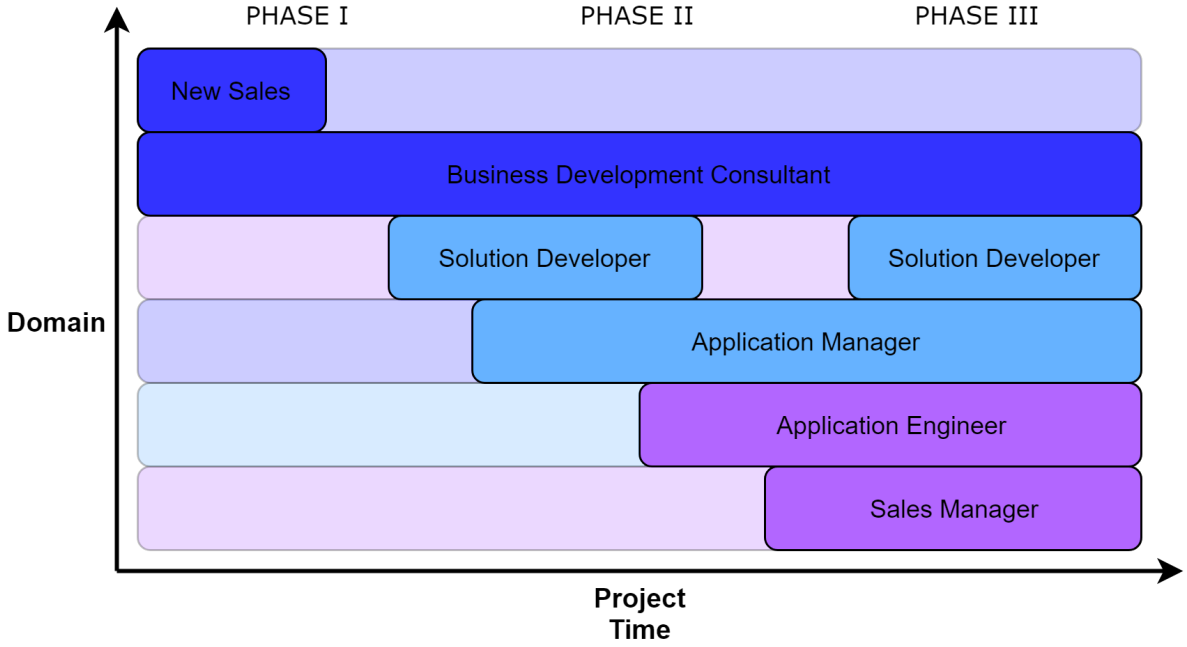


FIGURE 16 - THE REAL PRODUCT DEVELOPMENT PROCESS AT B&R DIVIDED INTO THREE PHASES, NOT FOUR

As mentioned earlier the first and second phase is about the meeting with the customer and building the relationship between B&R and them. Figure 16 looks seamless, but the reality of the situation is that there's gaps throughout the entire process in the majority of B&R's projects; the illustration shows the average project employee work distribution and when they respectable appear in the product development process, split across the three phases.

APQC (American Productivity & Quality Center) had a "Knowledge Management Community Call" in February of 2015 (APQC, 2015) and the headline of the community call was "Improving the rate of knowledge transfer". The said PDF was stumbled upon in the first phases of the thesis, but first in the end was it clear what influence it has on the first prototype.

The presentation was presented by two employees from APQC: Trees, L., a KM research program manager, and Lemons, D., a senior consultant.

All of the techniques to support knowledge transfer that APQC advices to use are matrix based. Three techniques are mentioned, APQC's knowledge map template, role-based knowledge matrix and knowledge flow matrix.

