GRADUATION REPORT

Smart technologies and human factors for detection during bridge operations

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Smart technologies and human factors for detection during bridge operations

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A

Five months ago, I started this graduation project, which not only marks the end of my master degree program Strategic Product Design but also my time as a student. Several people have contributed to the completion of this graduation project, and I would like to thank them all very much.

/ Rijkswaterstaat

In these past months, I have tasted what life after graduation is like and have experienced great joy while working at Rijkswaterstaat. I would like to thank my company coaches Ellemieke van Doorn and Karin de Jong in particular as they have not only given me the opportunity to graduate at Rijkswaterstaat but have also coached me incredibly well throughout the project. In addition to this, they have also shown me what a great organisation Rijkswaterstaat is and have inspired me to apply for a traineeship at Rijkswaterstaat.

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Maarten

/ Executive summary

E

The combination of centralised object control (of automatic bridges and locks) and the increase in traffic has led to a shift in object operations. In the past years, several incidents and accidents have made RWS see the value of innovation when it comes to the control of objects. A solutions RWS is considering is a smart camera system which would aid the operator. However, RWS also realises that there might be aspects which have not been considered. This master thesis will, therefore, start with defining which problems are relevant to operators and which solutions benefit them in object operations.

To gather inside on the deeper knowledge, experiences and emotions of operators during the operation process, contextmapping (Sanders & Stappers, 2012) was used. Contextmapping enhances the operator's own understanding of experiences around safe object operations. To validate the contextmapping findings, 13 operators were interviewed using a combination of semi-structured interviews (Barribal and While, 1994) and the Scenes™ method (SAP AppHaus, n.d.). The results from the contextmapping sessions and interviews were visualised in an operator segmentation and an operator journey map. The segmentation allows for a better understanding of the target group, when to utilise their expertise during the innovation process and how they will react towards specific solutions. The journeymap gives insight into the emotional state of the operator during the operation process. These pains (emotional lows) and gains (emotional highs) should be considered during the design phase as utilising them will result in the greatest user value (Osterwalder, Pigneur, Bernarda & Smith, 2014).

A roadmap containing 5 horizons was created to provide RWS with an innovation strategy for the future of object control. In order to deliver an optimal service for both road and waterway traffic, while accommodating both RWS and the operator's values the future vision regarding object operations will be: *the future of object control will be an all-inclusive system to increase safety and traffic flow on water and land.* The concepts proposed in these horizons all contribute to reaching this final vision. Furthermore, it is advised to keep involving the operators throughout every horizon using creative methods.

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CHAPTER 1

Background and scope

/ Background & scope

01

Bridges in the Netherlands form an essential part of its transportation system and are related to (cultural) history, recreation, tourism, technology and innovation. They are vital for the Dutch economy and connect people with each other. Comparatively, the Netherlands contains the most bridges per square meter (Nederland-Bruggenland, n.d.). The Dutch waterway authority Rijkswaterstaat (RWS) ensures that there is an efficient and safe flow of both road and waterway transport traffic (Rijkswaterstaat, 2015; Rijkswaterstaat, 2017a). RWS takes care of 12 traffic control centres, 115 moveable bridges and 91 lock complexes, which makes one of her responsibilities to ensure safe control of these bridges and locks (objects).

As seen from the past years' traffic keeps increasing. Road users (i.e., passenger cars, vehicles with heavy goods, delivery vans and buses) amounted a total annual mileage of 147.6 billion kilometres, which is a growth of 11.7% over a period of 15 years (statistics Netherlands, 2018a). On the other hand, Dutch waterways are becoming busier based on the amount of transported goods. In 2017 a total of 368 million tonnes were shipped, which denotes a rise of 4.8% over a decade (Statistics Netherlands, 2018b). An increase in both road and waterway traffic places more demand on operators as these objects need to be operated more frequently, which increases the likelihood of incidents and accidents.

A second development within object operations is that operators control from a distance using closed-circuit Television (CCTV). This has a few advantages, namely: better coordination between objects, an increase in efficiency and safety on the waterway network, an increase in usability for the waterway network as control centres provide around-the-clock operations, a more standardized way of object operation and a decrease in system failures (Rijkswaterstaat, 2014a). However, remote control of objects might also increase the probability of human error (de Jong, Oosting, van Velzen, & Bouwmeister, 2013). A combination of no direct contact with object users (i.e. road users, waterway users), less overview due to the lack of direct sight of an object and the parallel control of objects could lead to confusion and fatigue.

This, in combination with red light negation, unsafe situations (i.e. bad weather) and/or perceptual errors of road users and operators, can result in incidents or even accidents. (Intergo, 2017; Jansen, Berghman, Battjes, Brans, & van Scheijndel, 2017; Jansen, Berghman, Battjes, Brans, & van Scheijndel, 2017; Rietkerk, 2016; Roggeveen, 2009). For example, in an incident in 2017 at the Bosrandbrug, a car got stuck when the bridge opened (Figure 1). A combination of red traffic light negation by the driver and a perceptual error of the operator resulted in the activation of the bridge opening procedure, while the car was partly positioned on the movable area of the bridge. A fatal accident was prevented by a police boat who was able to contact the control centre, and the opening procedure could be stopped.

Figure 1. [Incident at the Bosrandbrug]. Reprinted from Radio Aalsmeer website, by Davey Photography / Rob Franken, 2017, retrieved from https://radioaalsmeer.nl/2017/06/bosrandbrug-open-met-auto-erop/

However, there are known cases where the combination of red light negation and perceptual error lead to more severe accidents (Dutch Safety Board, 2016; Roggeveen, 2008). On 6 February 2015, a fatal accident occurred when a 57-year-old woman missed red traffic lights, cycled and stopped on the movable part of the Den Uylbrug. When the bridge opened, the woman fell down 15 metres and died. When revisiting the video footage, the woman was clearly visible, but due to a perceptual error, the operator did not perceive the woman to be on the movable area of the bridge. After investigation, the Dutch Safety Board concluded that the operator was not aided optimally in his task of visually scanning before activating the opening procedure. The board concluded that the camera images of the cycling area of the bridge were not explicitly brought to the operator's attention, not self-explanatory and confusing. Not only have such accidents unimaginable consequences for the relatives of the victim, but also for the operator. Whenever an operator is involved in an accident, the operator has to go through a series of investigations and sometimes even a trial.
Van Veelen (2018) concluded that operators perceive operations based on direct vision as safer, compared to operations based on surveillance using video cameras alone. The current trend suggests that operations are moving more towards centralised control rooms, where operations are solely based on surveillance using video cameras. It is important to look for ways in which operators are supported during their operational tasks.

/ The operator's job

In general, the operator's job consists of 6 different tasks (Rijkswaterstaat, 2012) : (1) to register ships, (2) to plan ships, (3) object control and traffic management, (4) to regulate traffic, (5) to transfer and (6) administrative tasks. In this graduation project the focus will be on the first four tasks (to register, to plan, object control and traffic management and to regulate) as these contribute directly towards the safety on the road and waterway network:

Registering of a ship

In general, ships who want to pass a lock or movable bridge report to the operator using a maritime radio, a waterfront phone, phone or a special audio signal. The operator needs to register the ship in IVS Next (tracking system of all shipping). Commercial ships are obliged to state their ship's information, destination and cargo which are also registered in IVS Next.

Planning of a ship

When the ships are registered, the operator has to determine the sailing order, the layout of the lock and needs to communicate this to all ships who want to pass the lock. All this needs to be registered into IVS Next as well. When a ship wants to pass a bridge the operator needs to determine the time of which the bridge opens, the sailing order and consider the flow of road traffic (whenever there is a reference towards "road traffic", this document considers only road traffic on and around objects), where public transportation and emergency services have priority. Important here is that the operator has no authority concerning the flow and order of road traffic (other than lowering traffic barriers), while he has all authority to manage the flow and order of waterway traffic.

object control and traffic management

After all, ships are registered and planned the lock or bridge has to be operated. For a lock the operator has to: open the lock doors while visually scanning for safety, turn on waterway traffic lights to enter, monitor for safe entering, close the lock doors while visually scanning for safety, control the levelling process of the lock, open the lock doors while visually scanning for safety, turn on waterway traffic lights to exit and monitor for a safe exit.

Prior to the actual controlling of a bridge opening, the operator has to stop road traffic by the use of traffic lights and barriers. During this process, the operator has to visually scan for safety. When road traffic has stopped, the operator can open the bridge while carefully keeping safety in mind, turn on waterway traffic lights to sail through, monitor for safety, turn off traffic light to sail through, close the bridge while visually scanning for safety. Control traffic lights and barriers, monitor for safety.

During the visual scanning task, the operator has to keep his full attention to the moving parts of the lock or bridge and all traffic (both on land and water). During the monitoring task, (when the situations permits it) the operator is allowed to start the operation process of another object. A general rule of thumb is that the operator has to visually scan while parts of the object are moving and the operator has to monitor while a ship is sailing through or the levelling process is happening.

Regulating traffic

In the role of the traffic controller, the operator is responsible for the safe and smooth passage of waterway traffic. The operator has to provide passing ships with up to date traffic information and guidance. In addition to this the operator has to give waterway traffic permission for the following activities:

- Lying berth other than passage (i.e. to spend the night)
- To fuel near a lock or bridge
- To connect or disconnect convoys

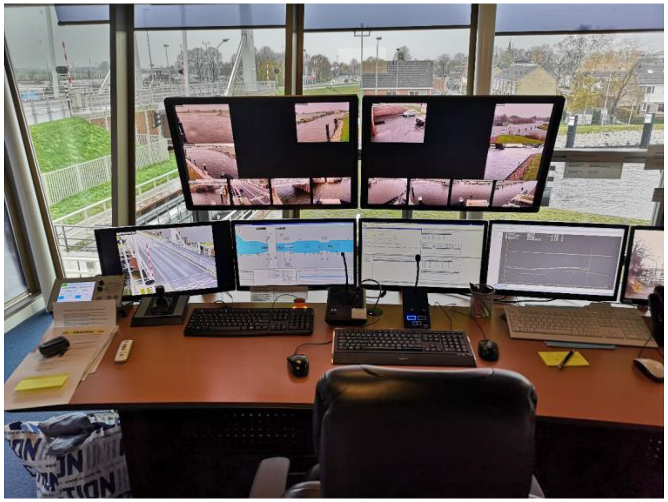


Figure 2. [Setup of control station] Reprinted from RWS intranet, 2019, retrieved from RWS CBB

One of the ways RWS is looking to support operators is by means of smart cameras. These smart cameras have as function to not only capture the scene but also interpret the image and give feedback to the operator. In this way, the smart camera mimics the human visual system (eyes receiving the image and the brain interpreting it). When the system is also capable of signalling the operator when a potentially unsafe situation occurs, the system can be classified as “smart”.

Unfortunately, smart cameras cannot guarantee a 100% detection rate. A recent study by Rijkswaterstaat (2017b) looked into the success rate of smart cameras in detecting road traffic and lost cargo. The results from this study concluded that the system detection rates varied between 96 and 98% for detecting road traffic and between 88 and 94% of lost cargo detection, depending on different conditions (i.g. Weather, time of day). Furthermore, RWS has not yet investigated how operators would react (emotionally) to a system which cannot guarantee a 100% detection rate. RWS envisions that while smart cameras cannot replace operators in their task of controlling bridges and locks, they might assist operators in their monitoring task.

In a preliminary research about smart cameras and object operations, Stuut (2019) looked at the effect of the use of reliable but partially inaccurate automatic object detection signals from smart cameras on bridge operators' performance. Stuut conducted a study where operators were asked to detect whether a cyclist was present on the movable area of a bridge. The study simulated the effect of a smart camera system by placing a red frame around the camera output when a cyclist was present on the movable area of a bridge. He then tested the effect of this simulated smart camera footage on the ability of operators to correctly spot the cyclist (performance). He concluded that operators performed better when aided by correctly simulated smart camera footage (true positives as well as true negatives) and that operators, on average, did not perform worse when presented with false negatives (where there was no signal from the smart camera given, but a cyclist was present on the movable area of the bridge). Stuut did not test on the effect of false positives.

/ Innovation implementation

Where RWS usually takes a top-down approach when innovating, this graduation project will focus on the users of the intended innovation when developing a new solution which increases safety while operating. Methods such as contextmapping, co-creation and semi-structured interviews will be used to involve the operator in the innovation process.

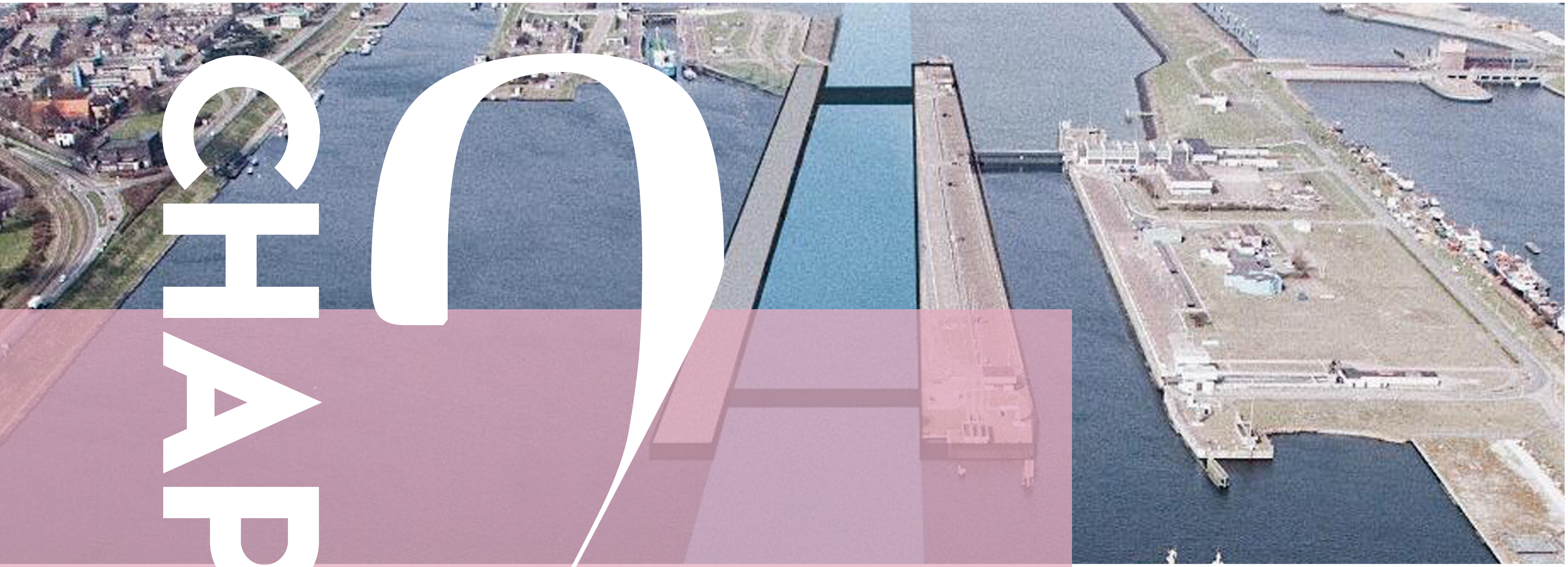
As smart cameras are still considered by RWS, it is necessary also to incorporate them within this project. Therefore, when new technology such as the smart camera is introduced, there are several aspects which have to be taken into account. Firstly the design of the complete system should be considered; what will be communicated to the operators, at what moment in the operation should this communication take place and how will this be communicated are all design related questions which should be answered before the implementation of this new technology can take place. Secondly, the manner of implementation should be considered. In the words of Klein and Knight (2005): *In changing work environments, innovation is imperative. Yet, many teams and organizations fail to realize the expected benefits of innovations that they adopt. A key reason is not innovation failure but implementation failure—the failure to gain targeted employees' skilled, consistent, and committed use of the innovation in question.* This suggests that even though the innovation in itself is potentially successful in its solution, it can still fail if not implemented correctly. There have been several studies about the causes of unsuccessful implementation when the innovation in itself had the potential to be successful. First, many innovations, especially in the field of technology, contain a lot of imperfections at the start of the implementation (e.g. bugs in software, difficult to use, breaking down). Klein and Ralls (1995) concluded that low technology quality and innovation use were strongly negatively correlated. Second, new technologies expect from future user to learn new skills. Especially when the innovation becomes more complex, user satisfaction towards that innovation significantly lowers (Aiman-Smith

& Green, 2002). The level of skill and knowledge needed for operators to use an innovation can, therefore, be tedious or stressful. Third, most of the time, the decision to implement an innovation comes from higher in the organization's hierarchy. This while the intended users of said innovation are more than comfortable in the status quo and therefore react with scepticism towards innovation. Nutt (1986) concluded that most managers use "persuasion" and "edict" when implementing an innovation, both strategies which negate input from the intended user. Fourth, implementation of innovation almost always has little short term advantages for both the intended user and the organisation. The user experiences a lot of pressure to maintain performance levels prior to the implementation (Repenning & Sterman, 2002), which is very difficult as the user first needs to be trained in using the innovation. For the organisation implementing an innovation is time-consuming and costs money. Last, Klein and Sorra (1996) suggest that *an organisation's climate for the implementation of a given innovation refers to targeted employees' shared summary perceptions of the extent to which their use of a specific innovation is rewarded, supported, and expected within their organisation.* In other words, the organisation is responsible for creating a suitable climate in which innovation is possible.

