Telling a story of the future: Using storyboards and narratives to evaluate anticipated experiences

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ABSTRACT

Evaluating User Experiences early in a development process can save both time and money by pro-actively mapping out user needs and behavior patterns. However, since most well-known UX-evaluation methods applies during or after user interaction, due to the "second-order" design problem of experiences being a byproduct of interaction, there is a desire within HCI for more early-stage UX-evaluation methods that could be applied to concept stages as well. This paper investigates the experiential evaluation of a storyboard and narrative through the Anticipated eXperience Method (AxE) and discusses how it compares to a re-iterated high-fidelity prototype created in Figma. The process of this study is described out of the context it has been executed in, which is together with the company Scania AB at their cabin production facility in Oskarshamn, Sweden. The study explores what insights can be found from evaluating anticipated user experiences in early concept development and how these insights can apply towards further development of a touchpad user Interface. The underlying foundation of this study has followed the approach of a design-inclusive UX-research project, which heavily incorporates design activities into the process of conducting research. Thus, the storyboard, narrative and interactive Figma prototype have been created along the process and takes center stage in the investigation of experiential evaluation at early stages of interactive product development.

CCS CONCEPTS:

 Human-centered computing • Human computer interaction (HCI) • HCI design and evaluation methods • User studies

KEYWORDS:

User experience evaluation, design thinking, user interfaces, experience prototypes, anticipated experiences

1 INTRODUCTION

When considering factors such as cost and effort in the development of interactive products, it is well known that getting feedback at an early stage in development makes it easier to make cost-efficient changes [30, 40]. Finding issues with the qualities of user experience after the product is fully developed can be very costly, which is why practitioners and developers have a strong need to gain insights into user experiences early [40]. Using prototyping as a tool to gain insight of user experiences and usability issues is for that reason an important part of interactive product development and the design thinking methodology [7, 13, 14, 19, 28, 30]. There are many different ways of prototyping , but one of the fastest and most cost-efficient ways of visualizing a concept is by sketching it out [8]. However, anticipating future needs can be difficult for user's and researchers alike in situations when new technology is developed [21]. According to von Hippel [21], this issue is most noticeable when it's concerning very novel products or products characterized by rapid change such as new technologies. Since user experiences are often considered a byproduct of interaction, it can also prove difficult to extract valid insights from purely viewing a concept without having the option to try out a working product [7]. Sketching as a method of prototyping might therefore be complicated when the goal is to get feedback of needs and user experiences.

This study was conducted with employees of the quality inspection unit "Quality Gate" at the vehicle manufacturing facility of Scania AB in Oskarshamn, which was undergoing a rapid digital transformation of tools and work processes. The employees at Quality Gate have participated in this study to lay a foundation of user needs and behaviors to aid the transition between an outdated, analog pen and paper, work process into a digital-aided work process which relies on a touchpad and a digital user interface. While the touchpad is not considered a novel invention by today, the employees of Quality Gate did not have

any previous experience with using one in the context of work. The rapid change and novelty of introducing a digital tool to replace the analog process with paper documents have similarities in what von Hippel[21] describes as a problem. To account for this problem, the approach of evaluating expectations through the method of Anticipated eXperience evaluation (AxE) [16] in combination with storyboards and narratives is proposed in this study, to investigate how it can contribute to developing a product that suits the user's needs in a situation where a rapid change of technology occurs.

According to Vermeeren et al. [41], there are only a few methods to choose from when evaluating user experiences before interaction occurs. As such, there is an expressed desire within the field of Human-computer interaction (HCI) to further investigate the use of early-stage evaluation methods in the UX-field [2, 3, 41]. Thus, this study aims to investigate the usefulness and limitations of evaluating experiential qualities at the conceptual stage in development. The main outcome of this study is to contribute knowledge towards experiential evaluation methods in UX-research and HCI.

1.1 Research question

How can experiential design insights gathered from anticipated user experiences guide future design decisions: A case study of a digitalization process at a vehicle manufacturing facility.

2 BACKGROUND AND RELEVANT WORK

2.1 Experience prototyping

Buchenau and Suri [7] explores the means of prototyping towards understanding user experiences with the term "Experience Prototyping". They describe classical prototypes as representations of unfinished designs while "experience prototypes" are aimed towards artifacts made with the intention of understanding, communicating, and exploring experiences. By "experience prototypes" they include all kinds of representation that can enable designers and users to get insights into the experiential qualities [7]. However, Buchenau and Suri also state that it's important to consider experiences as subjective which requires active participation by the participant to be able to interpret and understand the sensations themselves. The subjective nature of experiences have been discussed in previous research within HCI and it is a common conception that experiences take form first after interaction [1, 26, 36, 37] . Lankoski and Hopalainen [26] describes this phenomenon as a "second-order" design problem, meaning that it's not solely the

designer who is responsible for creating the experience, but the users too when they interact with the product.