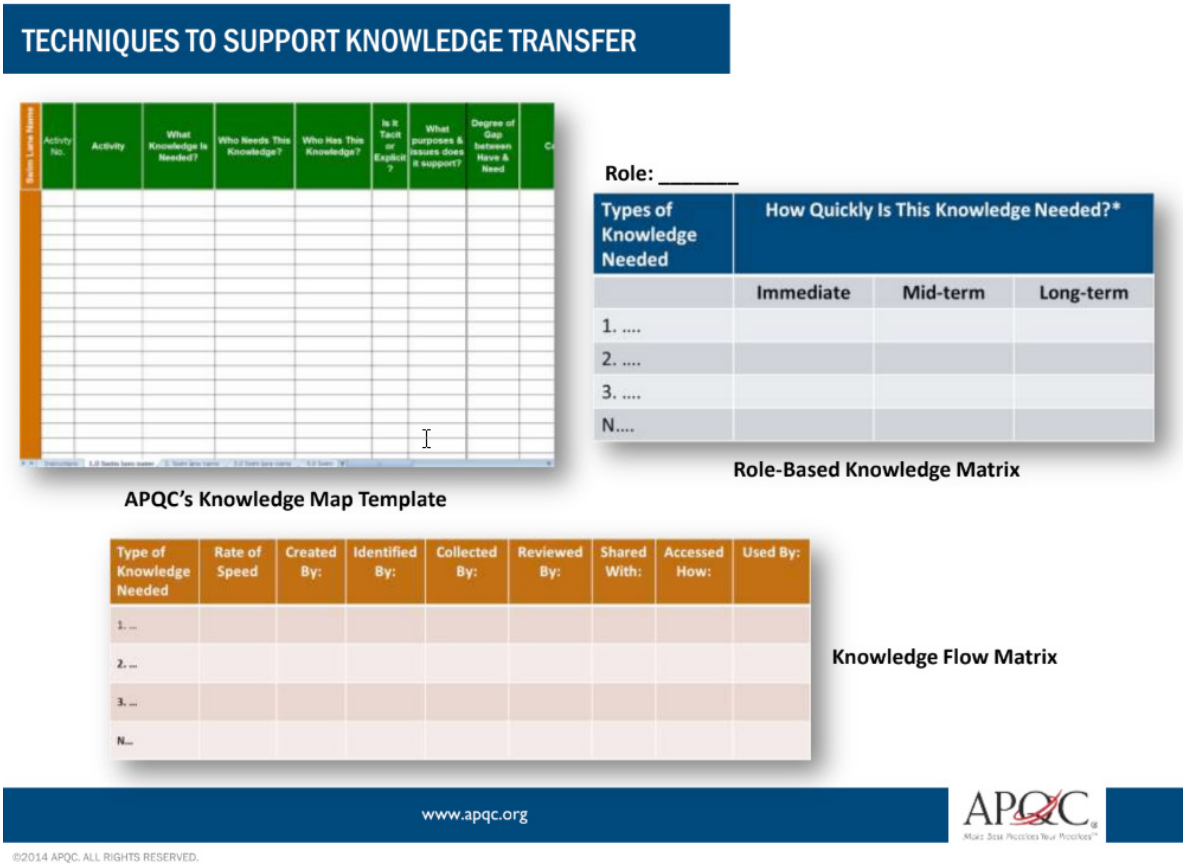


FIGURE 17 - SLIDE 12 FROM APQC: IMPROVING THE RATE OF KNOWLEDGE TRANSFER (2015).

B&R takes pride in using Kanban for their projects as it is a tool that suits their needs, it relies on a table/matrix lean project management approach, so it would be the most natural to offer something of similar caliber. Parallel to that, Excel is being utilized internally by the application engineers due to the vast database support Excel offers, as it meant to work with sheets, tables and matrices on a regular basis.

Backlog	To do	In Progress	Testing	Done
Engine bug (4 hours)	Update firmware (1 hour) Correct button (2 hours)	Import data (4 hours)		Offline support (8 hours) Restore data (6 hours)

TABLE 1 - A TYPICAL KANBAN BOARD, WITH SOFTWARE JOBS ON IT

The APQC PDF on improving the knowledge transfer rate presented some valuable techniques, however, the goal of the thesis is to investigate how the use of service design will support the knowledge transfer rate in the product development process that B&R uses. It is not about inventing a new solution, changing B&R's project methodology, but rather improving on their existent project service system to support them in inwcreasing their knowledge transfer rate.

Using the APQC knowledge transfer technique inspiration mixed with a kanban board, the preliminary result ended up as in Table 2.

Information type	**Backlog**	**Preliminary**	**Necessary**	**Critical**
Engine	Horsepower			Model
Roller	Speed		Width	
Printer	Ink temperature			Adjustability
Ink dispenser			Size	

TABLE 2 - FIRST PROTOTYPE, NAMED I-MATRIX

Different smaller tests were conducted on students around the library. The overall idea of the test was whether or not a standardized documentation system would enable the increase of knowledge transfer success, especially when transferring tacit knowledge.

4.2.1 PRETOTYPE TEST

Participants: 6 in one group, another 6 in the second group.
Duration: 10 minutes
Location: Copenhagen, Denmark

The first test was done as a design game. It was entirely inspired by the kids "whisper game". The whisper game is used to see how information is changed from person to person exclusively relying on word of mouth communication. Therefore this would be ideal to test whether tacit knowledge can be transferred successfully when it is sent through one person to the next.

Games always have a set of rules that needs to be followed. In this instance the participants were only allowed to transfer the knowledge once and that is it. Participants who are not next in line, are not allowed to listen to people knowledge sharing, hence the whispering.

Two groups of 6 random people were gathered at Copenhagen Main Library. They were asked to sit in a long line to begin the test. The test was once on two different groups of people. The first group were given a blank piece of paper they were allowed to write on after they heard the knowledge shared with them. The first group was made the control group.
The next group was given a paper with a already prepared template (see Table 3) of different information they had to pay extra attention to.

Information type	Neutralt	Vigtigt	Meget vigtigt
Svømme gæst	Håndklæde med i sauna, uden klipklapper, intet plastik	Må ikke løbe udenfor gummi tæpperne	Børn under 12 skal have forældre med
Svømme træner	Bestå svømme prøven under 1 time	Skal have en fløjte klar til brug	Have god overblik under hele dagen

TABLE 3 - PREPARED TEMPLATE ON SWIMMING INFORMATION

After each test the information loss between each person is clearly visible as there's a clear distinctive difference between the control group and the second group that used the template.