/ Summary of the chapter

The combination of the increase in traffic and centralised object control has led to a shift in object operations. In the past years, several incidents and accidents have made RWS see the value of innovation when it comes to the control of objects. A solutions RWS is considering is a smart camera system which would aid the operator. However, RWS also realises that there might be aspects which have not been considered. This master thesis will, therefore, start with defining which problems are relevant to operators and which solutions benefit them in object operations.

CHAPTER 2



Explore
and discover

/ Explore & discover

02

For the past years, Rijkswaterstaat (RWS) started to relocate object operations from local sites towards more centralised control centres. This entails that operators are now shifting from controlling objects based on a combination of direct sight and camera footage towards controlling from a distance using only closed-circuit Television (CCTV). This is advantageous because operators can better coordinate between objects, increasing efficiency and safety on the waterway network. Furthermore, these centralised control centres offer 24/7 operations, increasing usability for the waterway network (Rijkswaterstaat, 2014a). Several incidents concerning bridge operations from a distance (Intergo, 2017; Jansen, Berghman, Battjes, Brans, & van Scheijndel, 2017; Roggeveen, 2009) poses the question whether operators need better assistance than only CCTV while operating objects from a distance. In addition to this, Van Veelen (2018) concluded that operators perceive operations based on direct vision as safer, compared to operations based on CCTV alone. However, this study did not focus on why operators found direct vision to be safer or why operations based on CCTV to be less safe. To gather inside on this deeper knowledge, new data is needed. Contextmapping will be used to enhance the operator's understanding of experiences around safe object operations. Throughout the contextmapping session, memories, feelings, dreams and aspirations will be explored (Sanders & Stappers, 2012), providing the required insights.

/ Contextmapping preparation

Contextmapping revolves around experiences from the past, feelings about the present and aspirations for the future. In order to prepare for the contextmapping session, participants were presented with a sensitizing booklet, which asked participants to complete little exercises throughout their workweek. These exercises are designed to prepare participants for group sessions and trigger, encourage and motivate to think, reflect and explore aspects of participants personal context (Sleeswijk-Visser, Stappers, Van der Lugt & Sanders, 2005). The exercises included naming and drawing specific parts of their job participants liked and disliked, drawing their daily routines on a timeline and ranking several statements concerning innovation (appendix I).

/ Contextmapping group session

A total of 24 participants (*M* = 19, *F* = 5) took part in the contextmapping session. Of these 24 participants 18 (*M* = 15, *F* = 3) were operators and 6 (*M* = 4, *F* = 2) were senior operators. The participants were recruited through a so-called 'soundboard group', a pool of active operators who come together once a month to discuss developments of new systems. The set up of the session was a combination of a group session and pair session. As Sleeswijk-Visser et al. (2005) described, the advantages of group sessions are that participants can react to each other's experiences, create a global view of the context and they generate a large amount of diverse information within one session. However, group sessions can also be frightening towards participants who never took part in such a session. As this is the case, pair sessions can help participants to feel more comfortable, and pair sessions can help participants to reveal things about each other. As such the set up of the session was a group session where participants paired up in order to make them feel more comfortable with the setup of the session while still facilitating discussion about each other's experiences.

The session itself consisted of an introduction explaining the goal and planning of the session, two main co-creation exercises designed to delve deep into the participants' experiences, followed each with a round of discussions and a wrap-up.

The first exercise focused on the problems (functional and emotional) operators face when viewing and evaluating the safe operation of a bridge or lock. The participants were provided with an A3 sheet with a horizontal timeline, 48 ambiguous pictures printed on stickers and 48 written out emotions printed on stickers (appendix II). These materials were created following the guidelines posed by Vissers et al. (2005). The participants were asked to create collages using the provided materials and were told that they could use them in any matter they saw fit and that no solution was wrong, as long as it made sense to them. This 'collaging' is an accessible technique for eliciting memories and emotional response (Vissers et al., 2005). The question they were asked to answer was: *In pairs think of a worst case scenario during the viewing and analysing moments prior to opening or closing a bridge*. The resulting artefacts were then presented to the group, revealing their unmet needs and aspirations for the future.

The second exercise focused on the future of operating objects. The participants were presented with the same materials as in the first exercise (Appendix II) and were asked to create collages which answered the question: *In pairs think of a solution which would solve any of the problems discussed by the group during the first exercise*. Again, the resulting artefacts were then presented to the group, revealing their aspirations for the future and how this would help the operator in doing his job.

/ Analysing contextmapping session

As the artefacts and discussions produce rich, varied but complex data, an analysis based on the Grounded Theory approach for analysis (Corbin and Strauss, 1990) (and adapted for Contextmapping by Vissers et al. (2005)) is used. Instead of hypothesizing indicators of a phenomenon in advance, the Grounded Theory approach supports the researcher in discovering these indicators during the analysis. The analysis, as proposed, suggests the following three phases:

<u>Phase 1: Fixate on the data</u>

After the session, the initial thoughts and remarks are written down by the researcher and transcripts from audio records are written down. From these transcripts, interesting quotes and results are highlighted.

<u>Phase 2: Search and be surprised</u>

The second phase is a phase of iteration, where the researcher surrounds himself with the session materials and raw data. Combining the artefacts with the stories and transcripts, the researcher looks for which topics are mentioned, why these topics are mentioned, and what ideals participants pursue. All these impressions are written down and combined in themes.

<u>Phase 3: find patterns and create an overall view</u>

In the final phase, the connections between all the different insights are discovered. The researcher looks for patterns within the data and creates an overview of the relations within the data.

/ Contextmapping results

After analysing the contextmapping session, three directions which represented future directions (according to the participants) of operating objects became clear. The three directions are all portraying the same process: the one of operating an object. They all start with the request from a ship to open a bridge, followed by the controlling of the system and ending in a successful bridge operation. However, the three directions represent different concepts which became evident from the contextmapping sessions. Namely: (1) some participants provided solutions which would take away a lot of tasks and responsibilities from the operator. (2) Other participants, however, were stressing the fact that they wanted to be in full control of all systems during the operation process. (3) A final solution which was proposed was more in line with the classic understanding of smart systems aiding the operator in his operation functions. These three directions were visualised (appendix III) using visuals from the Scenes™ method (SAP AppHaus, n.d.). The three directions focus on three characters: Bianca the skipper, Patrick the operator and Robin representing the system. The directions are described as follows:

1. It is Monday morning, Bianca is on route from Oosterhout to Oirschot and wants the dr Deelenlaan bridge operated. Bianca uses her phone to contact Robin (the system) for a bridge opening at 11:00. Robin confirms this and enters all ship details in IVS Next. Robin scans the environment and only has to ask confirmation from Patrick to operate the bridge. While the bridge is opened, Patrick can concentrate on other tasks because Robin monitors for safety. When the waterway is free again robin scans again and only has to ask Patrick for confirmation to control the bridge.
2. It is Monday morning, Bianca is on route from Oosterhout to Oirschot and wants the dr Deelenlaan bridge operated. Bianca uses the maritime radio to contact Patrick for a bridge opening at 11:00. Patrick confirms this and enters all ship details in IVS Next. Patrick scans the environment when suddenly an alarm rings. The alarm notifies Patrick that his attention is needed for an emergency opening at another bridge. Patrick can now choose to turn on Robin for an extra pair of eyes, so that Patrick can focus on the other bridge and Robin can scan for safety around the dr Deelenlaan bridge. When the waterway is free again, Robin scans the environment and only has to ask Patrick for confirmation to control the bridge.
3. It is Monday morning, Bianca is on route from Oosterhout to Oirschot and wants the dr Deelenlaan bridge operated. Bianca uses the maritime radio to contact Patrick for a bridge opening at 11:00. Patrick confirms this and enters all ship details in IVS Next. Patrick scans the environment and start operating the bridge, however, warns Patrick that he missed an old lady on the movable area of the bridge. Because of this, Patrick is able to react in time and prevents an accident. When the waterway is free again, Robin scans the environment and only has to ask Patrick for confirmation to control the bridge.

/ Validating contextmapping findings

As stated before the participants of the contextmapping session were dedicated and enthusiastic operators who voluntarily take part in activities which promote innovation. However, this does not reflect all operators within the organisation. To validate the findings from the contextmapping session, 13 operators (M = 12, F = 1), who were no member of the soundboard group, were interviewed in their working environment.

In order to explore the perceptions and opinions of respondents, semi-structured interviews were selected as the means of validating data (Barribal and While, 1994). To further aid interviewees the Scenes™ method, developed by SAP AppHaus (n.d.), was used. This Method lets the participant create storyboards about products and services in a fast and iterative way. In order to validate the findings from the contextmapping session, the interviewees were presented with the three ready-made directions (appendix III), which they were asked to comment on, to improve on and to verify or disprove. The combination of a semi-structured interview with the storyboards made from Scenes™ provided the researcher with a way to validate the findings from the contextmapping session.

/ Analysing semi-structured interviews

For the analysis of the semi-structured interviews, a somewhat similar method is used in the analysis of the contextmapping session. The analysis is following the method of analysing interview transcripts in qualitative research (Burnard, 1991) and the Grounded Theory approach for analysis (Corbin and Strauss, 1990) and consists of four stages:

Phase 1:
After the session, the initial thoughts and remarks are written down by the researcher and transcripts from audio records are written down. From these transcripts, interesting quotes and results are highlighted.

Phase 2:
The second phase is a phase of iteration, where the researcher surrounds himself with the transcripts. The researcher looks which topics are mentioned, why these topics are mentioned, and what ideals participants pursue. All these impressions are written down and combined in themes and categories.

Phase 3:
In phase 3, the connections between all the different insights are discovered. The researcher looks for patterns within the data and creates an overview of the relations within the data.

Phase 4:
In the final phase, the results of the contextmapping analysis and the interview analysis are combined and analysed again. Connections between themes and categories are made between both analysis results, and an overview of all the data is created.

/ Interview results

What became evident from the interviews was that most operators are aware of the fact that innovation is a reality. The operators present in the contextmapping session were clearly more enthusiastic about future innovations and had a lot of input and ideas of what these innovations should look like. The operators who were interviewed had fewer ideas about the future. One even said: “before this interview, I didn’t even realise that my job could change in the future”. When confronted with the different scenarios, however, the operators were competent in judging the viability of the concepts.
In general, the first direction (where the smart system would control almost everything) was perceived as the least favourite by the interviewees. A few interviewees concluded that their job would be obsolete when such a system was introduced, and most operators could not foresee a future where a system would take most of the decisions when it came to object control. Some interviewees took the liberty to adjust the Scenes. I.e. one interviewee said he could see a future where the operator would have his workload relieved by a smart system. He would, however, always see an operator actively monitor and visually scan the environment for safety instead. One interviewee, however, was quite enthusiastic about such a

future and came up with several ideas where the operator could have a different role when he would not have to control separate objects anymore. He would envision a future where the operator would deliver a service towards waterway traffic and that communication between skippers and operators would become obsolete as the whole route would be planned out beforehand.

Interviewee reactions towards the second direction (where the operator would have the control whether he would use a smart system or not) were mixed. The idea of having control over a system was generally perceived as positive, but the interviewees almost unanimously concluded that the system proposed in the second direction would be far too easy to abuse. They all foresaw colleagues who would always have the system activated, lay back and relax. When asked how to improve the system in such a way that abuse would not be possible most interviewees came with a scenario which more or less represented the third direction. Another big concern for interviewees was what RWS wanted. They felt that in the past, RWS always had just implemented innovations without consent of the intended user. One interviewee said: "it is not whether I want such a solution, but whether RWS wants it."

The final direction (where the system is almost invisible but supports the operator when he misses a safety issue) was generally well received. The interviewees could all tell stories where such a solution would have relieved them from much stress due to missed people on the bridge. The reactions did differ however on how much authority such a system would have: some interviewees would have the system block all controls whereas other interviewees said a small warning sign would suffice.

Furthermore, the way the interviewee reactions gave insight into how willing these operators were in: (1) accepting/ embracing innovation, (2) how willing operators are to trust a smart system and (3) how much control they want over a smart system.

These three criteria go hand in hand with different types of operators (which are discussed in length below). When an operator is innovation oriented, he/she is also more willing to trust said innovation and has less trouble handing over specific tasks to this innovation. Different from the operators who were present at the contextmapping session, however, was that a part of the interviewees said that they would rather wait until the innovation was tried and tested before they would use it. Another part of interviewees was more sceptical towards the innovation-oriented concepts: they would not trust a smart system to carry out (in their words) critical tasks and would always see an operator have full control over all tasks.

Up until this point, three different groups of operators can be distinguished: active and innovation-oriented operators, passive and innovation-oriented operators (who rather wait until a new system is tried and tested) and operators who are happy with the way operations are done at this moment (more traditional). However, according to several employees of RWS, there should be a fourth type of operator. The operators who still remember the 'golden days' of object operations. These operators are convinced that object operations should be carried out on the object itself, where you are in much better contact with road and water traffic, can smell the water and feel the wind. To get into contact with this group, interviews were carried out on two locations where operations are still locally carried out, namely Weurt and Lith. In general, the last type of operator has a lot of knowledge about the locks and bridges they operate; they have been operating these objects for over 10 years and are very proud of their job. They feel that recent developments (centralised operations, more technology in their workflow) damage their job, which they receive as a craft.

/ Combined results

The combined results of the contextmapping sessions and interviews have been visualised in four user segments (Figure 3,4,5,6) and a user journey map (Figure 7). The user segments show the goals, motivations, challenges and opportunities for different types of operator. The four different types of operators are mapped on a matrix with axis; innovation oriented vs traditional and passive vs active. In this way, the four different types of operator can be identified as passive and innovation-oriented, active and innovation-oriented, passive and traditional, and active and traditional. This segmentation allows for better understanding of the different types of operators in relation to innovation. To make the four segments more relatable, they have been given titles which reflect their place in the matrix.

- *The realist* is the kind of operator who acknowledges that innovation is something that is inevitable but is not actively encouraging it. When new systems, services or products are introduced, the realist will try and use them as best as he can, but he would like to wait until others have verified that the innovation works.
- *The promoter* embraces innovation. He actively partakes in several activities which focus on innovation within his job. When new products or services don't immediately work, he will try and help to improve them so that it makes his work more effortless in the long run.
- *The protector* likes the way their work is at this moment and does not want to see it changed. When an innovation is introduced, the protector will wait a long time before accepting the benefits of the innovation. Usually, the protector has a lot of expertise and experience.
- *The nostalgic* wants object operation to go back to the way it used to be. The nostalgic knows a lot of the skippers personally and values expertise and experience while opening objects. During his job, the nostalgic is actively promoting operations as they used to be. I.e. locally controlling objects instead of centralised object control or not using systems which in his words "disregard the experience of the operator".