Sketches, storyboards, videos and scenarios can be considered as experience prototypes due to their representation of user experiences [7]. However, Buchenau and Suri imply that they mostly focus on communicating and demonstrating the experience while not providing the ability for the participants to try it out themselves [7]. This is a problematic statement if you want to be able to do UX-evaluation at even earlier stages of development on conceptual design ideas which have not yet been prototyped. It is common to see sketches, storyboards and narratives used for ideation purposes and concept creation, especially in a design thinking project as a part of the Ideate & Prototype phase [14, 28]. Gegner and Runonen [16] describes that these types of communicative experience prototypes can be evaluated through the notion of anticipation and imaginative futures. However, in situations where novel inventions or rapid changes in technology occurs, future needs can be notoriously hard to investigate or express by the user [21].

2.2 Evaluation of User Experiences

Many aspects of usability and user experience are intertwined as the level of usability often affect how the user experience is perceived. According to Law and Abrahão [27], User experience evaluation methods has evolved out of prior usability evaluation methods since they are so closely connected. While historically, the difference between usability and user experience have been unclear to many within interactive product development, but more recently it's been known that delivering a product with good usability is not enough as competitors might provide a better experience based on subjective hedonic needs [34, 40, 41]. This focus has been shifting in the traditional field of HCI, as it initially focused on interactive products mainly by exploring task-oriented problem solving and optimizing efficiency [2, 41]. This shift of perspective has changed from only investigating the pragmatic qualities of usability toward also focusing of hedonic qualities, such as pleasure and aesthetics [2].

2.3 Current state of UX-evaluation methods

Today, there exists a wide variety of UX-oriented methods for evaluating and gathering insights about the overall perceived experiences of users. Some of which can be conducted during the development phase and some of which can be conducted after the product is fully functional, but fewer that can be used before the user interaction [2, 3, 16]. Popular approaches for conducting UX-evaluation might include surveys, observations, interviews or

questionnaires with UX-attributes that are ranked on a scale [18, 32, 41].

According to Bargas-Avila and Hornbæk [2], Anticipated use is an important part of the research field regarding user experience (UX-research) and is also part of the ISO-9241-210 definition of Human-centered design for interactive systems [22]. Anticipated use is meant towards users' expectations about products and measurements of UX before interaction occurs [2, 3]. Despite of that, the proportion of UX-methods that can apply before interaction is much smaller than the methods that can be applied during and after interaction[2, 3, 41]. Vermeeren et al. [41] collected 97 UX-evaluation methods in an effort to establish an understanding of the current state and development needs of the evaluative UX methods which can be accessed on internet[1], gathered from the previous efforts to collect UX methods by EU projects ENGAGE from 2004-2006, HUMAINE from 2008, Isomoro et al. [23] and the book *Designing Pleasurable Products* by Patrick W. Jordan [24]. This collection shows clearly that the proportions of evaluative UX-methods that apply to concept stages are noticeable less than at later stages., out of those 97 methods there was only 37 methods that could be used in the early development phase, and of those 37 methods there were only 22 that was available in the non-functional prototype phase.

3 METHODOLOGY

3.1 Anticipated eXperience Evaluation (AxE)

Gegner and Runonen [16] draws inspiration from a research project by Van den Hende et al. [20], where they explore the topic of how concept narratives could be used to collect customer input based on imagined benefits behind technologies. Van den Hende et al. [20] discusses an evaluative approach that utilizes visual stimulation by presenting narratives together with either drawings, animations or pictures to customers in order to evaluate future possible scenarios. The usefulness of this approach is stated to work towards "standard" customers and not only expert groups, which is an advantage since they are usually easier to find [20]. An interesting insight that Van den Hende et al. came across in their study was that the visual medium of drawings had better transportation and comprehension than animations or pictures in presenting a concept, which was unexpected since most companies usually presents concepts through flashy animations or movies [20]. According to Buxton [8], sketches allow for more imaginative interpretations due to their ability to inherit qualities

of ambiguity, which might tie into the findings of Van den Hende et al. since their method is aimed at enabling imagination and free interpretation. Gegner and Runonen [16] adapted the approach of Van den Hende et al. [20] to include the ability to evaluate user experiences at the same early concept stage of the development process, the method is called Anticipated eXperience Evaluation (AxE).

The AxE-method is arranged by first briefing the participants about the concept and presenting descriptions, narratives, and visual stimuli [16]. Thereafter, the evaluation starts after the participants have performed a warm-up exercise and understands the instructions. The participants will thereafter associate the concept with a couple of contrasting image-pairs, which is supposed to help the participants to express experiences, attitudes, opinions, and beliefs toward the presented concept. During the evaluation, the participants will also be interviewed about the associations and interpretations they make of the image-pairs. During the evaluation process the interview is transcribed for later analysis. The transcribed statements are then divided into different segments, which is a way of performing content analysis towards categorizing perceived product features with associated attributes and anticipated consequences [16].