There is the argument that the second group is more "prepared" due to them already having a template ready for them, but that is the exact point, the simplicity of the test is to see whether the template provides any value in praxis.

Both groups made use of tacit knowledge transfer. The second group had the highest rate of knowledge transfer, as they were able to transfer key points across more reliably, than the control group which lost some valuable information such as the swimming coach has to finish his examination within 1 hour, and not just finish the examination.

This situation is not similar or at all comparable to the product development process at B&R, thus the next natural step is to facilitate a workshop with B&R, to better understand what kind of knowledge is important and what is less important in a R&D setting.

4.3 PROTOTYPE

This prototype, essentially the service concept, has been named the Information Matrix, for a more personalized approach.

The service that we will provide is a new and optimized way for B&R to document their data and process between each step and phase. By having a "template" for all types of knowledge exchanges e.g. physical meeting with clients, internal meetings, emails & phone calls. By combining their own system which is the kanban board with our own information matrix.

B&R uses a kanban board for the sake of keeping track of their software development process, and they have, in a ongoing project with Jensen (see 4.1.2 Workshop), shared the kanban board between their own employees and the software and mechanical engineers at Jensen to allow seamless communication inside the kanban board, tracking each others progress in the various tasks, and commenting on work progress for faster response times.

The service concept would be visible in each phase of the product development process, whenever a phone call, meeting or email containing any knowledge is transferred this would be documented.

Information type	Preliminary	Necessary	Critical
Engine			- Gear ratio - Speed ratio - Horsepower
Roller		- Material - Grip	
Printer	- Off-set - Digital		
Ink dispenser	- Size limit for largest /smallest paper	- Colors - Temperature	

TABLE 4 - SERVICE CONCEPT PROTOTYPE

Phone call	Email	Meeting
Customer said they do not have what the gear ratio should be	Customer will be unavailable for the next two weeks (date 24/3-4/4)	<picture inserted> Mechanical engineers drew out a setup of what they want to be done

TABLE 5 - POTENTIAL ADDONS TO THE INFORMATION MATRIX

As these tables are filled up, things would give a better overview of the necessities that need to be clarified. The reality of such concept is hard to conceptualize and put into context without a real test.

The next step is to do a case prototype test in collaboration with B&R, to see if the Information Matrix in the right hands contextualized correctly can make any difference.

4.4 KEY FINDINGS

With different workshops and tests the different parts of the new service solution can be defined better. As mentioned during the iteration a more domain specific test is needed to make it valid. Another way to validate the test a bit more is by having more than just one. The conclusion of our one test was that it would be better to have a template/standardized system of documentation, this is not completely valid due to the absence of more tests. For future reference more tests will be conducted before jumping to the conclusion.

To follow this decision a more detailed description of important knowledge was needed in the matrix. This information was gathered from the two different workshops which helped create a base for the information matrix.

4.5 CHANGEOVER

From these findings a more domain specific test will be executed. The plan is to do the same design game on the B&R employees with a more detailed information

5 | DELIVER

During this chapter a domain specific test will be done of B&R employees. Additionally a new system map will be presented as to show how the new system will be changed with the solution.

5.1 PROTOTYPE TEST

Participants: 2 roleplaying B&R, 2 roleplaying customers, 2 observants, 6 in total
Duration: 2x30 minutes per meeting and 30 minutes for feedback, 30 minutes introduction, 2½ hours total
Location: Odense, Denmark

After a presentation of the proposed service prototype, and the test at the library, Thomas Noerby and Mads Olsen were intrigued. The status meeting provided them with a glimpse of the potential they could create, even integrate with the kanban board.

they proposed to develop a more domain specific Information Matrix to align it with vocabulary they use at B&R during the meetings to make it as realistic as possible.

This prototype test that was done in collaboration with B&R as a two part case presentation.

Attending the prototype test workshop were the following people:

Conducting the customer interview:

- Michael Müller (Solution Developer)
- Jannik Larsen (Business Development Consultant)

Roleplaying the customer:

- Mike Gornitzka (New Sales Manager)
- Sverre Faureholm (Business Development Consultant)

Observers and facilitators:

- Thomas Noerby (Application Manager)
- Mads Olsen (Business Development Consultant)

The setup of the workshop was simple. Mike and Sverre were roleplaying customers they have extensive contact with in the most recent projects, thus providing a real life example for Michael and Jannik to interact with.

The goal for both customer meetings was to gain access to 3 things:

- An offer
- Estimate on RW time
- A potential demo of the technology

Of course, no two customers are the same, nor are the employees roleplaying them, however, this is the best test case scenario with the timeframe that could be played out.