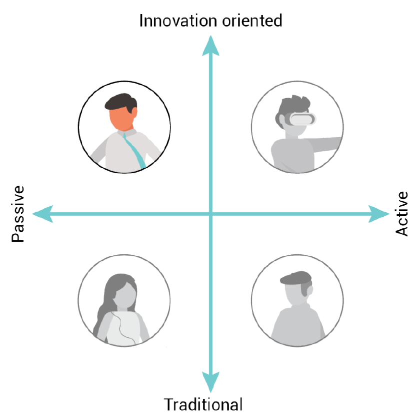
/ Segmentation

When designing a solution for better assistance than only CCTV, while operating objects from a distance, these user segments offer an overview of the different types of operators which should be taken into account. In addition to this, the segmentation could be used to decide which types of operators should be consulted during the innovation process. Furthermore, when considering the implementation of a new system, these user segments could shed light on which operators are willing to embrace innovation and which operators need more convincing. These segments could also be used to see how fast individual operators trust new systems and which steps should be introduced to improve system trust.

The realist

"I understand that innovation is inevitable, but can't we just wait until it works?"

Segmentation



Meet the realist

The realist acknowledges that innovation is a something that is inevitable, but is not actively encouraging it. When new systems, services or products are introduced the realist will try and use them as best as he can, but he would like to wait until others have verified that the innovation works.

Goals

- Efficiency
- Effective
- Quality
- Safety

Quotes

"Even though innovation can help you, it's important to keep the responsibility with the operator."

"Sometimes people make mistakes, so a smart solution could help."

Motivation

Safe systems are one of the most important things in the work of the realist. When he sees the benefits of an innovation the realist is quickly to adopt them, but he remains always critical.

Opportunities

- Values quality and is open to ideas when innovation is verified.
- Is very critical and therefore they can give very good feedback.

Challenges

Challenges the realist faces or identifies are:

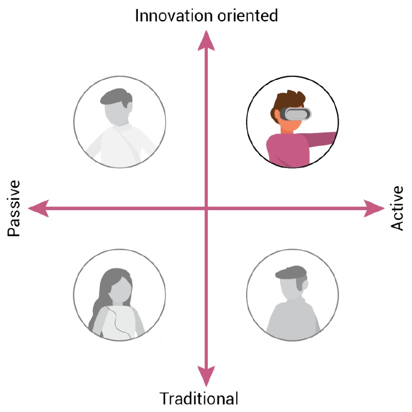
- The operator feels pressure from waterway traffic to ensure quick passage.
- Responsibilities of road and waterway traffic become responsibility of operator.

Figure 3: the realist

The promoter

"I want to be one step ahead of other operating centers"

Segmentation



Meet the promoter

The promoter embraces innovation, he actively partakes in several activities which focus on innovation within his job. When new products or services don't immediately work he will try and help to improve them so that it makes his work easier in the long run.

Goals

- Efficiency
- Effective
- Growth
- Creativity

Quotes

"I've seen in other work fields the capabilities of smart camera's and it's amazing what you can do with them."

"During the soundboard meetings you really get a say in the future of Rijkswaterstaat."

Motivation

The promoter is actively looking for ways to improve his work and values growth and efficiency in his work. He also tries to inspire others to work differently and is glad to share his opinion on innovation.

Opportunities

- Is very eager to work with innovations.
- Has a lot of ideas to improve things.
- Eager to learn and therefore open to new ideas.

Challenges

Challenges the promoter faces or identifies are:

- People have difficulty to work with smart systems, as the will only respond to the 'beeb'.
- Faulty camera plans make the operator miss ships.

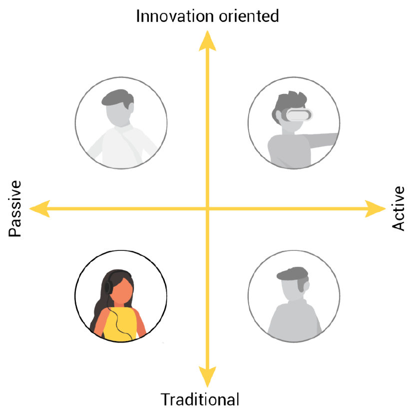
Figure 4: the promoter

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

The protector

"Everything works just fine, why would we change anything?"

Segmentation



Meet the protector

The protector likes the way their work is at this moment and does not want to see it changed. When an innovation is introduced the protector will wait a long time before accepting the benefits of the innovation. Usually the protector has a lot of expertise and experience.

Goals

Easy

Quality

Safety

Quotes

"An innovation has to be at least 150% safe before I would trust it."

"Some innovations make me less connected with the skippers."

Motivation

The protector values quality and ease of use. Systems that the protector is familiar with are in his opinion the best systems as they do their job perfectly. When innovations are introduced the protector questions if this innovation is easier to use than known solutions and wonders whether it makes situations safer.

Opportunities

- Needs to be persuaded of the benefits of innovation.
- Has a lot of expertise and experience.

Challenges

Challenges the protector faces or identifies are:

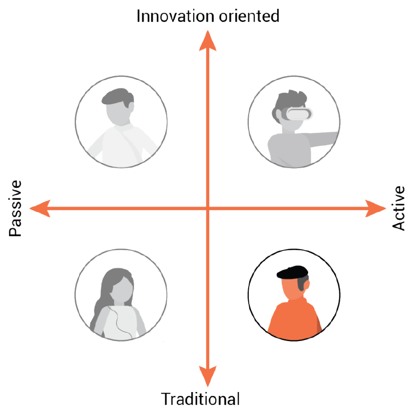
- Doing the same task over and over again will result in less proactive operators.
- Workload depends greatly on the time of day.
- Road traffic which stand still on movable area of the bridge are easily missed.

Figure 5: the protector

The nostalgic

“ Back in the days we knew everything about our objects and every skipper personally”

Segmentation



Meet the nostalgic

The nostalgic wants bridge and lock operation to go back to the way it used to be. The nostalgic knows a lot of the skippers personally and values expertise and experience while opening lock and bridges. The Nostalgic has a lot of experience operating locally and swears by this.

Goals

- Safety
- Quality
- The good old days

Quotes

“I don’t need IVS Next to help me with sorting ships in the lock, because I know the measurements of every lock by hard”

“I’ve been doing this work safely for over 30 years.”

Motivation

The nostalgic is very proud of his own expertise and has a very strong connection with the nautical world. He is usually very eager to teach a new generation of operators and encourages others to visit objects in real life. Quality and safety are priorities while working.

Opportunities

- Has a lot of knowledge and expertise which can be used to help colleagues.
- Needs to be persuaded of the benefits of innovation.

Challenges

Challenges the nostalgic faces or identifies are:

- As operations are centralised operators have a lesser sense of responsibility compared to local operations.
- Local systems do not connect well with centralised systems.

Figure 6: the nostalgic

/ Journeymap

The user journey map shows the process of operations, user experiences, emotions, and opportunities. Not only does the user journey map provide a structured overview of the experiences around object operations, it also enables identification of problem areas and opportunities for new services (Stickdorn, Schneider, Andrews & Lawrence, 2011). The contextmapping session focussed on the experiences of the operator during the different steps of the operating process. Results of this are visualised an operator journey map (Figure 7). The first row shows the different steps of the operating process: *Making contact, Visual scanning, Critical situation, Non-critical situation and Visual scanning*.

The second row shows a graph which represents the emotional state of the operator during the operation process.

The third row shows the actions the operator has to perform during the operation process.

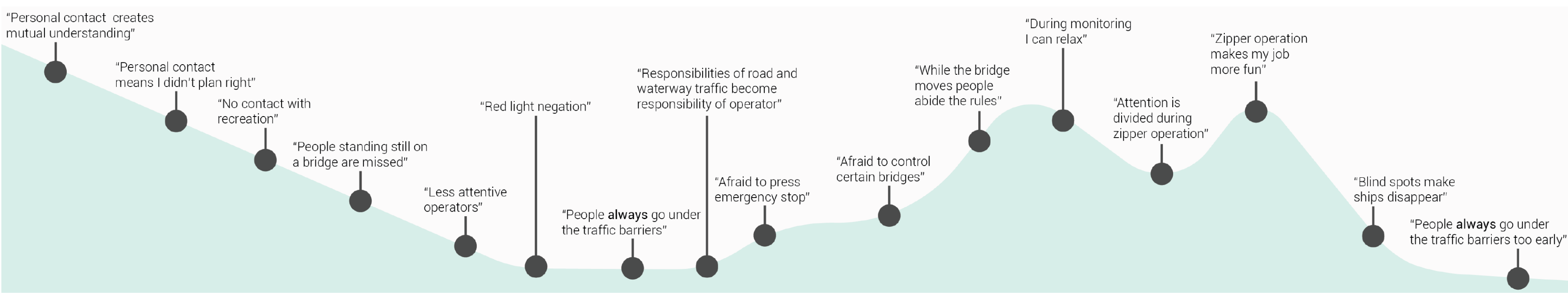
The fourth row shows quotes from the different sessions representing the emotional state during the operation process.

The fifth row shows different opportunities for each step in the operation process.

Several conclusions can be drawn from these results, which will be discussed in the following paragraphs.

Operator **journey map** of emotional impact during operations of a bridge.

STEPS: MAKING CONTACT | VISUAL SCANNING | CRITICAL SITUATION | NON-CRITICAL SITUATION | VISUAL SCANNING



ACTIONS	Ship contacts operator to request a bridge opening	Operator has contact with ship(s) to ensure all details are in order	Operator scans for any unsafe situations before he can control any objects	Operator controls traffic lights	Operator controls traffic barriers	Operator controls bridge	Operator scans the environment while the bridge is moving	While the bridge is not moving the operator only has to monitor for any unsafe situations	The operator can choose to start the operation of another object (so called zipper operating)	When the waterway is free of any ships the operator can start the closing process of the bridge	Operator scans the environment while the bridge is moving
EMOTIONS	"Personal contact with the skipper creates mutual understanding" "If I have to speak to the skipper that means I didn't plan well enough for a smooth passage"	"Not all ships have working AES systems" "Recreational ships have no means to communicate with"	"Cameras do not offer a clear enough view so I miss people on the bridge" "There is pressure from ships who want an immediate opened bridge"	"With every bridge opening there is at least 1 person negating red lights" "Doing the same tasks over and over again makes less attentive operators"	"People **always** go under the traffic barriers"	"Pressing the emergency stop creates a feeling of guild" "Responsibilities of road and waterway traffic become responsibility of operator"	"While the bridge is moving everybody follows the rules" "Some bridges are so difficult to oversee I almost don't dare to control them"	"During monitoring I can sit back and relax"	"If it's really busy zipper operating can be quite stressful" "Zipper operating creates a better flow of waterway traffic"	"Sometimes you think the waterway is free but small ships can be missed"	"People **always** go under the traffic barriers too early"
OPPORTUNITY	Promote mutual understanding between operator and skipper	Improve IVS Next Educate recreational ships on communication with operators	Improve camera images in order to support operators.	Promote understanding of road traffic about the consequences of red light negation	Promote understanding of road traffic about the consequences of going under traffic barriers	Offer support to operators on how to handle unsafe situations	Offer support to operators on how to operate in a safe and responsible manner, even with difficult bridges	Increase moments of relaxation during busy periods	Find the right balance between efficient and stressful zipper operating	Improve camera images to better support the operator	Promote understanding of road traffic about the consequences of going under traffic barriers

Figure 7: operator journey map

/ Pains & gains

Throughout the operation process, there are several negative and several positive influences on the operator. These negative and positive influences are described respectively as moments of pain and gain by Osterwalder, Pigneur, Bernarda & Smith (2014). These moments of pains and gains are visualised on the operator journeymap (Figure 7) on the second (emotional graph) and fourth row (emotions). According to Osterwalder et al. the solution which addresses the most impactful pains (pain relievers) or solutions which promote the most impactful gains (gain creators) create the most value for the end user. It is therefore important to discuss all pains and gains which became evident from the contextmapping sessions and interviews. Below the pains and gains are discussed for each operation step.

To start, the 'making contact' step is an important step in the process of operations. Most operators acknowledge the importance of personal contact with waterway traffic as this creates mutual understanding. Some skippers are in a hurry and can react quite grumpy when requesting an object to be operated. When the operator can explain that he will be with the skipper shortly, the skipper usually shows understanding which the operator values. However, there are also operators (mostly promoters) who feel that communicating with waterway traffic over marine VHF radio (VHF) is outdated and causes for a lot of 'noise' on the work floor. These operators say that many skippers just want to have a chat over the VHF, which, in their words, "does not promote a professional relationship". Some operators go even further and explain that they want to deliver an optimal service towards waterway traffic by trying to ready objects in advance to deliver an optimal route for skippers. Moreover, they feel that when they have almost no contact with waterway traffic is a sign of this service being well delivered.

By far the most impactful 'pains' are during the 'visual scanning' step. Here operators are tasked with making sure the roads and waterway are free of any dangerous situations before starting any control tasks. Some pains even strengthen each other, e.g. performing the same task over and over again may lead to less attentive operators, which in term causes operators to miss people standing still on a bridge. From the contextmapping session, it became evident that these two pains cause much stress. Other pains during the visual scanning step are red light negation of signal lights and people skipping under traffic barriers. These two pains happen almost every time when a bridge is controlled according to operators and are the most impactful pains during the process of controlling an object. As road users do not obey the traffic rules around an object the operator feels a responsibility shift; road users do not take their responsibility concerning the safety of themselves and others, and therefore the operator has to take this responsibility on himself.

During the 'critical situation' step, the operator is entirely focussed on the control task; roads and waterways are free of traffic and parts of the object are moving. Operators usually perceive this step as "manageable stress due to focus", most of the time, traffic abide the traffic rules, as it is visible that not abiding by these rules lead to unsafe situations. There are however objects which some operators do not dare control, as "these objects are too difficult or unpredictable" in this case operators ask colleagues to operate these objects for them. This pain is rather pressing as operators are very much aware of the severity of this fact.

After the 'critical situation' there follows a 'non-critical situation' where there are no moving parts of an object, with bridges, this means the bridge is fully opened, and with the lock, this means the water within the lock is levelling. This step is usually considered to be rather relaxed as the operator has a clear overview of what is happening on and around the object. During this step, the operator can start operating a different object to enhance traffic flow. This so-called ‘zipper operating’ “makes the job challenging and fun”, but can sometimes lead to stressful situations when it is hectic, and attention is divided between two objects.

The final step, again, causes impactful pains as this step is very similar, but reverse, to the visual scanning step earlier in the process. Here road traffic skips under traffic barriers too early and negates red lights once more. In addition to this, some objects have inadequate camera plans, which can result in ships completely vanishing for a moment.

/ Summary of the chapter

To gather inside on the deeper knowledge, experiences and emotions of operators during the operation process, contextmapping was used. Contextmapping enhances the operator’s own understanding of experiences around safe object operations. To validate the contextmapping findings, 13 operators were interviewed using a combination of semi-structured interviews (Barribal and While, 1994) and the Scenes™ method (SAP AppHaus, n.d.). The results from the contextmapping sessions and interviews were visualised in an operator segmentation (Figure 3,4,5,6) and an operator journey map (Figure 7). The segmentation allows for a better understanding of the target group, when to utilise their expertise during the innovation process and how they will react towards specific solutions. The journeymap gives insight into the emotional state of the operator during the operation process. These pains (emotional lows) and gains (emotional highs) should be considered during the design phase as utilising them will result in the greatest user value (Osterwalder, Pigneur, Bernarda & Smith, 2014).

CHAPTER 3

Define and develop

/ **Define & develop**

03

From the research conducted, it became evident that the future of object operations is going to change massively in the coming years. More and more objects will be operated in centralised control rooms, and eventually, all RWS objects will primairly be controled remotely. Both RWS and its operators recognize that a change in operations is inevitable, and innovation in this area is profitable. In addition to this, both road and waterway traffic is increasing and demands better service regarding navigation and guidance. In order to deliver, RWS has to create a future vision regarding object operations and its services for both road and waterway traffic. Design roadmapping (Simonse, 2017) is used to create a strategy of design innovations leading to such a future vision. A roadmap is defined as: *"a visual portrayal of design innovation elements plotted on a timeline"*. A roadmap has no one format but needs to be developed for every case specifically. Benefits of a roadmap are an improvement of internal communications within RWS as it creates a common vocabulary (albright and Kappel, 2003), helps to explore future scenarios regarding object operations and increased traffic flow and helps to give insight in user values (Simonse, 2017). Typical elements of a roadmap, however, are trends, user values, products, services, touchpoints and of course a Timeline. Usually, a roadmap includes timepacing elements defined by market-specific demand moments. For an organisation like RWS, this works a little different as RWS is not operating on a market pull basis. As such, the time pacing element is not dependant on market demand but more on market supply. Within RWS 'the market' is defined as companies which supply RWS and not consumers (as is the case with commercial companies). Whenever the market is ready to provide certain technologies which are specified in the roadmap, RWS should try to acquire and implement them. *The driving force for this roadmap is the innovation of operation control, how will this transform in the coming years to accommodate increased traffic, more efficient processes and an increase in safety for both road and waterway traffic?*

/ **How to read the roadmap**

The roadmap consists of five 'horizons' each represented by a future vision (first row). The final vision represents the future vision of RWS concerning operations; by 2023, RWS wants full corridor focussed operations on the Rotterdam- Germany corridor. This entails a new way of working for operators as they will be responsible for corridor control instead of object control. The concepts and systems developed in this graduation project will contribute towards this final vision of RWS, which is the reason this future vision is incorporated in the roadmap. Furthermore, several of the developed concepts (during the contextmapping sessions as well as the interviews) are reflected by this vision of corridor control.