3.2 Design-inclusive UX research

The approach of conducting research together with design has been widely discussed within the field of HCI as a way to combine the two aspects of design practice and research in order to find an alternative to traditional scientific studies [25, 42, 44]. The emergence of design research grew out of the necessity to be able to explore the approaches and methods that design practitioners would use to solve these types of problems [44]. Design knowledge has been found to also emerge from the actual process of designing and has therefore highlighted the importance of the additions to the terminology surrounding design research with terms like Research through design (RtD) and constructive design research [25]. According to Koskinen [25], RtD refers to the act of making design artifacts while acknowledging the possible embodiment of knowledge within that process or design material. The concept of RtD and constructive design research has promoted the idea of *Design-inclusive UX research*, which is presented by Vermeeren et al. [42] as a way to include the field of UX to the approach of combining design and research to further build the knowledge bank for UX research. Vermeeren et al. [42] defines *UX research* as research focused on expanding the

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[1]https://web.archive.org/web/20210422071144/http://www.allaboutux.org/all-methods

knowledge within the field of UX design. Design activities take the center stage as well when engaging in Design-inclusive UX research which can be useful for studying aspects of experience and interaction by constructing prototypes or testing out new approaches, methods or techniques [42].

3.3 Research ethics

This study has been performed with awareness to the European Academies (ALLEA) publication of "The European Code of Conduct for Research Integrity" [39] and the internal guidelines of Scania ISEC code of conduct. The ALLEA publication states the four fundamental principles on which ethical research should be conducted. The principles of reliability, honesty, respect, and accountability have been followed by safekeeping sensitive data such as identities of anonymous participants, sending out consent forms for all types of data collection and being transparent with the goal and outcomes of the research, as well as investing the integrity of the data collection for unintended bias.

Collaborative working has been a key aspect of this project, which is why it has been important to respect the integrity of stakeholders and participants alike and promote fairness towards all included parties. The consent forms which were sent out to all participants also provided the option to opt out at any time and withdraw from the study. The recorded data has been treated to ensure confidentiality and has been coded to not include any identifiers to avoid any leak of sensitive information during data analysis.

The integrity sensitive information of the stakeholders has been followed through a process of internal review to ensure that no information that could potentially hurt or affect the organization negatively will be published publicly. Scania has given consent for the content in this article to be published.

4 CASE STUDY: SCANIA OSKARSHAMN

This study was conducted toward the project case: *"UX as an enabler in production"* at the vehicle manufacturing facility of Scania in Oskarshamn, which mostly produces and distributes semi-truck cabs for the Scania brand [15]. The project case was done in collaboration with Emma Dahl from Linköping University, the IT-department INBC and the Quality Gate unit MCQAC at Scania. The manufacturing facility consists of several production units, robots, IT-systems, and departments that all must work together in unison to produce the required number of vehicles per day. The employees at this manufacturing facility can be divided into white-collar and blue-collar workers depending if they are working on the production floor or not. The production flow is divided into different sections that manages different parts of the

vehicle assembly from pressing the metal, painting the bodies, and assembling the parts. At the department of MC (Manufacturing Cab) there are several lines that assembles the different parts that make up the complete vehicle body, and at the end of each line there is a quality inspection unit called QG (Quality Gate) (see Figure 1).

Figure 1. Scania Oskarshamn cab manufacturing production line, image from [38].

The Quality Gate unit is undergoing a digital transformation in which a digital application will eventually replace the analog work process of reporting deviations and filling out work orders with pen and paper. The analog work process also affects surrounding work habits of handling and writing on paper, printing out paper, throwing away paper and keeping track of paper. The aim of the project case was to support the transition between the existing analog work process to a digital assisted work process, in which a touch tablet and a user interface could replace the old-fashioned pen and paper (Figure 2). The participants of this study (28 participants) all work at Quality Gate either as team leaders or as quality inspectors, apart from the participating stakeholders at the IT-department whom I will not be referring to as participants. Since the participants of this study did not have any prior experience in using digital tools and touchpads in the same context, it was difficult for them to make any direct comparisons to the upcoming digital transition. Instead, the participants provided their expectations of the future implementation of the digital user interface and touch tablet. This provided a rich context in which a qualitative User Research and UX/UI-design process could be performed and analyzed together with the anticipated experiences and preliminary insights of current user needs and behavior patterns.

Figure 2. Example of a work order, which is one of several paper documents included in the Quality Gate work process.