First customer meeting - control

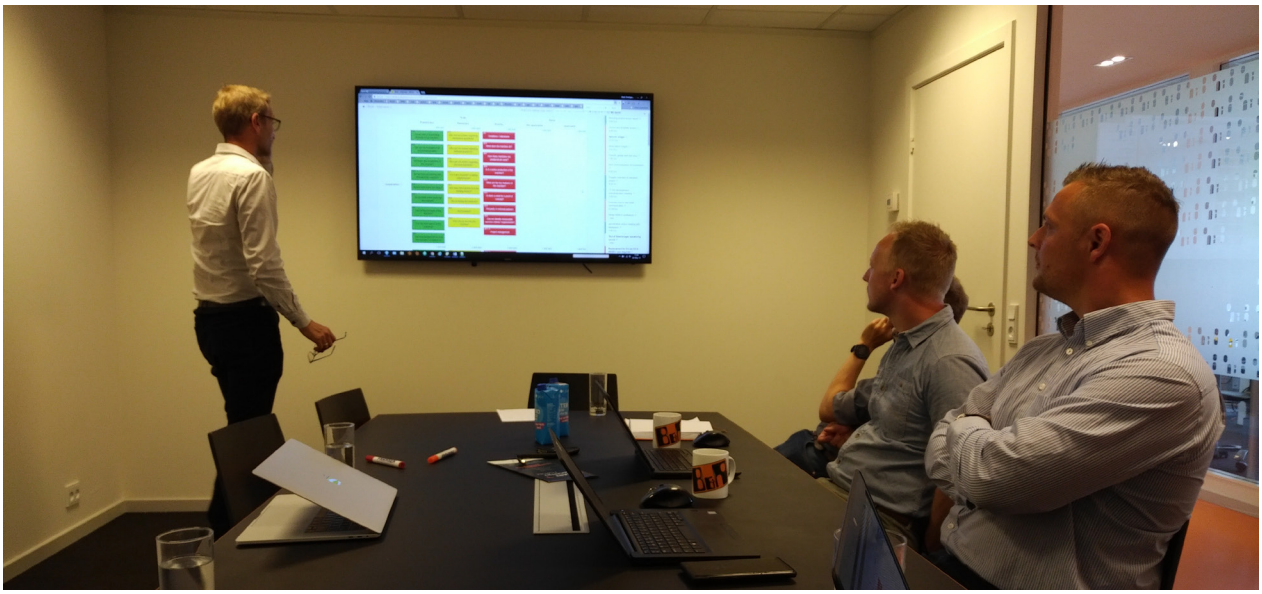
Duration: 30 minutes for the customer meeting, 30 minutes discussion

The first meeting, being the control, was conducted with Mike as the customer, roleplaying the owner of Icelandic fish processing machines.

Mike was a tough customer, so it was naturally difficult to extract information from him.

Michael and Jannik, managed to extract the necessary information out of him, however, using the typical setup B&R employees do when they go and meet with the customer.

They were prepared beforehand, and it is unrealistic to say that there is no preparation going on before a meeting, however, specific information that the customer might unveil can answer questions they haven't intended to ask yet,



Second customer meeting - test

Duration: 15 minutes introduction, 30 minutes for the customer meeting, 30 minutes discussion

The second meeting, being the test, was conducted with Sverre as the customer, roleplaying a customer who works for a testing and quality control equipment manufacturer for the plastics industry.

Michael and Jannik were not familiar with this customer, so they were given a quick debriefing of what the company does.

FIGURE 18 - THE CONTEXTUALIZED INFORMATION MATRIX, BY THOMAS AND MADS

Feedback session

The discussion sessions and last feedback session dove into many obstacles that needed to be addressed. The goal throughout this thesis has not been to further complicate the product development process, but rather to work parallel to it, making future work easier, reducing unnecessary overhead.

The feedback session allowed for a number of new requirements: (in no particular order)

- Allow for multiple levels of questions, sales, security
    - Level 1: History of the company
        - How does the company work
        - Why is it unique
    - Level 2: Conversations with engineers from B&R and the customers side
        - A software engineer talks with a software engineer; mirroring meetings
    - Level 3: Making the machine

- "Roadmap" / custom Information Matrix based on each role the person holds

- Allowing the use of tags, similar to tags on kanban boards
    - The use of tags would allow for a sorting system
        - #firstmeeting
        - #owner
        - #requirements

- Important to not go overboard with tasks, questions and requirements when dealing with the Information Matrix as it is easy to lose oversight.

- Potentially create a database after the a number of Information Matrices to develop a software solution
    - A decision tree based on all the gathered knowledge (Figure 19)