/ **Trends & developments**

When creating a roadmap, it is essential to have a good understanding of the current and future trends regarding object operations. Mapping these trends on a timeline makes it possible to formulate a fitting vision (Figure 8). Furthermore, these trends influence operator demands. Using the creative trend research method (Simonse, 2017), five trend areas with the highest expected impact on object operations have been discovered. The five trends are:

<u>Centralised object control</u>

In the past objects were all controlled locally whereas recent developments have operators controlling from a distance in centralised control rooms. This has a few advantages, namely: better coordination between objects, an increase in efficiency and safety on the waterway network, an increase in usability for the waterway network as control centres provide around-the-clock operations, a more standardized way of object operation and a decrease in system failures (Rijkswaterstaat, 2014a).

Machine learning

Machine learning is the ability for a computer to optimize a performance criterion using example data. This means that by use of training data which needs to be 'fed' to the computer by humans, the computer is able to describe or predict certain aspects of and from that data (Alpaydin, 2009). Machine learning has seen a significant evolution in recent years and will continue to evolve in the coming years.

Deep learning

'Regular' algorithms can easily solve problems which are intellectually difficult for humans (i.e. problems that can be described by mathematical rules). When faced with problems more intuitive to humans (i.e. recognizing speech or faces), these 'regular' algorithms have much more trouble. *"Deep learning allows computers to learn from experience and understand the world in terms of the hierarchy of concepts, with each concept defined through its relation to simpler concepts. By gathering knowledge from experience, this approach avoids the need for human operators to formally specify all knowledge that the computer needs. The hierarchy of concepts enables the computer to learn complicated concepts by building them out of simpler ones"* (Goodfellow, Bengio, & Courville, 2016).

Corridor based operations

By 2023 RWS wants to realise full corridor (a collection of waterways between the same beginning and end point) based operations on the corridor between Rotteradm and Germany. From local object control and shipping guidance towards service delivery throughout the corridor. Live information exchange between RWS and shipping will become the standard when corridor based operations become a reality. This will not only benefit waterway traffic in terms of efficiency; it will also provide RWS with the opportunity to increase safety on the waterways.

Synchromodal transport

Synchromodality focuses on the optimal, flexible and sustainable use of road transport, rail transport, inland shipping and coastal shipping in a network under the direction of a logistics service provider. Synchromodality aims to offer the customer (often a shipper) an integrated solution for his transport so that he can use a better service at acceptable costs.

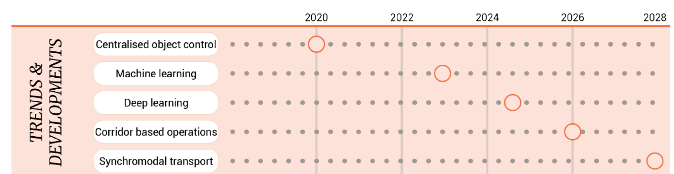


Figure 8: Trends and development which are of influence on the future of object operations.

While these trends and developments exist simultaneously, there are specific periods where they are expected to have more influence on the innovation process of RWS. When these trends are then combined with available technologies and ideas, this will create a moment of high relevance, which is portrayed in figure 8 by a dot. This does not mean that after the dot RWS should not concern itself with the trend or development anymore, the dot merely represents the time where the trend or development will have the most influence on the operation process. As an example, centralised object control is a development which has a direct impact on object operations and is already happening right now. Through the research described in chapter 2, it became evident that operators have the need to be heard throughout the entire innovation process. Combining the operator needs with the organizational development, it becomes evident that in the first horizon, RWS should *involve the user in the innovation process,* how to do that is described below.

Developments such as machine learning are already existing nowadays, but are of more importance to RWS in a later stage. Therefore RWS should invest in these developments at a later stage in the innovation process. Combining these trends and developments with the values of both operators and RWS has led to a clear innovation strategy for the future of object control was created (Figure 9).

/ Operator & RWS values

The horizons each hold specific operator (third row) and RWS (fifth row) values. These values can evolve into other values because of the proposed concepts. I.e. the values *Acceptance of new systems* and *use of expertise* will result in more influence on new systems. This will happen because the proposed concepts, systems and technologies (in this case, continuous involvement of operators during the innovation process using contextmapping). Mapping the values relevant for RWS as an organisation makes it possible to define visions which are leading to the increase of safety and traffic flow. The operator plays a vital role when it comes to the future of operations. Therefore, it is important to also map out their values on a timeline. This will not only allow for better alignment between the organisation and operations but will also result in a more efficient innovation process. As the understanding between organisation and operation will increase when the innovation process takes both values into account.

/ Systems & technologies

In order to fulfil the respected vision, each horizon needs certain technologies, systems and/or concepts. These are reflected in the illustrations in the fourth row. These systems and technologies each build upon each other in order to create a holistic process which increases safety and traffic flow.

/ Operator roles

The last row links to the operator segmentation and reflects which type of operators should be involved during the realisation of that vision. As each type of operator has its distinct advantages and challenges, they can contribute most when involved at the moment where they add the most value. I.e. the nostalgic should be consulted about his knowledge and expertise regarding specific locks and bridges, while the promoter should be consulted when in need of more concrete solutions. It needs to be said that operators do not have a label saying which type of operator they are and that operators can have certain traits from one segment and certain traits from another segment. In some cases, the row reflects which operators one can expect to voluntarily participate with certain activities, while sometimes certain types of operators need to be specifically targeted (i.e. the protector is not very likely to participate voluntarily in activities concerning innovation, while their input is valuable for certain developments).

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Roadmap towards a safer water and road network.

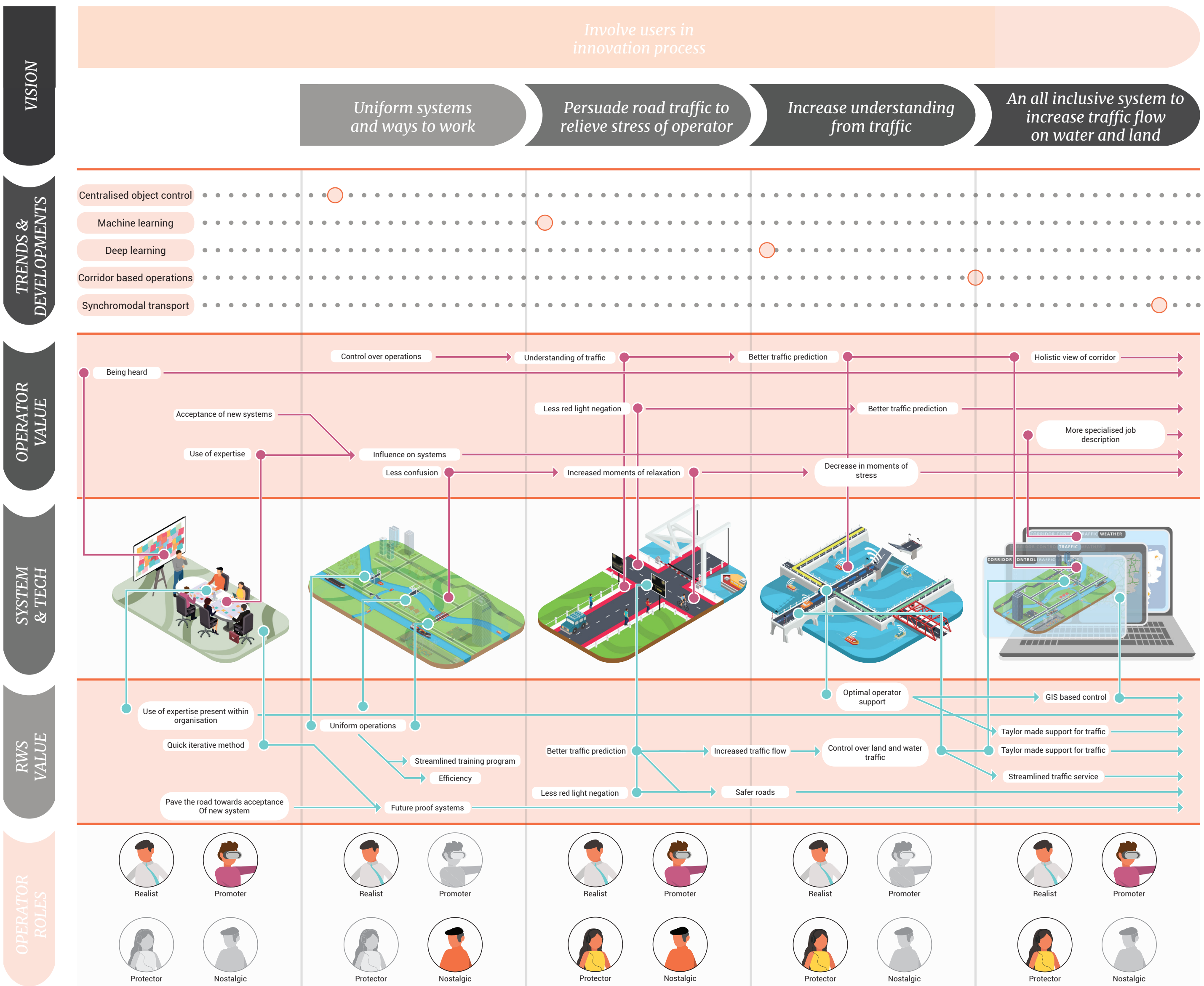

Figure 9: Roadmap.

/ Vision

While looking at the future of operations, there are several factors which will play an important role in the innovation process. Firstly society places an increased demand on road and waterway networks. Secondly, RWS is looking for ways to increase safety and efficiency around object control. Lastly, operators often feel neglected when it comes to being involved during innovation processes. In order to deliver an optimal service for both road and waterway traffic, while accommodating both RWS and the operator's values the future vision regarding object operations will be: *the future of object control will be an all-inclusive system to increase safety and traffic flow on water and land.* Where RWS used to operate objects locally, the future of operations will be corridor based and synchromodal oriented. In order to achieve this future vision, five systems were developed. The following pages will discuss each horizon and its respective systems separately and in depth.

/ Horizon 1
/ Vision

By actively involving the operator in the innovation process, will bridge the gap between management and operations.

/ System & technology

The first horizon describes how to involve the user within the innovation process. RWS has many employees with a lot of expertise in the field of operating. When encouraged in the right way, these operators show a considerable amount of potential in coming up with solutions when faced with challenges in their work. By use of contextmapping (as described in chapter 2) or other co-creation methods, operators are contributing actively towards their future. A key aspect of this horizon is to keep involving the operator throughout the entire innovation process. Contextmapping and co-creation methods are excellent methods to be used iteratively throughout the entire innovation process. This horizon, therefore, spans the entire innovation process (as represented in Figure 9). It is advised to organise contextmapping workshops at set time intervals. By doing this, RWS ensures operators are constantly involved during the innovation process. This will not only improve solutions, it will also create better understanding between the operational site and management.

In order to help RWS in better understanding their user group an introduction booklet to contextmapping was created (Appendix IV). With this booklet RWS can start using the contextmapping method by themselves to bridge the gap between operations and management. Even though this booklet contains the basics of contextmapping, it is advised to consult a professional designer with expertise in contextmapping if RWS wants to take their user research a step further. This can either be an internal or external expert.

/ Operator values

For the operator, this will increase their acceptance of developed solutions (as they contributed to them), will make them feel heard (which is now not always the case) and makes them feel proud of their expertise. In addition to this methods like contextmapping have proven to increase acceptance of new systems and innovations (Sanders & Stappers, 2012).

/ RWS values

For RWS, this way of working ensures that its employees true potential is used, it paves the road towards acceptance of innovation and it delivers a very quick way to gather information from the intended user group.

/ Operator roles

A requirement for co-creation in any form is that these sessions are facilitated by qualified people who are able to transform the gathered insights into viable concepts. Within RWS, there are monthly soundboard meetings where these sessions could be held. This, however, also forms an obstacle in recruiting operators to join these sessions. During this stage, you ideally would like to have an equal distribution of the different types of operators. However, in reality, this will prove difficult as operators who take part in these soundboard meetings are there voluntarily. This will result that in general, the types of operators who are present at these meetings will be the realist and the promoter. This because they either have many ideas to improve their work (the promoter) and are innovation oriented (the realist).

Figure 10: System of horizon 1

/ Horizon 2
/ Vision

With uniform systems and ways to work, operators will have a better understanding of objects. Object control will become more centralised, and the operation process more uniform.

/ System & technology

The second horizon describes the first steps that need to be taken in order to realise a more safe environment for both operator and traffic. One of the first things operators mention is the non-uniformity of existing camera plans. There are several frameworks within RWS which describe the rules concerning the installation and use of camera plans (Rijkswaterstaat, 2014b; Rijkswaterstaat, 2014c; Rijkswaterstaat, 2018). What became evident from the different sessions is that there are numerous situations and objects, where the camera images are: a,) not clear to interpretation and b) not on par with the existing frameworks. The latter is mostly the case when objects are locally controlled, so where operations on direct sight are also possible. As RWS is moving towards more centralised operations, investing in getting camera plans on par with the frameworks is needed. In order for future systems to be implemented, a solid foundation has to be laid out where operators feel comfortable operation objects using the existing systems. From the research, it became evident that there is a need for a more universal way of operating. The challenge here is that every object is different, reacts differently and has a different camera set-up. Some worst-case scenarios where camera images are not clear to interpretation are camera images where ships seem to come from different directions while moving through the video wall. This is demonstrated in Figure 11: an operator would see a ship appearing on his video wall in frame 1 going from west to east. The next time the operator would see the ship is on frame 3 appearing to go from east to west. As the ships sails through the lock or under the bridge, it appears to come from all different kinds of directions.

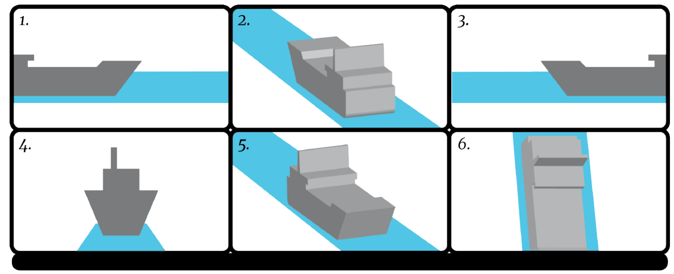

Figure 11: simplified video wall.

The first step towards uniform systems and ways to work would be to set up camera plans which offer a more intuitive overview of the situation. A solution to this could be to create a digital overview of the situation where different camera images are combined in one overview of the situation. In this manner, the operator would only have to give a glance at this overview to get a good impression of whether the situation is safe. It became evident from the different sessions that operators have developed the ability to create such an overview from the current camera images. This, however, takes time and effort, which means that the time to learn controlling objects would be decreased with a solution like the digital overview.

Another system which would increase uniformity is a more standard way of communicating with waterway traffic. From the sessions, it became clear that in order to create mutual understanding between operator and waterway traffic, direct communication is key. However, there are also operators who complain that communication with the waterway how it used to be (while operating on location) is not compatible with operation from a centralised control room. Where in the past operator and skipper were communication more on a friendly basis (as opposed to a professional one), the increase in traffic demands professionalization when it comes to communications. During the research, it became evident that it is not uncommon that waterway traffic uses the communication channels to blow off steam instead of exchanging important information. AIS (Automatic Identification System), a recent development within waterway traffic, created an enormous amount of valuable information for both the operator and waterway traffic. With AIS, all professional shipping shares its location, cargo, route etc. with other waterway traffic and operators. With such increase of information available to both operator and waterway traffic, it is key that RWS invests in communication channels which support both the operator and waterway traffic in such a way that they can both do their job as efficient as possible.