4.1 Preliminary user research phase

The first stage of the study mainly focused on the activity of understanding the situation and environment surrounding the users/participants included in this study to know what type of product that would be designed and what it was going to be used for. The practical structure of this study was inspired by design thinking, and this phase could be referred to as the empathize phase in design thinking methodology [14]. A contextual understanding of the user's environment is important for designing user centered products, which in this case was found through interviews, stakeholder meetings, observations, and surveys. These methods are recognized and standardized in user centered design (UCD) methodology [19, 30].

Getting a first-hand view of the users' work environment was very important since the scale and complexity of the facility is hard to understand by explanations only. This made it easier to gain an understanding of the context in which the users were situated in. Apart from seeing and experiencing the users' environment and the overall processes of their production facility, it was also necessary to gain insight of user needs and pain-points. This was done by triangulating information through different methods: Observation, Interview and Survey. The main purpose of

triangulation is to rule out information that isn't coherent and improve the validity of collected data by combining different methods towards the same research topic [19]. The number of participants for each study was:

Survey: 28 Participants from MCQAC, 10 women and 18 men, average years of employment 19,5 years at Scania.

Interview: 4 participants from MCQAC, 2 team leaders and 2 quality inspectors, 60 minutes each

Observation: 4 observations during the morning shift and evening shift at the production facility.

4.1.1 User research outcomes

The user research provided context and information about the user needs and pain-points to guide the making of the storyboard and narrative, as well as the final high-fidelity prototype. However, this information covered 28 participants, whose needs and behaviors did not fully match each other. Some participants also had a different work role as team leader. Finding a design solution to a problem with inconsistent definitions reflects the perspective of "wicked" problems [11, 35, 44], which in this case corresponds to no true/false solutions based on conflicting user needs. Designing a product that prioritizes every need and every individual opinion of users can result in unfocused or incoherent solutions [19]. But by encapsulating and reviewing the most critical behaviors that covers the most necessary and important factors it is possible to cover the majority of the users' needs, which can be achieved by creating Personas [17].

The user-centered design method of creating Personas, created by Alan Cooper in the late 90's, is widely recognized within the cross-disciplinary fields of HCI and IxD and is used as a tool to visualize and communicate a representative end-user while also enabling a design team to interpret characteristics and personality traits towards potential user needs [5, 9, 10]. The method of personas combines gathered insights, behavioral patterns and user needs with personal and biographical information to create fictional archetypes that is representative of several participants [17, 19, 30, 34]. The archetypes can consist of short descriptions or scenarios, personality traits, needs and pain-points, attitudes and a profile picture [17, 19, 30]. For this project, three different personas were created (see Figure 3), along with additional collections of insights gathered from the user research, to better understand how the users and guide the creation of the storyboard and narrative. The additional collection of insights was analyzed through affinity diagrams, which according to Marsh [30] is a method of organizing patterns of data.

The user research showed that some user's had mixed emotions about the change of work habits that the digital transformation would bring. However, it was difficult to fully comprehend the concerns since the users were not entirely sure about what aspects would be problematic, because they found it difficult to express or imagine the outcome of the digitalization beforehand. But the most prominent user needs that were brought from the user research into the ideation of the concept were: simplicity of UI, reducing the anxiety of making mistakes, reducing repetitive tasks, avoiding handling paper, and maintaining good workflow.
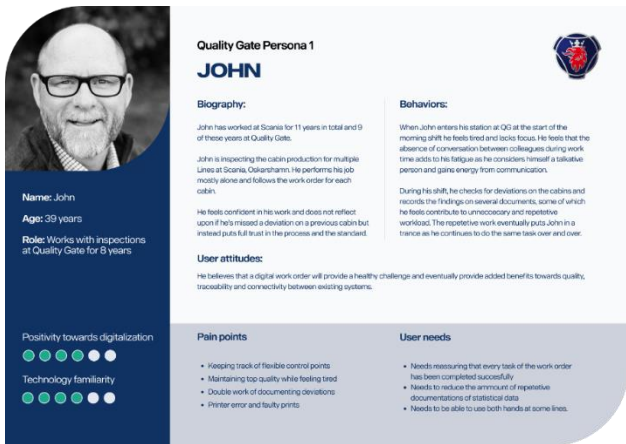