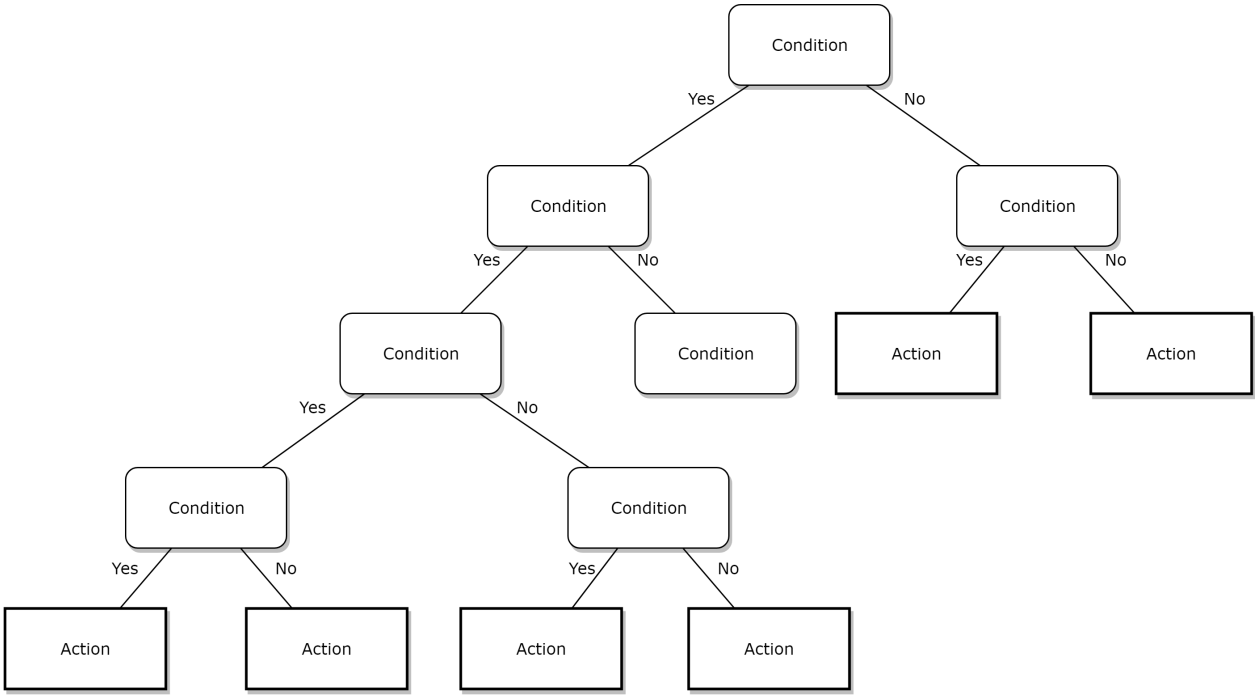
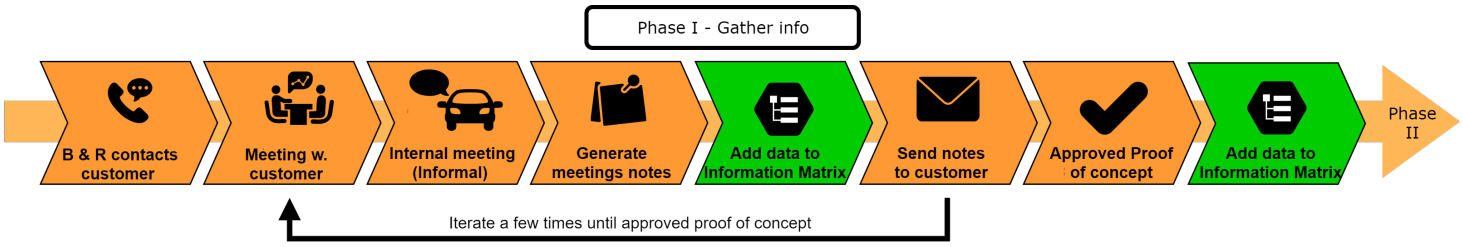


FIGURE 19 - DECISION TREE

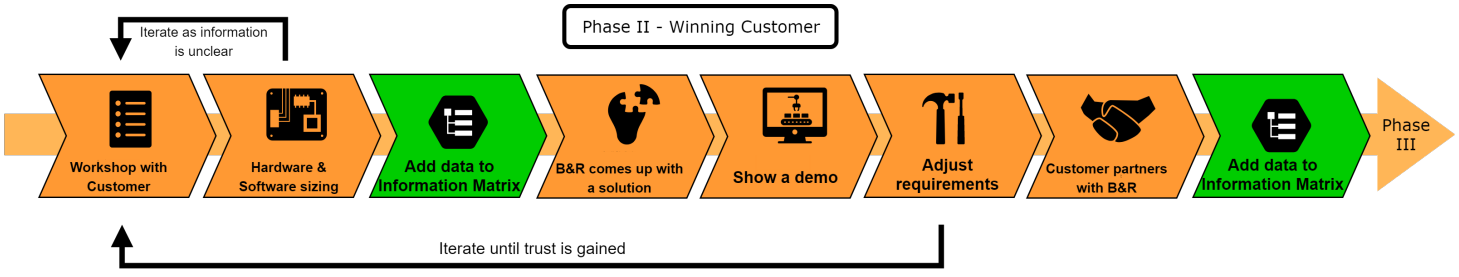
5.2 NEW USER JOURNEY

This user journey will focus mostly on the first 2 phases as this is where most of the knowledge transfer processes take place.