A realistic direction would be to increase uniformity within every control centre (as opposed to nationwide uniformity). As in the future every corridor will have dedicated control centres, it is advised to start developing *uniform systems and ways to work* within the control centres which are now being set up by RWS.

/ Operator values

Within this horizon, the operator will feel more in control of operations, as objects within his control centre will be more uniform. The operator will experience less confusion when switching between objects as object control is more uniform. Furthermore, the operator will feel to have more influence on systems, as he has contributed towards the detailing of operation control.

/ RWS values

With operation actively involved in the innovation process, RWS will be able to create future proof systems. Uniform systems and ways to work will create a more streamlined training program for future operators. Creating a more professional way of communicating with waterway traffic will result in more efficiency for operations and waterway traffic.

/ Operator roles

Within this horizon, the nostalgic operator should be involved, as he has the most knowledge and expertise concerning camera overview and camera plans. As this type of operator has been creating an overview in his head for a long time, he knows best which challenges different objects hold. The realist, on the other hand, can help test on the uniformity of the proposed camera plans and digital overview.

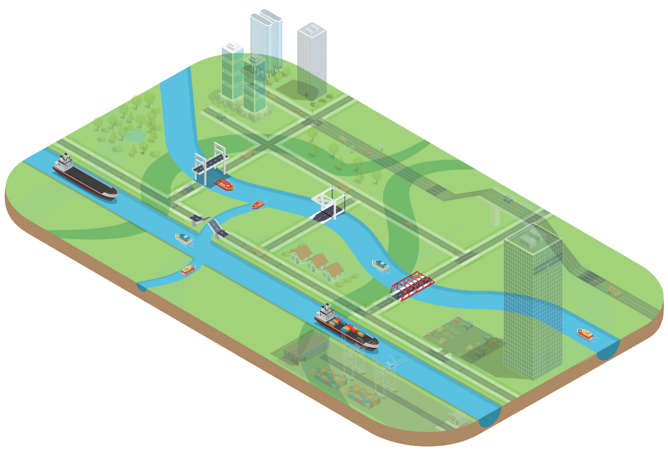

Figure 12: System of horizon 2

/ Horizon 3
/ Vision

By use of existing communication technologies, road traffic will be persuaded to abide traffic rules, in such a way that the operator experiences less stressful moments during object control.

/ System & technology

During this graduation project, it became evident that red light negation and skipping under traffic barriers were situations which not only happen nearly every bridge operation but were also the cause of the most stressful situations during a bridge operation. Previous research concluded that the longer the waiting time for a bridge lasts the more likely red light negation and skipping under traffic barriers occurs (Mulders, 1981; Hooijdonk, Merkx, Beumer & Janssen, 2016). Furthermore, Retzko and Androsch (1974) found that the credibility of red lights diminishes when there is no apparent reason for the red light: i.e. when there is no visible crossing traffic. In other words; when there is low perceived risk, red light negation is high. This, however, has a significant influence on the operators. During all sessions, the operators indicated that this specific part in the operation process causes most stressful situations and near accident moments.

Where in previous horizons the operator had a clear view of road traffic, the operator itself was mostly invisible to traffic. As far as the road user is concerned the operations of a bridge could be completely autonomous. The third horizon, however, focuses on giving smart feedback to enhance the road user's experience during the opening of a bridge. Looking at solutions towards red light negation in general, the most useful solution to date is the Green Signal Countdown Device (GSCD). Lum and Halim (2006) reported a reduction of 65% in red light negation with pedestrians compared to traffic lights without the GSCD. Installing such a device on traffic lights of bridges will most likely not lead to results in the study of Lum and Halim (2006), as the average process of controlling a bridge lasts 8 minutes. The study does, however, present an insight in changing traffic behaviour by use of expectation management.

To realise better understanding from traffic this horizon proposes two concepts: a) traffic signs indicating from where a ship is approaching and b) traffic signs offering alternative routes. Retzko and Androsch (1974) concluded that people will be more likely to negate red light when there is no visible crossing traffic. Therefore traffic signs which indicate from which direction the ship is approaching could simulate the effect of seeing an actual ship approaching (fig. 11). Existing DRIP (Dynamic Route Information Panel) signs could be used as dynamic traffic signs to communicate from which direction a ship is approaching.

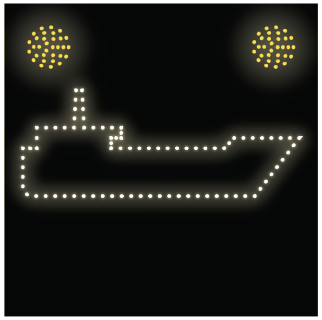

Figure 13: DRIP traffic sign indicating a ship approaching from the left

This horizon also proposes to offer road users alternative routes when a bridge is about to open. Especially in more rural areas, bridges are close to each other and driving, cycling, or walking to the next bridge will usually not cost much extra time. In addition to an alternative route, the road user should also be presented with the expected waiting time during the opening of a bridge. By doing this, the road user will be motivated to take a detour as it will be apparent that taking a detour will take less time than waiting. This can be achieved by the use of DRIP traffic signs.

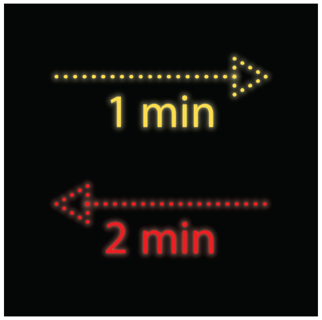

Figure 14: DRIP traffic sign indicating alternative routes and the extra travel time

/ Operator values

The introduction of DRIP signs will result in a positive change in land traffic behaviour. Pedestrians and cyclists will negate red lights less often, as they will be provided with alternative routes. In turn, this will decrease the near accident situations, creating a more relaxed work environment for the operator.

/ RWS values

For RWS traffic safety is a top priority, with the introduction of alternative routes for road traffic it is expected that fewer people will negate red light, increasing traffic safety. An additional advantage of alternative routing is better traffic flow for road traffic, as there will be fewer people waiting before an opened object. Furthermore, RWS is able to predict traffic better, and there can make a start working towards future horizons.

/ Operator roles

In this horizon the protector plays a key role. The protector values quality and ease of use, therefore this operator is perfect to give feedback on these aspects. When the protector is convinced red light negation drops and there is more understanding from road users the system has proven itself qualified. The realist on the other hand can be used to monitor the safety and efficiency of the proposed system. The DRIP traffic signs and navigation integration should be developed and tested in iterative cycles. With the DRIP signs different content should be tested to see if the concepts works and what the most effective way of visual output should be portrayed on the DRIP signs. The realist could provide valuable feedback during these cycles.

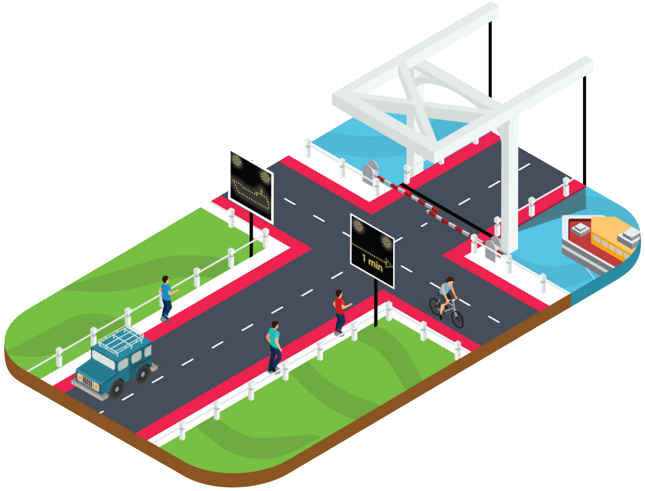

Figure 15: System of horizon 3

/ Horizon 4
/ Vision

The combination of smart systems on and around objects and the growing availability of traffic data will create an ecosystem where the operator will better understand both water and road traffic.

/ System & technology

After the second horizon ensured a more uniform way of working, in the fourth horizon, smart systems can be installed to aid the operator. The combination of machine learning and AIS provides RWS with the opportunity to develop systems which optimally utilise the information stream. To better understand the waterway traffic along the corridor, machine learning based applications could provide the operator with predictions about waterway traffic along the corridor.

Where smart information systems should aid the operator in better understanding of waterway traffic, smart solutions should also be developed to aid the operator in understanding road traffic. With the use of smart cameras, operators can react quicker and spot a dangerous situation more accurately in order to prevent accidents. In this horizon, smart cameras should be used to aid and not replace the operator. This has several reasons, namely:

- Several tests with fully automatic object control have proven that the waterway network is not ready for fully automated solutions. The tests let skippers control locks by themselves. Unfortunately there is too much waterway traffic for a solution without an operator provided traffic guidance.
- It is not RWS's policy to replace operators at this moment in time.
- Machine learning based software needs to be presented with so called training data. With this training data the software can improve in recognising unsafe situations. By involving the operator in this learning process the system can be provided with real data from practice. Because of this, operators will play a vital part in the development of smart camera software.

Throughout this research, specific, functional requirements for a smart camera system were discovered. With these functional requirements, RWS will be able to start development and testing of such a system. The functional requirements for a smart camera system proposed by this graduation project are:

- The smart camera system should be a standalone system existing next to current hardware. RWS has as priority safe operations and is able to do this with current systems. When developing an additional system such as a smart camera system, it is important that current systems keep functioning. Furthermore, camera hardware currently in use is not designed with add ons in mind. Trying to develop a system which would be an add on towards current systems would require too much effort with a high chance of damaging current systems. Another advantage of a stand-alone smart camera system is that by developing it separate from current hardware, iterative testing will be much easier as only part of the complete system will be in development.
- The smart camera output should not be visible during operations. From this research, it became evident that both operators and management realised that when a smart camera system will occupy a prominent position within the available camera footage operators will either rely on it entirely or will not use it at all. The general idea of smart camera output is a coloured frame around the detected object. However, this would distract the operator from the rest of the camera

footage. Current smart camera solutions can not offer a 100% detection rate and therefore should not (yet) be continuously shown to the operator. In the future, the detection rate will most likely come close to this 100%, but even then it should not be advised to have a constant visual reminder of the detected objects. Even if the perfect smart camera has a 100% detection rate, there are still scenarios in which this type of camera would fail. I.e. too many objects on screen will result in an image which shows too much visual feedback to the operator. At the end of the day, the operator will still be responsible for the safety on and around an object, but smart cameras have the potential to aid operators if appropriately used. As such, the smart camera output should only be visible after the operator has initiated the control process (Figure 16). In Figure 16, a potential scenario is created where the operator follows the standard process of opening a bridge. When the bridge opening is initiated, and the smart camera system detects a safety risk, the operator will not be able to execute the bridge opening. The system will ask the operator to confirm if there is an unsafe situation. If there is an unsafe situation, the operator can start the process again once the situation is safe. If there is a safe situation, and the smart camera system detected something which was not there, the operator has the opportunity to report this. The system will thank the operator for reporting this and will notify the operator to have learned from this. As smart systems are currently learning these errors will happen less frequent over time. The feedback towards the operator that the system will learn from this situation in future scenarios is important as it will make the operator understand that the system will get better over time, increasing system trust.

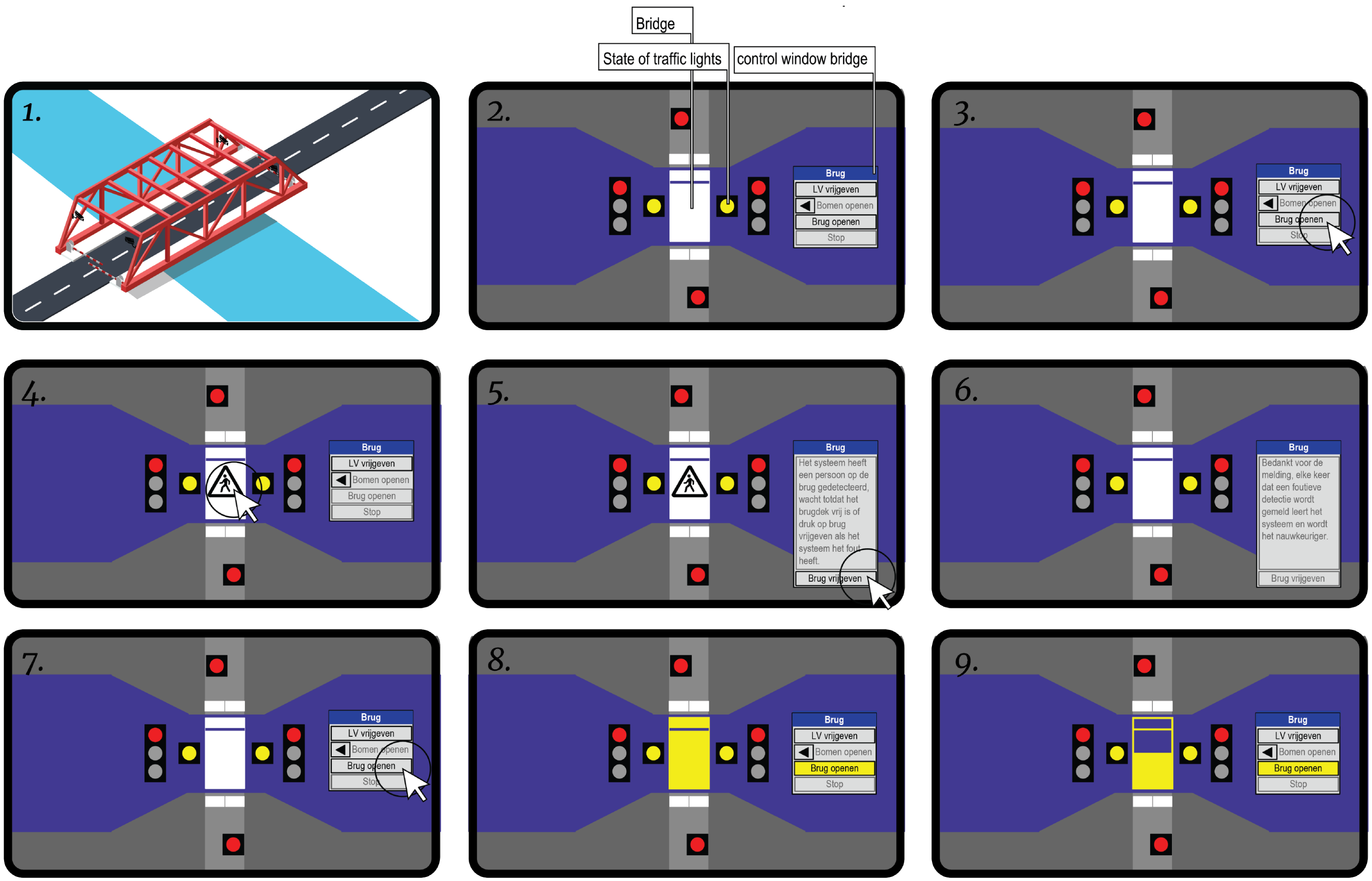

Figure 16: integration of smart camera system within current control system.