Figure 3. Persona archetype of a quality inspector. Number 1 of 3

5 EVALUATION OF ANTICIPATED USER EXPERIENCES

5.1 Narratives and storyboards

Based on the user research, a concept depicting the digital transformation was created in the form of a storyboard (see Figure 4) paired with a narrative. The storyboard and narrative were created with a *second-person* perspective to instill better immersion and open for better subjective interpretations. A *second-person* perspective refers to a perspective directed at the reader, for example *"you are walking,"*, to put the reader into the shoes of the person in the story. The actual drawings in the storyboards are kept simple enough to leave room for interpretation, but clear enough to understand the scenario and the situation. Inspired by the words of Buxton [8] who said that sketches inherit ambiguity which leaves room for interpretation. This was exactly what was sought after, imaginative interpretation. The narrative was also kept relatively simple, describing each picture in the storyboard scenario with 1-5 sentences. The basis of the storyboard and narrative is a depiction of a standard routine for Quality Gate inspectors when they inspect a cabin for quality deviations, but this time with a digital touchpad replacement instead of handling the paper documents. The story also hints the changed work habits that would come from digitalizing the work process, some of these changes reflect the team leaders and stakeholders' vision for ensuring better quality and efficiency through minimizing the amounts of available choices and movements into a more rigid work process.
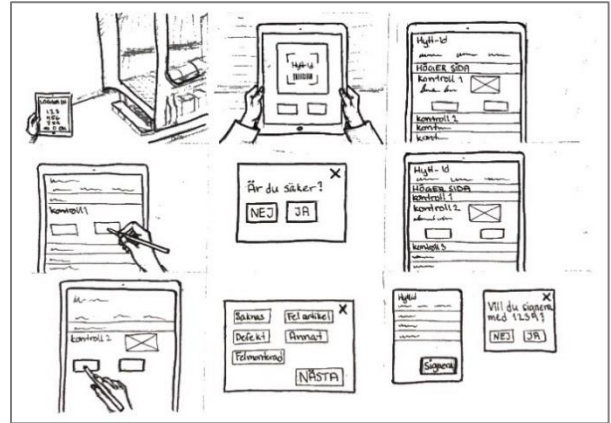

Figure 4. Storyboard that depicts the process of inspecting a cabin with the help of a digital touchpad

The storyboard and narrative was then evaluated through the AxE-method, as described by Gegner and Runonen [16], to see if it what new potential insights could be gained.

5.2 Evaluation process

The participants were first introduced to the Anticipated eXperience evaluation (AxE) method, as described by Gegner and Runonen [16], with an instruction sheet and 2 example tasks. One example task was explained and presented by the facilitator and the second example task acted as a test for the participant to make sure they understood the task and why it was performed (see Figure 5). The AxE-method is based on assessment through image-pair association, which can seem like a fussy and confusing method without knowing what type of answer is acceptable. Since this activity also requires the participants to really dig deep into their creative and imaginary side, it can be uncomfortable for some to take that step from pragmatism and utility into the more fuzzy and unstructured approach of free interpretation, especially if they are not used to this type of activity. Therefore, it was important to highlight that there were no wrong answers and that the participants should feel comfortable with expressing their subjective interpretations in their way.

("I interpret these images as fast and slow... It feels like a slow and tedious process to have to do this and that because of....")

Figure 5. Example task to explain the process for the participants

The contrasting image-pairs were chosen carefully through a brainstorming session where 10 attributes or functions acted as the starting point for what the images was going to represent. Each attribute or function was chosen based on the anticipated changes that the future concept would affect. An anticipated change with the digitalization of work orders was for example the elimination of so called "temporary and flexible inspections." These types of inspections are temporary tasks on the work order that pops up irregularly and requires extra attention, which the user research uncovered as an existing pain-point regarding interferences with the workflow. This anticipated change for instance was given the tag "structured-unstructured" and was thereafter paired with related images (see Figure 6). However, this grounding of image-pairs was only known to the activity facilitator and not the participant to avoid impacting the answers. The reason why the images were grounded in this way was to try and direct the answers towards relevant topics for the development process. The AxE-activity included 10 image-pairs in total.


Figure 6. Image-pair with contrasting attributes, structured – unstructured

During the assessment of each image-pair a short interview was held to get the participant to explain why they chose to associate the concept towards one image more than the other. This mid-assessment interruption also allowed for follow-up questions to further stimulate reflections and thoughts from the participant. The image-pairs were grounded on the following attributes, translated from Swedish to English:

Structured – Unstructured
Agile – Clumsy
Challenging – Relaxing
Predictable – Unpredictable
Conform – Rebel
Complicated – Easy
Robust – Fragile

Frustrating – Enjoyable
Clear – Confusing
Tedious – Concise

However, it was not necessary by the participants to make the same subjective interpretations of the images. The images were only grounded in these written out attributes in hope that it would help to keep the discussions within relevant topics that could produce useful insights and aid the development process.
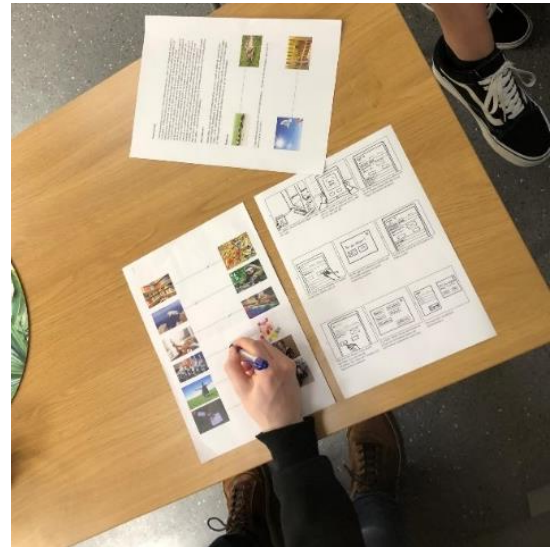
Figure 7. AxE-evaluation in progress. Concept with storyboard and narrative in the image to the right