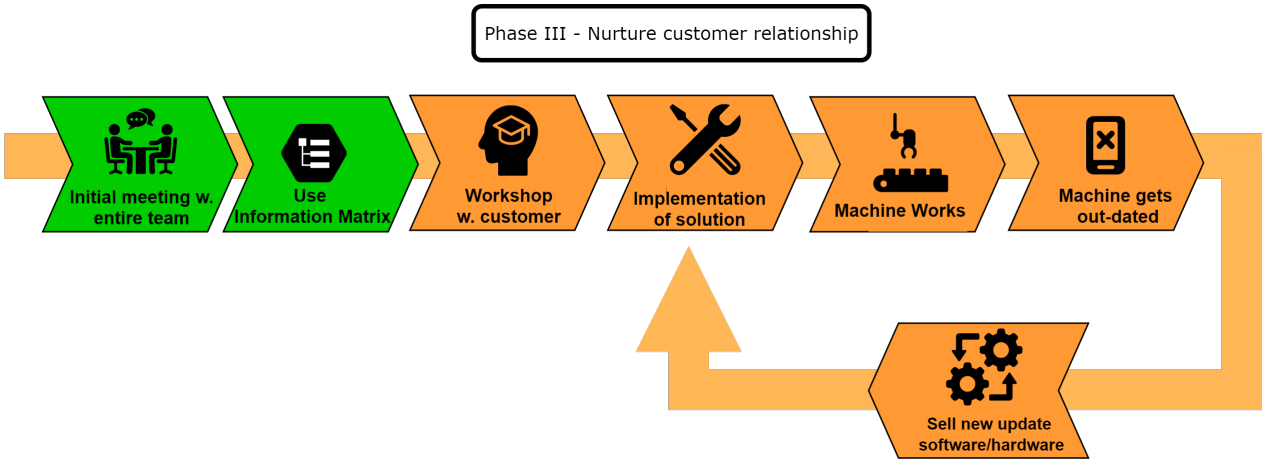
Introducing phase I, the matured use of Information Matrix will involve using it from previous projects applicable on the current customer. As no two customers are equal, it makes sense to add data slightly further ahead in the project once the internal meeting has been held. Being transparent and flexible, one could even share a specific Information Matrix with the customer, allowing them to see the progress of the projects, in a special custom Information Matrix made for them.



Phase II has the Information Matrix as a “step”, however, the way it would be used in this phase is to facilitate a central notes system.

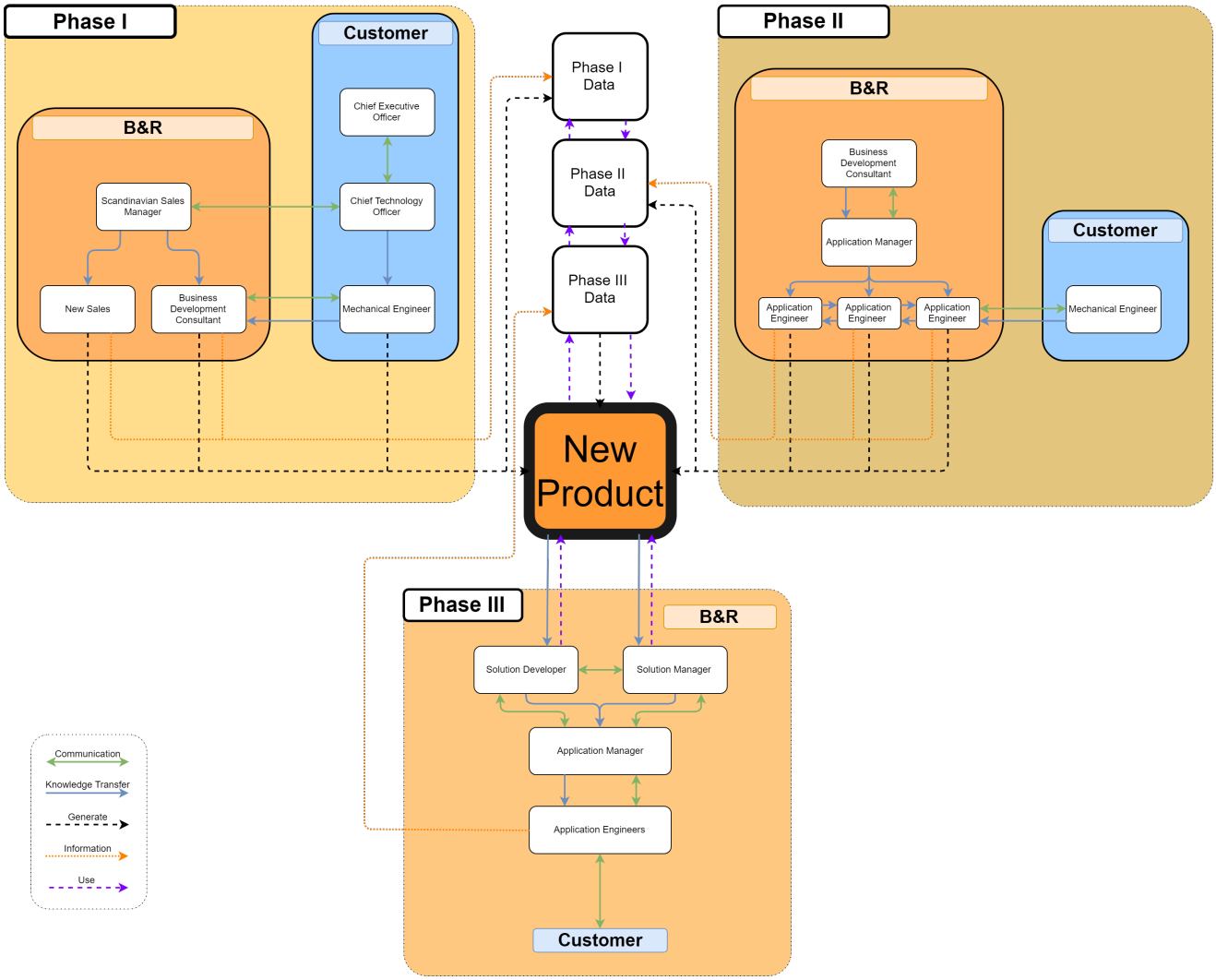


Phase III still has the Information Matrix acting as a note system, whilst simultaneously also being the database for all the previous information gathered, and it will always be accessible.