1. The bridge that has to be opened.
2. Control screen of the operator.
3. All traffic lights and barriers are activated, land traffic (LV) is at a standstill, the operator presses open bridge (brug openen)
4. Notification that smart camera system detected traffic on the bridge, operator clicks on the appearing icon
5. A notification appears explaining the system has detected traffic on bridge area, the operator clicks release bridge to report detection error
6. Systems thanks operator for reporting the error and improves the software
7. Bridge control is available again; the operator clicks open bridge
8. Bridge opening is activated
9. The bridge is opening

- As RWS is continuously adding new objects to control centres, operation time becomes more and more important. Therefore, the interaction time with the smart camera system should be kept to a minimal.
- While RWS has several graphics frameworks for camera plans and object control, for these new types of cameras, RWS does not have a framework yet. Operators are already familiar with these frameworks and have worked within them for their entire career. A combination of existing frameworks and the several sessions and research during this graduation project a start towards a graphics framework for smart camera output can be made. When the system would detect an unsafe situation, albeit people on movable parts or potential jaywalkers, there should be a uniform signal to warn the operator. For any graphical signals, RWS has a framework (Rijkswaterstaat, 2015b) dictating the functions of different graphics objects. As the operators are already working within this framework, it is advised (if graphic signals are used for the smart camera output) to adhere to these guidelines. This would mean that the colour red (255,0,0) should be used to indicate an unseen dangerous situation and the blinking of a graphic object with a frequency of 2 Hz should be used to communicate the need for direct attention of the operator.
- As operators are already using several applications while operating the way of interacting with the smart camera system could be (partially) based on these existing applications. As the smart camera system should be tested with operators regularly within an iterative process, the interaction with this system can be perfected within the development of the system itself.

A different way the operator could interact with a smart camera system would be an application of the smart camera where, combined with deep learning, the system would be able to predict traffic flow on and around an object. Using deep learning, the smart camera system would be able to predict which traffic users are likely to skip under a barrier or negate red light. This could then be communicated to the operator when the operator asks this from the system. By providing the operator with this kind of information the operator would experience less stressful situations during his job.

As systems around the objects are getting increasingly smarter, it will be possible to incorporate navigation information into navigation systems (Google maps, TomTom, etc.). In such a way that road traffic will be able to get real-time feedback on their navigation systems on object openings. This will tap into the future trends of mobility. With concepts as Mobility as a Service (MaaS), the rise of autonomous vehicles and the development of smart cities, a bridge system which would actively communicate with its users in a smart way is a logical step into the future.

/ Operator values

/ RWS values

With the aid of smart systems, the operator will be able to predict traffic better and act correspondingly. A better understanding of traffic will result in less stressful situations, as there will be fewer scenarios where the operator has little overview of a situation.

/ Operator roles

By implementing smart systems, RWS builds towards safer waterways and roads. Furthermore, smart systems ensure RWS is optimally supporting its operators and working towards increased traffic flow.

Within this horizon, it is advised to involve all types of operators, as this would drastically change their workflow. To determine the precise functionality of smart systems and how they are communicated with the operator, soundboard groups should be organised. Furthermore, these systems will be mostly software based and can, therefore, be developed and tested on location. RWS already has experience with the scrum method (from the development of IVS Next) and should incorporate this way of developing a system incorporation with all types of operators.

Figure 17: System of horizon 4.

/ Horizon 5
/ Vision

RWS will offer an all inclusive service to increase traffic flow on water and land. With the introduction of corridor based operations RWS will pave the way towards a synchromodal system by enabling an integrated solution for waterway traffic.

/ System & technology

Where RWS used to operate objects locally, the future of operations will be corridor based. This means that instead of operating one object at the time, RWS will provide full corridor guidance and taylormade support for waterway traffic. This in turn will tap into the trend of synchromodality.

Synchromodality focuses on the optimal, flexible and sustainable use of road transport, rail transport, inland shipping and coastal shipping in a network under the direction of a logistics service provider. Synchromodality aims to offer the shipper an integrated solution for his transport so that he can use a better service at acceptable costs. Facilitating such a large transport stream will be a major task for RWS. An effective synchromodal system is only possible when the infrastructure of all different modalities connect with one another. Important criteria to make a synchromodality a success are the density and reliability of the transportation network. In most areas from the four modalities only one or two are available for the logistics service provider to choose from. Even though the Netherlands has a very dense transportation network of roads, rails and inland shipping. As such does this network provide an excellent opportunity for synchromodal transport.

Reliability is one of the most important prerequisites for synchromodal transport. In order to plan for different modes of transport, there needs to be as little as possible congestion. So besides dense infrastructure, it is important that this infrastructure is also reliable. Furthermore, the use of corridor operations ensure that transportation providers are able to anticipate much better prior

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and during transportation. By creating a system

where all stakeholders have access to transparent information these parties have the opportunity to choose the best fitting modality for their transport. This will increase efficiency not only on the waterway, but also on roads and rail. By investing in corridor operations RWS automatically invests in synchromodality. RWS ensures it can not only stay relevant but take the lead in a future where synchromodality prevails.

/ Operator values

For the operator, corridor operations mean a lot is going to change in their workflow. In previous horizons the operator still had only one object under his control within corridor operations the operator can fulfill four different roles throughout his job. These four roles are:

Corridor planner: An operator in the role of corridor planner has to plan and control the routes of ships within a certain corridor and takes care of the water management over that same corridor. In addition to this, the corridor planner manages all the information regarding ships on his corridor.

Operational network employee: An operator in the role of operational network employee is the first point of contact for the corridor regarding incident, crisis and water management. In addition to this, the operational network employee monitors and anticipates for situations which might cause delays on the corridor.

Traffic controller: An operator in the role of traffic controller delivers all relevant information about the corridor to the waterway. If necessary the traffic controller delivers the waterway traffic with guidance to increase safety and traffic flow.

Object operator: An operator in the role of object operator controls objects as he is used to. The object operator works closely with the corridor planner as the corridor planner delivers the planning for when which objects need to be controlled. As technological development of smart systems (as described in horizon 4) will progress and machine and deep learning will ensure reliability in operating objects this role will eventually cease to exist.

The split in operation functions creates a new dynamic of working; operators are now able to specialize themselves during their career and become an expert within their function. The operator needs to work in a much more holistic manner, where the operator needs to have a much more precise overview of the corridor (both in terms of traffic as in terms of water management). All previous horizons contribute towards this need in creating a better overview; uniform systems and ways of working ensure operators can control objects in a plug and play manner and increase understanding of and from traffic. This contributes to less stressful situations while operating objects.

/ RWS values

For RWS, this way of working holds many advantages as well: first of all, RWS can provide taylormade support for both waterway and road traffic. Both these types of traffic have increased and keep increasing, and by offering a more streamlined service, RWS contributes to better flow both on water and on land. Secondly, RWS is more versatile in their operations; operators are able to control (almost) every object. Thirdly the use of people will be more efficient.

/ Operator roles

In this final horizon, it becomes clear that there is little left of the good old days of object control. Where in the past, the operator had his object to take care of, the focus now is much more on delivering the optimal routes for both land and water traffic. As such, the nostalgic operator will have a hard time adjusting to this new reality. The other three types of operators will have gotten more used to this type of working (and thinking) throughout the previous horizons. Additionally, the new operator roles allow the operators to focus on parts of the operation they enjoy most; are you an operator who values contact with the nautical side of operating then traffic controller is a great way to keep in touch with skippers and all waterway related. If you are an operator who enjoys a more holistic view of the corridor than corridor planner is best suited for you. In this way, operators can really distinguish themselves from their colleagues.

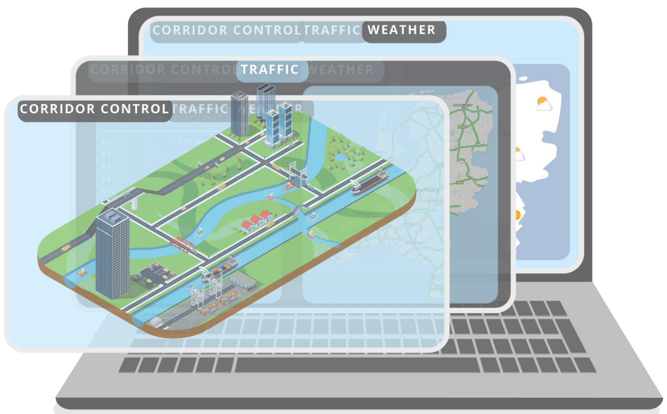

Figure 18: System of horizon 5

/ Summary of the chapter

A roadmap containing 5 horizons was created to provide RWS with an innovation strategy for the future of object control. In order to deliver an optimal service for both road and waterway traffic, while accommodating both RWS and the operator's values the future vision regarding object operations will be: *the future of object control will be an all-inclusive system to increase safety and traffic flow on water and land*. The concepts proposed in these horizons all contribute to reaching this final vision. Furthermore, it is advised to keep involving the operators throughout every horizon using creative methods.

CHAPTER 4

Conclusion and recommendations

/ Conclusion & recommendations

04

The initial goal of this thesis was to research in which way smart cameras could contribute to the safety of movable bridges and locks. The focus was based on several incidents and fatal accidents in the past. Where operators, in combination with red light negation, missed road traffic while controlling bridges and locks.
In addition to this, RWS is concerned with smooth traffic flow on both water and land. For this reason, not only a redesign of only object operation was required but also a future vision and implementation plan on a more holistic way of operating was needed.

/ Analysis

RWS has numerous frameworks dictation almost every aspect related to operations. Studying these documents resulted in a robust theoretical understanding of operations. It did not, however, give insight into how actual operations where done. While visiting several operation locations, it became clear that operations differ not only from the frameworks, but operations also differ from location to location. With the use of contextmapping different operators from different locations were invited to share their process and brainstorm about the future of operations.

/ User research

Initially, RWS was looking at smart cameras to aid the operator during object control. By use of contextmapping, the complete operation process was reviewed together with operators. This resulted in insights on what the target group values and where they saw improvement. By keeping the scope broader than only smart cameras, it became evident that there was the need for a more encompassing solution. From the user research, a user journey map was created showing the operation process with all corresponding emotions, opportunities and challenges. In addition to this, operators were also interviewed at their work, which resulted in an operator segmentation. This segmentation shows four different types of operators. The segmentation can be used to involve certain types of operators during the innovation process.

/ Design roadmapping

With design roadmapping, a future vision for object operations, with the operator in mind, is presented. The roadmap presents the needed horizons before smart cameras can be implemented. However, the roadmap also offers RWS a look beyond implementing smart cameras in the operation process. Operations will change massively in the coming years; from local object operations towards central control rooms and from separately controlled objects towards corridor control and guidance. With this comes much change for both operators and traffic. Here the roadmap can serve as a future vision which enhances communication and understanding within RWS.

/ Implementation

This thesis advises RWS to involve the user more in the innovation process. This will not only ensure the use of expertise from within the organisation. It will also create better product and service fit, as the user can give feedback and influence the development of innovation. Lastly, it will increase innovation acceptation. Throughout this research, numerous operators complained about innovations which were implemented without consulting the intended user, leading to a misfit of user and product or service. With methods like contextmapping or co-creation, users can be made experts of their own experiences and add value to the innovation process.

/ Discussion

The initial assignment was heavily focussed on the output of smart cameras. The use of smart cameras looked already decided from the start of the project. Researching solutions from the perspective of the operator was not considered. A more fitting research question would have been How to improve the safety of object operations while ensuring a successful implementation of the proposed solution.

/ Scope

As mentioned in the previous paragraph, the initial scope of the project was rather narrow. At the beginning of the graduation project, the focus was still very much on smart cameras and how to communicate the signals. After discussing with the supervisory team, the scope was broadened. Sticking to the original scope would have resulted in a design which would not have looked at the impact on the operator, the impact on operations in general and would not have incorporated the future vision of RWS on operations. In hindsight, the scope should have been more thoroughly discussed in order to have a more streamlined start of the project.

/ User research

The use of contextmapping was clearly the right choice. Not only did the participants react enthusiastic towards the sessions, management also saw the value of this method, when presented with the results. As an Industrial Design student, methods like contextmapping are considered to be standard and an obvious choice when doing user research. This graduation project showed that not nearly as many people have come in contact with this way of working as previously thought. To further aid RWS, an introduction booklet was created dictating several creative research methods so that RWS can use them in future research.

Although the contextmapping results were validated with interviewing operators in their work environment. These operators were still voluntarily participating. To truly get a grip of every type of operator, future research should be done where either operators are obligated to participate or where operators are unaware that they take part in a research.

/ Result

The result provides a holistic view of the future of operations. A student more experienced in interaction design (design for interaction) might have focussed more on developing the actual interaction of the operator with smart cameras. However, the research conducted in this thesis shows that operators want to be involved in the innovation process and that they too see the need for change within their work. If there had been more time (parts of), the concepts proposed in the different horizons could have been prototyped and tested out.

/ Recommendations

The final concept offers room for several follow up projects. Firstly the roadmap should be updated as time progresses. New developments (internal and external) could lead to a shift in operations or vision demanding the roadmap to be altered. The roadmap in itself is a good way of communicating the future vision, but regular update sessions should ensure technologies stay relevant, available and mature enough for implementation. Secondly the horizons should be developed, tested and implemented. With the framework for the smart camera (horizon 4), future graduate students can start building and testing proof of concepts, and with the roadmap in general, RWS can start building towards true corridor guidance and control.

/ User research

Throughout this graduation project, RWS has taken an interest in the use of contextmapping. In consultation with Pieter Jan Stappers, Professor of Design Techniques at the

TU Delft, five recommendations regarding the use of contextmapping for RWS have been formalised:

1. Contact the department of Product Innovation Management (PIM) from the faculty of Industrial Design at the TU Delft in order to formulate a graduation brief. Within this brief, the emphasis should be on how to embed contextmapping within the organisation.
2. If RWS wants to have a better understanding of a particular user group, the help of a professional design agency could be the answer. Companies like Muzus are specialised in the use of contextmapping and have done previous projects to aid governmental organisations.
3. The faculty of Industrial Design at the TU Delft have in the past, organised several contextmapping masterclasses. Offering employees from RWS the opportunity to join such masterclass should be considered. The advantage of this is that RWS does not need to rely on external parties when doing user research but is training its employees to create better alignment between user and organisation.
4. Every September an elective about contextmapping is part of the curriculum within the faculty of Industrial Design at the TU Delft. During this elective students work on cases from real companies and organisations. RWS could sign up as an organisation providing said cases.
5. RWS should consider hiring designers within their organisation. Designers trained in contextmapping have the ability to, not only conduct user research but also translate the findings in concepts and prototypes.

/ Etics

Whenever technology takes over human tasks there is always the discussion who is responsible when incidents and accidents happen. Within this project it is proposed that object operations are (partially) automated by smart technologies. Throughout the research it became clear that operators themselves are very aware of this possible shift in responsibility. They are in general very hesitant to trust automated systems taking over their job and are immediately asking who is to blame when incidents or accidents happen. For RWS it is important to understand that questions like this are very much alive in the minds of the operators.

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I

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

HOE KUNNEN WE SAMEN VERNIEUWEN?

Een kwalitatief onderzoek naar nieuwe technieken tijdens het schouwen

HALLO!

Bedankt dat je mee wilt doen aan mijn onderzoek. Dit boekje is jouw dagboek voor de komende 5 werkdagen. Het helpt je inzicht te geven in je eigen gedrag tijdens je werkdag.

Elke dag bevat een paar vragen. Wil je deze zo eerlijk mogelijk beantwoorden? Er is geen fout antwoord. Het gaat om jouw mening en jouw ervaringen. Je antwoorden worden alleen besproken met jouw collegas binnen de CBB klankboordgroep.

Om te beginnen wil ik je vragen rechts iets over jezelf te vertellen. De vragen zijn vrij makkelijk te beantwoorden, maar probeer er de tijd voor te nemen. Als er gevraagd wordt iets te tekenen probeer dat dan ook, er zijn immers geen foute antwoorden.

Neem dit boekje mee naar de bijeenkomst op 13 maart, daar zullen we de antwoorden gaan bespreken. Tijdens de bijeenkomst vraag ik je een vraag toe te lichten die je het meest aan het denken heeft gezet.

Alvast bedankt,
Maarten

2

WIE BEN JIJ?

Naam

....

Leeftijd .... man/vrouw ....

Voor het eerst een brug/sluis bediend in het jaar?

....

Meest bijzondere moment bij Rijkswaterstaat?

....
....
....
....
....

3

DAG 1.

Wat vind jij de 3 **leukste** dingen aan je werk? Teken en beschrijf deze:

4

Wat vind jij de 3 **minst leuke** dingen aan je werk? Teken en beschrijf deze:

5

DAG 2.

Teken op de tijdslijn hieronder hoe jouw dienst eruit ziet. Vanaf het moment dat je op werk aankomt. Tot aan het moment dat je naar huis gaat. Beschrijf specifieke handelingen die belangrijk zijn voor het werk en die belangrijk zijn voor jou.

Op de bovenste balk teken/ schrijf je de gebeurtenissen en op de onderste balk hoe je je daarbij voelde.