5.3 Data collection

In the AxE-evaluation activity, there were four participants who volunteered from Quality Gate. Two of these participants were team leaders and two were regular quality inspectors. Each session lasted around an hour and was performed individually by all participants. Because of the unfamiliarity of the approach and requirement for openness and creativity by the participants in this evaluation activity, a certain uncomfortableness was observed in the first participant. It was also due to the participant's awareness of the audio recording device on the table. The audio recording device was only there to help the process of transcribing the interviews and statements at a later stage, but since this would hinder the free expressions of the participant and create a performative environment it had to be removed. Creating a safe space for expression seemed very important for this activity. This reflects the importance of being aware of the social context and the quality of relationship between facilitator and participant in participatory approaches, which is mentioned in previous HCI research [4, 12].

There was also a slight variation in the concept material toward the last two participants to see whether a less nuanced narrative would be more engaging for free interpretation and imagination. The narrative for the storyboard was shortened by 2-3 sentences per image to leave more room for ambiguity. This resulted in a slightly more openness towards the presented concept, but since there were only four participants in total this could be hard to confirm. However, the answers were a little bit more imaginary and creative after the change to the narrative. As Dearden and Rizvi [12] mentioned, a too polished product might create a tunnel vision for the viewer, leaving less room for imagination of alternatives.

The AxE-evaluation activity was analyzed through Gegner and Runonen's[16] analytical framework (see Figure 8). At first, all the transcripts and notes were collected and sorted through thematic analysis. This resulted in a collection of participant statements that were color coded by perceived product feature. The product features could be sorted under the categories: Content, interaction, functionality, presentation or general. The last mentioned category "General" was where statements that could not be designated towards any specific feature were collected, as according to Gegner and Runonen[16] . The sorted statements would thereafter be further sorted into subcategories of either pragmatic or hedonic attributes based on the impressions that the participants experienced. This would also expose whether the participants showed liking or disliking of the part of the concept that reflected the statement. The pragmatic attributes indicated utilitarian needs and usability issues while the hedonic attributes indicated either evocation of memories, stimulation of motivated use and favorable concept identity. The last addition to the categorization of statements were the anticipated consequences of the concept which classified the judgments of the concept, which could be placed either as a behavioral change or towards attractiveness and enjoyment. All statements and interview snippets that were considered important but could not be sorted into any category was simply placed into its own category of "meta."
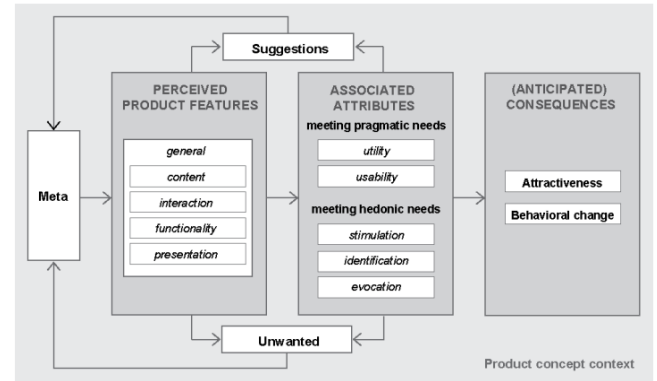

Figure 8. Analytical framework of Anticipated eXperience Evaluation. Picture from [16], page 7

6 DATA ANALYSIS AND RESULT

6.1 Analysis of anticipated experiences

The total amount of statements that were relevant and sortable into categories was 24. Of these 24 statements, 9 were evaluated as negative judgments of anticipated experiences, 11 were evaluated as positive, 2 were labeled as both positive and negative, and 2 were neither positive nor negative. The participants all answered in Swedish, so the presented results will be a translation. The first segment of the statements references to what the participants interpreted behind the image-pairs.

The first set of interesting results are the negative judgments of anticipated experiences (see Table 1). These showed that there were concerns with the future implementation of a digital tool to replace the analog work process as it is today. This problem was already known from the User research and observations done prior to the AxE-evaluation, but it was difficult to pinpoint these concerns to specific features or qualities. Now, when the participants had the opportunity to explore the concept themselves through interpretation and imagination the concerns became more visible. The answers must be re-interpreted by the facilitator in some regards. Even though follow-up questions are asked to every statement, there remains some space between what the participants are expressing and to what specific part of the concept it concerns. It was possible to extract some insights about potential issues to avoid in the design process from the negative anticipated experiences. These statements highlighted the need for focusing on the usability needs of navigation, exit strategies, simplicity, and the ability to erase and edit content.