5.3 NEW SYSTEM MAP

The new system map (appendix F) has had minor changes, this is because the channels that were blocked due to inconsistent or lack of documentation, now is replaced with a open and improved rate of knowledge transfer throughout phase I, II and III.



5.4 FINAL PROTOTYPE

The final prototype is the result of of the pretotype testing, the prototype testing and several iterations of work in one.

Taking heavy inspiration in Thomas' and Mads' Information Matrix done on a kanban board, with one difference, the customization for each type of person attending the interview.

	To Do			Done	
	Preliminary	**Necessary**	**Priority**	**Not applicable**	**Applicable**
Cooperation	Any competitors?		Proof of concept?	NDA needed?	
Offer	Need for PC?				
Demo					

Information Matrix 2: Mechanical Engineer

	To Do			Done	
	Preliminary	**Necessary**	**Priority**	**Not applicable**	**Applicable**
Cooperation	Video of machine?				
Software		FAT list?	Gear ratio?		
Demo		Test solution?			

Information Matrix 3: Software Engineer

	To Do			Done	
	Preliminary	**Necessary**	**Priority**	**Not applicable**	**Applicable**
Offer		External systems?			Programming language?
Software			HMI pages?	Cloud data logs?	

5.5 REFLECTION

This section will reflect at the design process throughout the entire thesis, the service created and the case study.

The case study

Collaborating with a company has been difficult, the sheer amount of work it takes to plan everything, to make the schedules line up, has been complicated.

B&R has been unreasonably flexible, and helped us throughout the entire process of setting up meetings, having workshops and having monthly status meetings with them.

We have been transparent and flexible throughout the entire thesis when B&R asked it of us, we have been attending meetings set up last second and going to Odense each and every time we had any form of work at B&R's headquarters.

The initial design brief didn't detail the scope of this issue at hand, and B&R never did have anyone try to come to evaluate or improve their product development process before.

As the project moved ahead it became evident that the sheer scope of the problem was far greater than originally thought, and that was ultimately our pitfall.

Discovery chapter

The general understanding of the handling of the thesis was changed as each interview progressed. The preliminary introduction was that B&R had all the three engineers (software, mechanical and electrical) in their company and that the main issue was the communication between their own internal engineers, however, it quickly became evident that B&R consists solely of software engineers with various educational backgrounds. This revelation shifted the thesis focus, but the overall picture didn't move.

Following the interviews, the main problems apparently occur when talking with the customers, the original equipment manufacturers (OEM's). The customer consists mostly of mechanical engineers and this is where the issues start.

The mechanical and software engineers think in different domains and focuses on different parts of the machine. Additionally the communication problems between B&R and their customer is also due to the misunderstanding the customers thinks that B&R is a product supplier and not a service provider. B&R aims to provide a product line of several machines, but with their Automation Studio software, to facilitate a standardized set up across all machines, making them interchangeable, maintain and sell to their end customers.

These interviews gave a still picture of the current situation and the problem was placed into context. As each interview was conducted, it became evident that the issue most likely lies within B&R, and not between the two, as previously assumed.

Each and every employee had an idea of their own on how the product development process runs and is facilitated correctly, and this isn't within the margin of error.

A number of keywords were of high importance as they were mentioned several times in each interview, by the employees:

- Communication
- Common
- Think
- Understand
- Knowledge
- Information

With this information the initial approach will be changed to better fit the case.

Define chapter

The define chapter took a more visual outlook on the findings from the discover phase.

The key findings for this chapter was that the knowledge transfer is a part of all their interactions with their customer and engineers. This is a big problem as the knowledge transfer is not done properly. Since knowledge transfer is such a big part of the problem a proper solution can have a bigger impact on the company than was initially intended.

A stakeholders map was created to understand the bigger picture of all the involved stakeholders, unfortunately it didn't dig deep enough but gave a good overview of all stakeholders.

The user journey was very interesting to improve upon as a more detailed description was given as the understanding of current situation was reached in the ending of the discover phase.

The new user journey was done in co-creation with B&R, to allow for a still frame of the situation painted by the employees themselves.

Develop chapter

With different workshops and tests the different parts of the new service solution can be defined better. As mentioned during the iteration a more domain specific test is needed to make it valid. Another way to validate the test a bit more is by having more than just one.

The conclusion of our one test was that it would be better to have a template/ standardized system of documentation, this is not completely valid due to the absence of more tests. For future reference more tests will be conducted before jumping to the conclusion.