Begin dienst

Naar huis

Tijd

........uur

........uur

Emotie

DAG 3.

Teken en beschrijf de **beste** vernieuwing(en) binnen je werk.

En waarom vind je deze vernieuwing(en) het best?

Teken en beschrijf de **slechtste** vernieuwing(en) binnen je werk.

En waarom vind je deze vernieuwing(en) het slechtst?

DAG 4.

Geef aan of je het met de volgende stellingen eens bent. 0 is helemaal niet mee eens, 5 is helemaal mee eens.

Ik word betrokken bij het ontwikkelen van vernieuwingen.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Ik word betrokken bij hoe en wanneer vernieuwingen worden ingevoerd.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Ik vind vernieuwing nodig.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Waarom gaf je deze antwoorden? Kun je voorbeelden geven? Welke verandering vond je wel of niet nodig? En hoe werd je hier bij betrokken?

Geef aan of je het met de volgende stellingen eens bent. 0 is helemaal niet mee eens, 5 is helemaal mee eens.

Ik word voldoende opgeleid om vernieuwingen/ nieuwe systemen te gebruiken.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Als ik ideeën heb om iets te verbeteren in mijn werk wordt daar naar geluisterd.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Wanneer ik vind dat sommige systemen niet goed werken wordt er naar mij geluisterd.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

Waarom gaf je deze antwoorden? Hoe word je opgeleid? Hoe wordt er met jouw feedback omgegaan?

DAG 5.

Teken op de tijdslijn hieronder hoe **jouw** schouwproces eruit ziet. Vanaf het moment dat je een object moet bedienen, tot aan het moment dat je niet meer hoeft te schouwen. Beschrijf specifieke handelingen die belangrijk zijn voor het werk en die belangrijk zijn voor jou, wees zo gedetailleerd mogelijk.

Op de bovenste balk teken/ schrijf je de gebeurtenissen en op de onderste balk hoe je je daarbij voelde. Eventueel zou je boven de tijdsbalk kunnen tekenen hoe dat bij een brug gaat en onder de balk hoe dat bij een sluis gaat.

Begin schouwproces

Einde schouwproces

Tijd

........uur

........uur

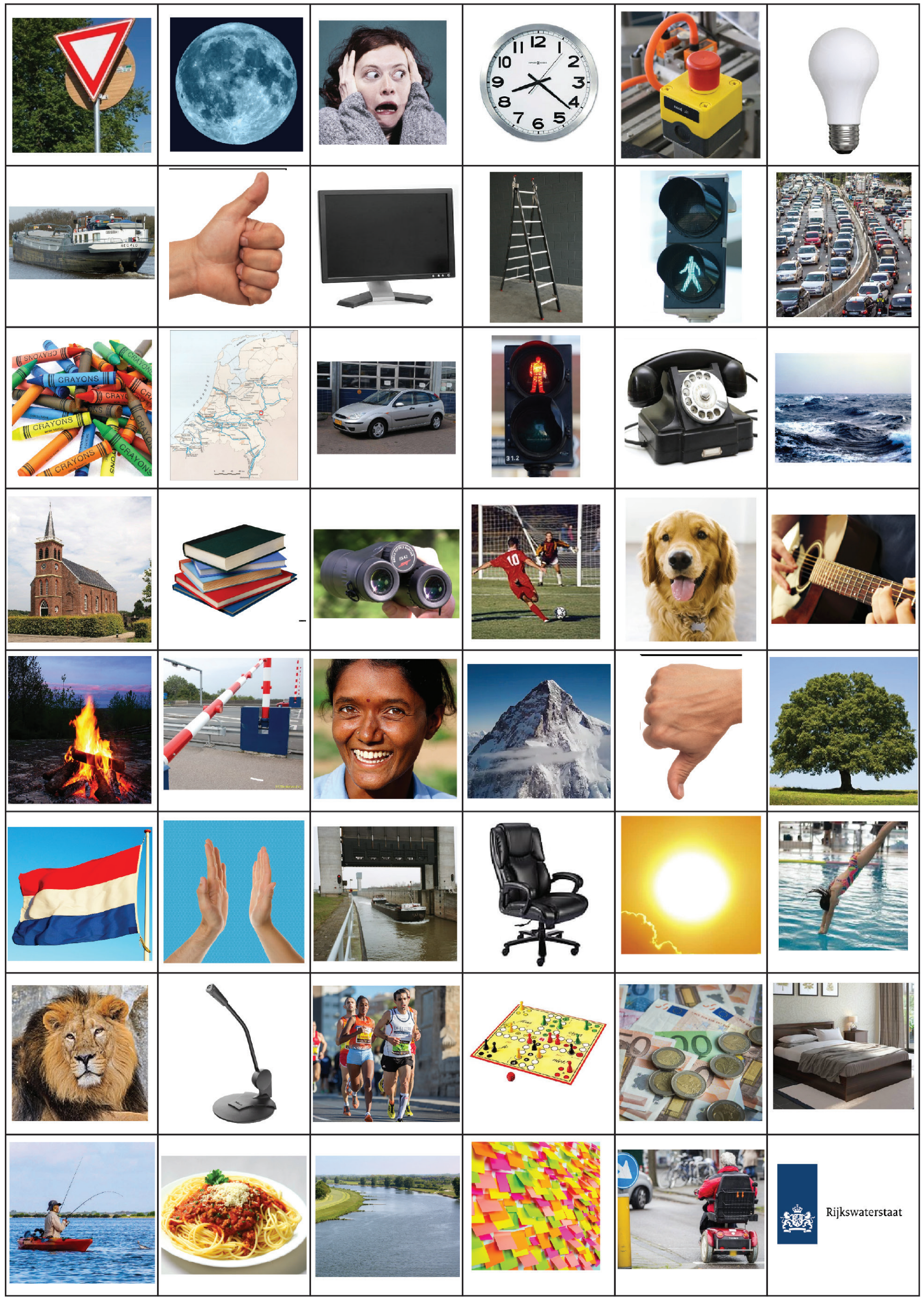
Emotie

BEDANKT!

Neem dit boekje mee naar de bijeenkomst op 13 maart. Aan de hand van jouw antwoorden gaan we kijken hoe we samen kunnen innoveren.

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

II



koud	S.O.S.	blij	trots	boos	NERVEUS
depressief	enthousiast	GENOT	geirriteerd	wanhopig	dankbaar
MACHTELOOS	plezier	frustratie	delen	smart	opgelucht
EENZAAM	schuldgevoel	virtual reality	ENTHOUSIAST	VERBAASD	bezorgd
ongerust	paniekerig	respect	nerveus	CREATIVITEIT	woede
artificial intelligence	energiek	warm	wantrouwend	HELP	bezorgd
opgewonden	tevreden	BIJDRAGEN	trots	schrik	social media
ZENUWACHTIG	verwonderd	verontwaardigd	vastberaden	cool	gespannen

III

ALLES AUTOMATISCH

door

Maarten van Rooij

Personages

Patrick, 45
Bedienaar

Bianca, 40
Schipper

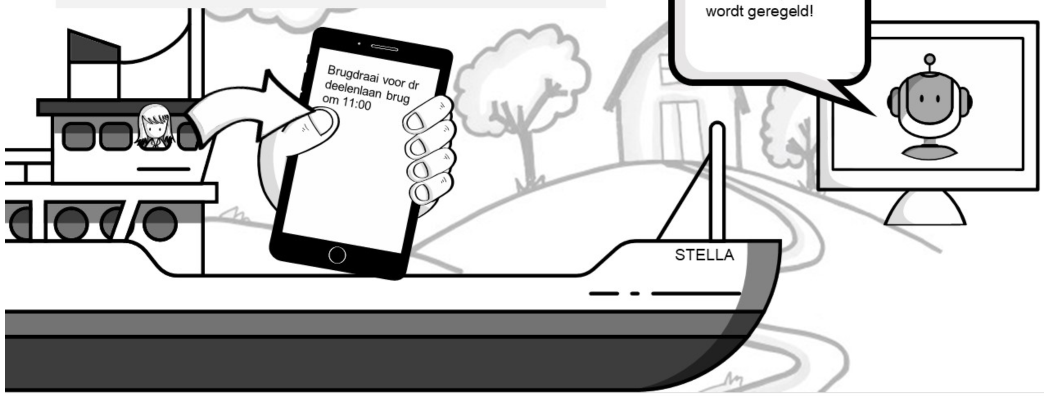
Robin
Systeem

Alles Automatisch

Scene 1: Aanmelden van een schip

Hoofdpersoon: **Bianca** | Pagina **02**

Het is maandagochtend. Bianca is onderweg naar Oirschot vanuit Oosterhout en vraagt een brugdraai aan voor de dr deelenlaan brug.



Alles Automatisch

Scene 2: Brugdraai voorbereiden

Hoofdpersoon: **Robin** | Pagina **03**

Het system heeft het schip in ivs next aangemeld en gaat het schouwproces starten. Patrick hoeft alleen maar te monitoren

Scene 3: Brugdraai

Hoofdpersoon: **Robin** | Pagina **04**

Het system opent de brug en monitort of het schip veilig doorvaart. Patrick kan zich met een ander object bezighouden.

Scene 4: Vaarweg is vrij

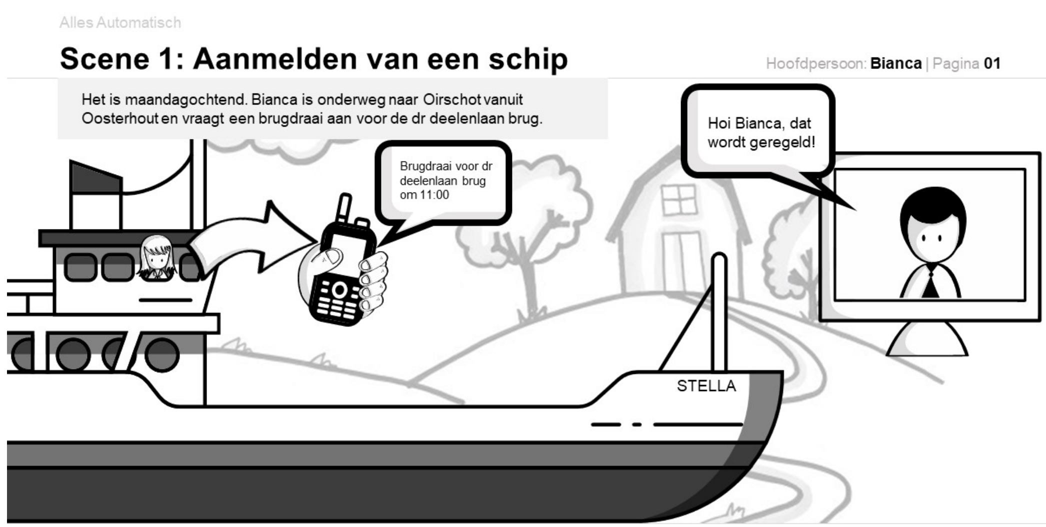
Hoofdpersoon: **Patrick** | Pagina **05**

Het system vraagt aan Patrick of hij de brug mag sluiten wanener de vaarweg vrij is.

ALLE CONTROLE

door

Maarten van Rooij



Scene 2: Brugdraai voorbereiden

Hoofdpersoon: **Patrick** | Pagina **02**

Patrick heeft het schip in ivs next aangemeld en gaat het schouwproces starten.

Scene 3: Brugdraai voorbereiden

Hoofdpersoon: **Patrick** | Pagina **03**

Tijdens het schouwen krijgt Patrick een melding en kiest ervoor Robin in te schakelen

SAMENWERKING

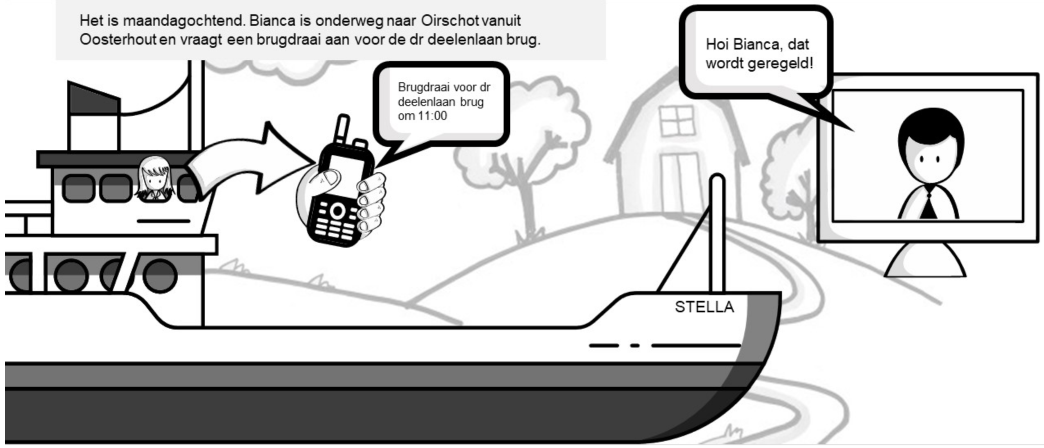
door

Maarten van Rooij

Scene 1: Aanmelden van een schip

Hoofdpersoon: **Bianca** | Pagina **01**

Het is maandagochtend. Bianca is onderweg naar Oirschot vanuit Oosterhout en vraagt een brugdraai aan voor de dr deelenlaan brug.



Scene 2: Brugdraai voorbereiden

Hoofdpersoon: **Patrick** | Pagina **02**

Robin heeft het schip in ivs next aangemeld en Patrick gaat het schouwproces starten.

Scene 3: Brugdraai voorbereiden

Hoofdpersoon: **Patrick** | Pagina **03**

Tijdens het schouwen krijgt feedback van Robin over de veiligheid

Alles Automatisch

Scene 4: Vaarweg is vrij

Hoofdpersoon: **Patrick** | Pagina **04**

Het system vraagt aan Patrick of hij de brug mag sluiten wanener de vaarweg vrij is.

IV

CONTEXTMAPPING

Een methode om de gebruiker te betrekken in het innovatieproces

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

TU Delft

INTRODUCTIE

Tijdens mijn afstudeerstage bij Rijkswaterstaat werd ik blij verrast door de positiviteit en energie die door heel de organisatie stroomt. Toen mij werd gevraagd mijn onderzoekstechniek te vertalen naar een bruikbare tool voor mijn collega's heb ik geen moment getwijfeld. Uiteraard wilde ik maar wat graag iets teruggeven aan de organisatie die mij heeft geholpen met het behalen van mijn masterdiploma.

Het onderwerp van dit boekje is een methode die *Contextmapping* wordt genoemd. Contextmapping is een methode die inzicht geeft in de leefwereld van de gebruiker. Het stelt de onderzoeker in staat om de emoties en behoeften van de gebruiker te achterhalen waardoor producten en diensten beter aansluiten bij deze gebruiker. Maar ook wanneer je de gebruiker wil laten meedenken in het innovatieproces kan Contextmapping heel erg goed worden toegepast.

Dit boekje is een eerste aanzet richting Contextmapping, wanneer je dieper in de methode wil duiken raad ik je aan het boek *Convivial Toolbox* door Sanders & Stappers[1] te lezen.

Ik wil in het bijzonder Ellemieke van Doorn en Karin de Jong bedanken voor de uitstekende begeleiding tijdens mijn afstudeerproject.

Veel leesplezier,
Maarten van Rooij MSc

WAAROM CONTEXTMAPPING?

De voordelen van contextmapping op een rijtje:

- Het legt een structurele link en bouwt intensief contact op tussen verschillende betrokken partijen, zoals bedrijf, klant en ontwerpteam
- Het schept een gedeelde taal en begrip tussen deze partijen
- Het genereert inspiratie, informatie en empathie op verschillende niveaus
- Het helpt relevante vragen uit te kristalliseren en legt blinde vlekken bloot
- Het kan vooroordelen over een gebruikers(groep) ontkrachten of juist bevestigen
- Het kan ervoor zorgen dat in een relatief korte tijd veel partijen gehoord worden
- Participanten zijn vaak gemotiveerd om langer mee te doen aan het onderzoek
- Het creëert draagvlak voor innovatie. Participanten zullen enthousiast zijn over voorgestelde oplossingen (omdat ze daar zelf aan hebben meegewerkt)

Pagina 5

WAT IS CONTEXTMAPPING?