Product feature	Attribute	Statement	Valuation
Meta	Unwanted	*"The checkpoint binder makes no difference, [you can be] insecure regardless of an image. You already know the checkpoint binder when you inspect a cab, you have studied it before."*	Negative
Function	Unwanted, Suggestion, *(enforced process)*	*"You have no choice /---/, you do what I tell you. It's better to have more options. Not only at (production line) position. You have different movements during checks, there is a lot of variation"*	Negative
Function	Pragmatic, Unwanted *(Exit strategy)*	*" If the eggs are in the box, nothing happens. Pen strokes can be erased, you are in control and can come back and change. On the iPad, you do not have the same control. If someone comes by and says hello, then maybe I mess up."*	Negative
Function	Bad usability, Unwanted, suggestion *(Exit strategy)*	*"Carbon dioxide, gas, a place where you wait too long, you stand there more than you need, it leads to stress /---/ What happens if the iPad is not updated? We forget, it's normal, we can forget to post things. Greater risk of it going wrong."*	Negative
General	Pragmatic (usability) Suggestion	*"Chaos / Order. We have so many inspection tasks, so it feels like a lack of time. But it can work if you remove some tasks"*	Negative
General	Behavioral Change Non stimulative, not attractive	*"Calm / not calm. It's a new way of working"*	Negative
General	Behavioral change, Identification	*"[I see] A lot of paperwork or scattered colors. It will be like this [Points to scattered colors] in the beginning, scattered. Older people may have never held an iPad before."*	Negative
Interaction	usability	*"Searching for the route / knowing where to go. You have to find where all the functions are in the beginning."*	Negative
Interaction	usability	*"Difficult to find the location or knowing where to go. It's going to be difficult to find (information) in the beginning"*	Negative
Function	Behavioral change, Identification, Unwanted	*"Fast and slow. Fast once you have learned. I think it will be easy to learn. Checkpoint time, many will be annoyed at it. (" Are you sure? ")*	Negative/Positive
Function	Stimulation, Pragmatic, Behavioral change	*"Relaxing - you do not have to run away to the printer, or pick up a new work orders, as long as nothing lags. Technical problems might occur still. If you think it will be a smooth process, then it will go to hell"*	Negative/positive
Content	Pragmatic usability *(overview of WO)*	*"You are standing in line, hot, stressful, but you are getting closer, it is important to see the goal. The goal is that I have done my job right and well. Done right from start to finish. [but if] You have a lot of options, it takes time, we do not have time for that on production line. "*	Not applicable
Function	Suggestion	*"You can go anywhere, find your own path, create your own path and you have a freedom to do it. You have a freedom that you can go in any direction, to any destination. /---/ Choice is important for work orders. "*	Not applicable

Table 1. Statements including concerns from the anticipated experience evaluation

While the negative judgments of anticipated experiences highlighted design concerns worth investigating, the positive judgments could be seen as validation for the presented design ideas (see Table 2). The collected statements of positive judgments can also be seen as user expectations. This might indicate how the users perceive certain features and expect them to work like. This could be useful information to set up goals to meet the users' expectations. The overall positive statements bring up expectations such as: A digital application to replace paper is going to make the work process more structured, eliminate unnecessary tasks (such as printer related tasks) and make the work process more relaxing. However, the statements which have both positive and negative valuation describe how useful changes

might still include downsides, they also highlight the need for good learnability. An example of a statement directed towards learnability is: *""Fast and slow. Fast once you have learned ".* This Negative/positive statement can be compared to the all-negative statement: *"/---/It's going to be difficult to find (information) in the beginning"*. They both refer to learnability, the difference is the attitude towards it. The statement regarding learnability highlights two things, firstly that not all users' have the same level of skill towards digital equipment (touchpads), and secondly that it will be a period of learning the tool that has to be accounted for in the beginning to ensure that safety and efficiency can remain high.