To follow this decision a more detailed description of important knowledge was needed in the matrix. This information was gathered from the two different workshops which helped create a base for the information matrix.

5.6 CONCLUSION

Ultimately, this thesis tried to accomplish a far greater task than it seeked out to achieve.

The sheer detail and work that is required to increase the knowledge transfer rate is difficult.

The case study has the following problem formulation:

"How can we increase the knowledge transfer success rate for B&R internally as well as between their customers with the use of a standardized system of documenting data through each of the product development process phases?"

The final service concept tries to increase the success rate by implementing incremental steps by minimizing the overhead for each new product development process phase, essentially taking Figure 20 and turning it into Figure 21 by slowly minimizing the information lost in each product development process phase.

What happens is that the extra work is gone, and a tremendous amount of time is saved on each project, furthermore this information wouldn't be lost as it is written down, in a tagged and organized manner, allowing any B&R employee to join a project late.

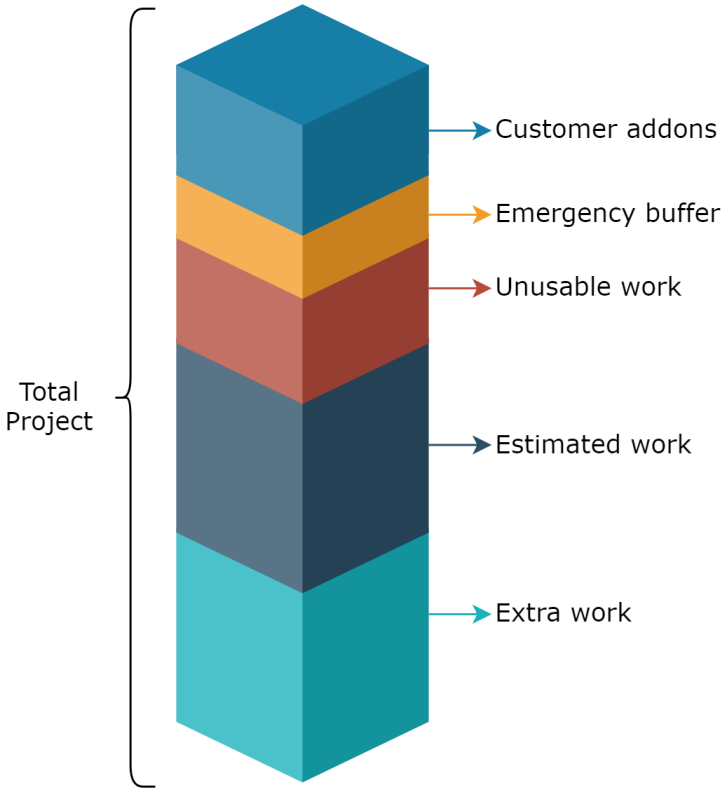


FIGURE 20 - OLD WORKLOAD

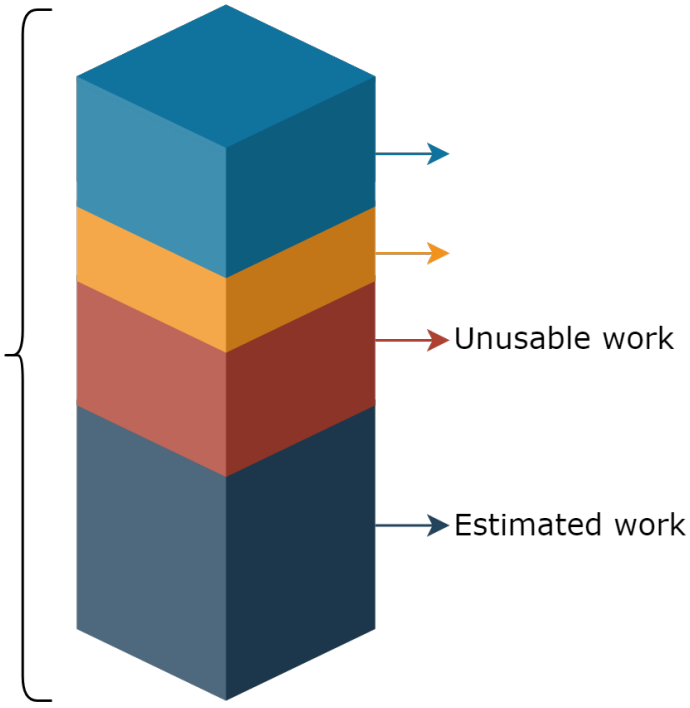


FIGURE 21 - NEW WORKLOAD

All of this was based on the vast amount of interviews and workshops conducted throughout this study across a time period of 5 month. It was found that knowledge transfer does occur, but only between the customer and one employee, however the rate of which the knowledge transfer occurs at is not sufficient, as the information logging methods are lacking, this forces the employee/engineer to go back and await further instructions from the customer, delaying everything.

A good way to mitigate this, that a few people did mention, was to send an email confirming the entire conversation to the customer as soon as the conversation is over, to agree on the things understood by both partners.