Door middel van generatieve technieken is het mogelijk om latente kennis, kennis die mensen (onbewust) bezitten en moeilijk kunnen uiten, zichtbaar te maken. Deze technieken zijn vooral bedoeld om mensen iets te laten maken, en daar vervolgens over te laten vertellen. Wat de gebruikers maken tijdens de sessies worden artefacten genoemd. Tijdens contextmapping staat de gebruiker centraal en wordt hij gezien als de 'expert van zijn eigen ervaringen'. Contextmapping kan op het eerste ogenblik eng of spannend lijken. Wanneer er bijvoorbeeld gevraagd wordt om iets te tekenen zijn participanten vaak bang om voor schut te staan en is de kans aanwezig dat de resultaten oppervlakkig blijven. Het is daarom belangrijk om de gebruiker in kleine stapjes mee te nemen om er zo voor te zorgen dat kennis en ervaringen op diepere niveaus zichtbaar worden.

Hoe werkt CONTEXTMAPPING?

Contextmapping bestaat grofweg uit 4 stappen: gevoelig maken, generatieve sessie, analyseren en communiceren.

Gevoelig maken: Omdat participanten vaak nog onbekend zijn met de manier van onderzoeken is het belangrijk om ze alvast voor te bereiden op de contextmapping sessie. Dit kan door middel van korte opdrachten die de participanten voor de sessie toegestuurd worden. Deze opdrachten kunnen bijvoorbeeld vragen zijn over het onderwerp in de vorm van een dagboek of fotojournaal. Het is belangrijk dat deze opdrachten breed geformuleerd zijn en weinig tijd in beslag nemen.

Generatieve sessie: Tijdens de sessie zelf gaan de participanten aan de slag met het onderwerp. Er worden artefacten gemaakt door middel van zogenoemde toolkits. Het is belangrijk dat deze toolkits expressie faciliteren. Activiteiten die tijdens de sessie gedaan kunnen worden zijn bijvoorbeeld: herinneringen ophalen, verbanden leggen, gevoelens uiten of toekomstige ervaringen bedenken. Tijdens de sessie is het belangrijk dat er na de 'maak fase' ook een 'discussie fase' komt. Hierin vertellen de participanten wat ze gemaakt hebben en discussiëren ze over de uitkomst van de sessie. Zorg ervoor dat deze discussies worden opgenomen zodat je

Pagina 7

ze later terug kunt luisteren en analyseren.

Analyseren: doordat de artefacten en discussies rijke en gevarieerde data bevatten is het belangrijk om een bepaalde structuur aan te houden voor de analyse. Daarin zijn vier stappen belangrijk:

Fixeer op de data: zorg ervoor dat je na de sessie je eerste ideeën opschrijft en zorg ervoor dat je de opgenomen discussies transcribeert.
Zoek en wordt verbaast: omring jezelf met de artefacten en ruwe data. Kijk naar de verschillende onderwerpen die worden genoemd en waarom. Schrijf al je indrukken op en probeer thema's te vormen.

Patronen en overzicht: verbind alle thema's en kijk naar de patronen binnen de data. Maak daarna een overzicht van de relatie van de data.
Resultaten en conclusies: schrijf je conclusies.

Communiceren: het is belangrijk om je resultaten te communiceren met de participanten. Hierdoor zullen de participanten gemotiveerd zijn om mee te werken aan volgende onderzoeken en creëer je draagvlak voor je geopperde oplossingen.

MATERIALEN EN TECHNIEKEN

Contextmapping maakt gebruik van, zoals eerder genoemd, verschillende technieken. Dit omdat geen onderzoek of onderzoeksvraag hetzelfde is. Voor elk project zal er dus nagedacht moeten worden wat de onderzoeker uit de contextmapping sessie wil halen, hoe hij deze informatie wil verkrijgen en in welke vorm hij deze informatie wil hebben. Andere elementen waaraan gedacht moet worden zijn: dimensie, inhoud en tijd.

Dimensie: verschillende materialen kunnen mensen helpen om artefacten te maken in 2 of 3 dimensies. Denk aan pennen, potloden, stickers voor 2 dimensionale artefacten en lego of klei voor 3 dimensionale artefacten.

Inhoud: de inhoud kan variëren van functioneel aan de ene kant van het spectrum tot emotioneel aan de andere kant.

Tijd: leg je de focus op een bepaald moment of op een proces dat langer duurt.

Wanneer je hebt besloten waar de focus van je contextmapping sessie ligt is het tijd om je toolkit samen te stellen. Een toolkit bestaat uit verschillende materialen die associaties op kunnen roepen. Dit kan zoals eerder gezegd in 2D of 3D, woorden, foto's, onderdelen. Elk soort materiaal (figuur 1) en elke soort toolkit (figuur 2) heeft zijn eigen voordelen.

Figuur 1.

Emotionele toolkit: foto's en woorden worden gebruikt om herinneringen op te halen uit het verleden. Een achtergrond kan gebruikt worden om structuur te geven: goede herinneringen in de cirkel, slechte erbuiten.

Cognitieve toolkit: Simpele en symbolische vormen worden gecombineerd met woorden om de realtie tussen ideeën weer te geven. Bijvoorbeeld: wat betekent teamwork voor jou?

Poppenhuis toolkit: voor meer gefocuste sessies waar bepaalde concrete scenarios worden uitgewerkt.

Groep cognitieve toolkit: Wanneer je een toolkit ontwerpt voor groepswerk moet je ervoor zorgen dat alle elementen groter zijn zodat je ze samen kunt gebruiken.

Verhaallijn toolkit: voor het vertellen van een verhaal. De tijdslijn zorgt ervoor dat je verhaal chronologisch kunt vertellen. Stickers en woorden kunnen toegevoegd worden om bepaalde emoties uit te drukken.

Figuur 2.

HET PAD VAN EXPRESSIE

Veel projecten zullen over toekomstbeelden gaan. Maar hoe zorg je er nu voor dat participanten inhoudelijk over de toekomst gaan praten en dat wat ze zeggen van hoge kwaliteit is? Je kunt niet zomaar aan een participant vragen: "hoe ziet uw werk er over 10 jaar uit?". Want dan zal hij daar niet zomaar een zinnig antwoord op kunnen geven. Hier zijn binnen contextmapping verschillende manieren voor waarvan de eerste de gevoelig maken stap is die hierboven wordt benoemd.

Een tweede oplossing is het pad van expressie. Het pad van expressie is als het ware een reis door de tijd. Tijden de contextmapping sessie zelf zorg je ervoor dat de verschillende activiteiten focussen op verschillende momenten in de tijd. Het pad bestaat uit vier stappen:

Observeren en documenteren van huidige activiteiten: hoe ziet je werk er nu uit, wat speelt er op dit moment zijn vragen die je hier kunt stellen.

Focus op het verleden: hoe zag het werk er vroeger uit, wat speelde er vroeger etc..

Reflecteer op deze herinneringen: wat zijn de verschillen tussen vroeger en nu?

Richt de aandacht op de toekomst: wat zou je nog willen veranderen, hoe ziet de toekomst eruit?

Deze vier stappen kunnen allemaal een aparte opdracht zijn tijdens een contextmapping sessie. Bijvoorbeeld:

- De vragen tijdens het **gevoelig maken** richten op het huidige proces van een brug of sluis bedienaar.
- De eerste opdracht van de **contextmapping sessie** richt zich op het bedienen van vroeger.
- Tijdens de **discussie** die na de eerste opdracht volgt worden de verschillen besproken tussen het huidige bedienproces en het bedienen van vroeger maar ook wat er nu nog fout gaat.
- De tweede opdracht tijdens de **contextmapping sessie** richt zich op de toekomst van het bedienen, wat wil je als bedienaar nog verbeteren?
- Een afsluitende **discussie** bespreekt de ideeën.

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V

DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy". Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name: van Rooij
initials: M given name: Maarten
student number: 4756835
street & no.: Oostsingel 67
zipcode & city: 2612HD Delft
country: Nederland
phone: 0611960468
email: m.vanrooij@student.tudelft.nl

Your master programme (only select the options that apply to you):
IDE master(s): IPD / DfI / SPD (selected: SPD)
2nd non-IDE master:
individual programme: - - (give date of approval)
honours programme: Honours Programme Master
specialisation / annotation: Medisign / Tech. in Sustainable Design / Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair: Prof. dr. Snelders, H.M.J.J. dept. / section: PIM
** mentor: Dr. Egmond, R. van dept. / section: ID
2nd mentor: Dr. ir. Doorn, E. van
organisation: Rijkswaterstaat
city: Delft country: Nederland
comments (optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Procedural Checks - IDE Master Graduation

TU Delft

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair: Prof. dr. Snelders, H.M.J.J. date: - - signature:

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: ____ EC
Of which, taking the conditional requirements into account, can be part of the exam programme ____ EC
List of electives obtained before the third semester without approval of the BoE

YES (selected) all 1st year master courses passed
NO missing 1st year master courses are:

name date - - signature

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: APPROVED / NOT APPROVED
Procedure: APPROVED / NOT APPROVED

comments

name date - - signature

Initials & Name: M van Rooij Student number: 4756835
Title of Project: Slimme technologie en human factors voor detectie bij brugbediening

Slimme technologie en human factors voor detectie bij brugbediening

project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 08 - 02 - 2019

28 - 06 - 2019 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Rijkswaterstaat ensures safe and fluent flow of traffic on roads and over water. Part of this is the operation of bridges and locks. In the current situation bridge and lock operators determine whether there is a safe situation for bystanders to start the operation process based on direct sight and camera footage.
Despite well trained operators and carefully designed camera plans, there are still instances where conventional methods don't hold up in terms of safety.
As a graduate I am going to research how these operators can benefit best from smart technologies to increase safety for all bystanders. The research should not only focus on the technical possibilities, but also on human factors. Human factors within Rijkswaterstaat is understood to be the interaction between people and technology. The smart technology which is mainly considered are smart cameras.
Some of the successful experiments conducted within smart patrol have been found hard to implement within operational practice, while others were implemented quite easily. In order to guarantee successful implementation of future projects it is important to find which factors determine success and which dot not. In addition to the human factors for detection road users by bridge and lock operations,I am going to research which factors play a role in the successful implementation of smart patrol projects.
Prior to starting the graduation project I have specified the following stakeholders and their (expected) interests.
Operators (on site): As operator on site it is your job to ensure the area surrounding the bridge or lock is free of any bystanders and that the bridge or lock is free to open or close safely. As operator on site you have access to camera images provided by the cameras on and around the bridge or lock and you are in contact with the skipper. As traffic is constantly increasing operators are tasked with not only safety but also traffic flow, both on the road and on water.
Operators (off site): Different from the operator on site the operator off site is entirely dependent on cameras and can only judge the situation based off camera images and contact with skippers. As traffic is constantly increasing operators are tasked with not only safety but also traffic flow, both on the road and on water.
Apart from the two types of operators other stakeholders are: Pedestrians, car drivers, cyclists, leisurely skippers and professional skippers.

space available for images / figures on next page

introduction (continued): space for images

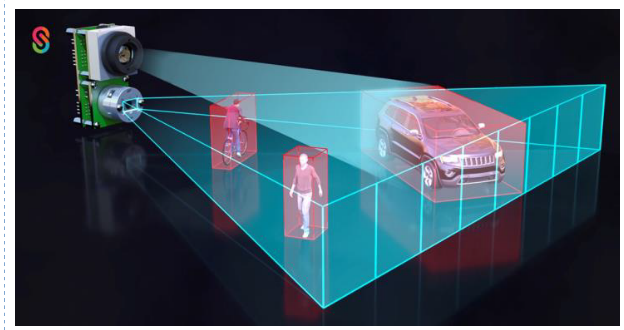


image / figure 1: Smart camera technology

TO PLACE YOUR IMAGE IN THIS AREA:
- **SAVE THIS DOCUMENT TO YOUR COMPUTER AND OPEN IT IN ADOBE READER**
- **CLICK AREA TO PLACE IMAGE / FIGURE**

PLEASE NOTE:
- **IMAGE WILL SCALE TO FIT AUTOMATICALLY**
- **NATIVE IMAGE RATIO IS 16:10**
- **IF YOU EXPERIENCE PROBLEMS IN UPLOADING, COVERT IMAGE TO PDF AND TRY AGAIN**

image / figure 2:

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Is there a way to make the operation of bridges and locks safer through the use of smart technologies? What kind of signals are most effective in supporting the users of the bridges and locks and how and when are they delivered in order to create a safer and more effective scenario regarding bridges and locks. In order to answer these questions Rijkswaterstaat has specified the following facets of the project they want to see researched:

preliminary research smart technologies: assessment of suitable smart solutions and human factors when handling said technologies, including 'out-of-the-loop' problems (An out-of-the-loop performance problem leaves operators of automated systems handicapped in their ability to take over manual operations in the event of automation failure (Endsley & Kris., 1995).)

Which type of technology is best used in which situation and what kind of signal is most effective in supporting the users of the bridges and locks

Preparation and execution of simulation in collaboration with the smart patrol project.

Evaluation of the simulation and a written advice concerning the future of the project.

In order to guarantee successful implementation of future projects I am going to research which factors determine the success or failure regarding the implementation of innovation projects.

Endsley, M. R., & Kiris, E. O. (1995). The out-of-the-loop performance problem and level of control in automation. Huma

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

I am going to research in which way smart innovations can contribute to the safety of bridges and locks. Then I am going to create a simulation where these innovations can be tested and evaluated by operators and other stakeholders of interest.
In addition to this I am going to research which factors determine the success or failure regarding the implementation of innovation projects.

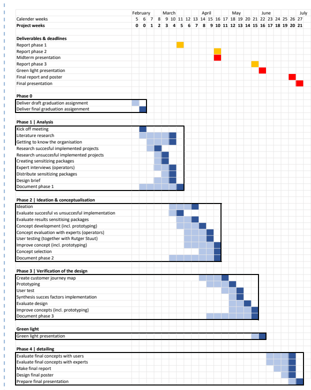
I envision my solution to be twofold:
Firstly I am going to create a set up in where operators benefit most from the proposed smart technologies.

Secondly I am going to write a recommendation on how to successfully implement an innovation project within Smart Patrol.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 8 - 2 - 2019   28 - 6 - 2019 end date



Phase 1: Analysis
Literature and desktop research as well as experts interviews will be used to create a comprehensive view on how all stakeholders experience the opening and closing of a bridge. Next to that I will start to search for successful and unsuccessful implemented projects. During the interviews I will also address the success factors of implementation. Finally I am going to use generative research tools in order to reveal latent knowledge of the users of the system. The final deliverable of phase 1 will be a design brief (scope of the project, requirements, the stakeholders and their needs and the design goal) and an analysis of the structure of Rijkswaterstaat.

Phase 2: Ideation and conceptualization
The design brief will be the starting point of ideation, which will include mock ups to verify design decisions, user interaction with the system and user testing. I will be comparing the success factors of earlier researched projects. The final deliverable will be a concept that will be tested in the field and a journey map of all relevant users.

Phase 3: Verification
A Testable prototype will be made to verify the concept with the intended target group (Operators & other users). A synthesis will be written on the success factors of project implementation.

Phase 4: Detailing
Insights of the User test will be implemented in a final iteration phase. The advise on implementation of innovation will be finalised.

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

The interaction between man and technology has always been fascinating to me. I think that, if technology is used in the right way, it can extend human capabilities and enhance experiences. This is most effective when used to detect dangerous situations and create a safer environment. For many (me included) it is self-evident that we have access to such a well organised and safe road- and water- network. This project offers me a great opportunity to contribute to this safety and it will allow me to experience working in a professional environment.
As this project concerns many different stakeholders, who have very distinct routines and habits in their work, I want to use context mapping to involve stakeholders as 'experts of their experience'. During my master I have used context mapping in several courses, but during my graduation project I intend to use context mapping in a professional environment.
I am also intrigued by complex organisational structures and how they handle innovation. I have been told that innovation can be quite slow in structures like these. This for me is all the more reason to try and add value in the field of innovation management.
Finally, I want to experience working in a professional environment. Rijkswaterstaat is a large organisation with a large social responsibility. I am thrilled to experience working for an organisation which adds value to society.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.