Product feature	Attribute	Statement	Valuation
Function	Stimulation	*"Queue that goes by slow, [the other picture] has a better flow. A bit like the coffee cup. You cannot get it completely perfect."*	Positive
Function	Stimulation	*"Stable, as long as there is battery (in the touchpad). Paper is more of a hassle. (Printers) must have toner, etc. If you do not check the pop-id, it's easy to take the wrong cab. (Digital) is more stable."*	Positive
General	Stimulative, challenging,	*"Freedom, dare to jump between rocks, freedom when QG has learned. I will have more time to focus on my own work, more freedom"*	Positive
General	Pragmatic utility	*"Structure, messy. I want structure, everything to come in one place, 100% more structured"*	Positive
General	Stimulation, behavioral change	*"It will be a little more robotized, the robot will help you. The industry will move towards robots. If you take it to the next step, they will bring in robots. For me it feels good because I want to work with such things."*	Positive
General	Stimulation, pragmatic usability, attractive	*"Eggs are lighter ("easier", Swedish translation) than metal balls, you want it to be easier. To me it will be easier, avoid extra calls, avoid the Work order department. Easier to do the job yourself, avoid others disturbing your work that causes waiting time"*	Positive
General	Pragmatic	*"Order and chaos. It's more against order, everything is structured, colors, etc. it is structured, everything falls in the right sequence. It'll be chaos (without a Work Order)"*	Positive
General	Pragmatic	*"Child-friendly, yes or no-simple."*	Positive
General	Pragmatic usability, stimulation (navigation)	*"Trying to find a way. You know where you are going. Everyone knows where they are going. For me it feels like that, but everyone is different"*	Positive
General	Behavioral change, Stimulation	*"Cumbersome and hard to go with packing. You have to carry paper, reuse paper. (Digital work orders are) more flexible"*	Positive

Table 2. Positive statements from the anticipated experience evaluation

6.2 High-fidelity re-iteration of concept

Based off the preliminary user research and the newly interpreted user needs from the AxE-evaluation, a re-iteration of the concept was created in the form of an interactive Figma prototype (see Figure 9). The final high-fidelity prototype was evaluated by 4 volunteering participants during work hours through remote testing on a computer via Microsoft Teams. All the functions and features of the final prototype were grounded in the previous activities aimed at collecting user needs. The ground structure and main elements of the digital user interface were based mostly on the interviews and observations, which exposed what sort of pragmatic functional requirements were needed or requested for the Quality Gate personnel to perform their inspections efficiently. However, changes in design were thoughtfully made to mitigate the reported concerns of complexity and confusion in navigation and overall layout. These changes included exit strategies from sub sections within the application, the ability to hide or show information that might not always be relevant and overall simplification of the user interface.

Figure 9. Final prototype for the Quality Gate digital tool

The feedback that was gathered from the AxE-evaluation brought up the expectation of added complications towards the work process, and that a digital application would somehow make the same work tasks more difficult even though the process would remain the same. If anything, the vision that was presented to the participants was that a digital replacement would make their work process easier by eliminating double-work and repetitive actions

such as getting paper from printers and filling in lists that could automatically be filled out if the process was digital instead. However, the hesitation from the participants toward the concept was less directed to specific functions or features and more directed to the idea that it would bring changes in work habits. A change that would bring them out of the ordinary habits into something new, which can also be traced back to the AxE-evaluation result sheet if sorted under the attribute of "behavioral change." This understanding of reluctance to change was also incorporated into the design by keeping some of the "look" and structure of the paper document in the digital user interface.

An interesting aspect was to see if the final prototype had fulfilled the uncovered user needs and how it would compare to the participant statements from in the AxE-evaluation activity. These statements were re-formulated as questions during the evaluation of the final prototype to see if there was any difference between the anticipated experiences on the concept before interaction and the experience from interacting with the semi-working tangible prototype.

6.3 Feedback of the final prototype

The feedback of the final prototype was vastly different from the anticipated experiences of the AxE-evaluation. While all the participants answered that the work process would most certainly change and it would include a learning phase, none of the participants found it a concern anymore. What previously was interpreted in the AxE-evaluation as an issue now sounded more like a positive challenge: *"I feel much calmer now when I have seen it, it looks much better now. I don't think it feels stressful at all /---/ it might take time to learn how to use it, but everyone will be able to learn eventually."* Another participant said: *I think it looks much better than I had expected, not at all messy. I thought it would be much messier (the user interface), having to struggle with clicking back and forth on inspection tasks. /---/ I think it looks easy, I thought it would be much more difficult to understand how to use it."* Both participants had anticipated a high level of difficulty and unpracticality with using the digital tool and was surprised that the expectations did not match the new experiences. The change of work habits and work process did not seem as concerning any longer once they had gathered a first-hand experience of the prototype: *"The work process will surely change, but I only see positive things. There won't be any issues with printing out papers since this approach solves that. In all honesty, I don't see anything negative. All the information is there."* One participant had a slightly less surprising tone about the change of work habits; however, this participant had also been part of stakeholder workshops and had a slightly better insight of

the design process: *"The work process will be easier in some ways; you can keep focus when you've discovered a deviation. It's also useful to be able to call for help directly in the app automatically instead of having to complete the whole first task section."*

None of the participants found it overly difficult to navigate through the user interface, nor did they believe it would be a complicated process to learn how to use it. However, one participant struggled to find the "back" button but later said that once it was understood the problem would never arise again: *"The text was a bit small, that's why I didn't find the back button. But now I know where to look for it".* The issue of the text being a bit small could also have been depending on the resolution of the computer screen since the test was done through Figma and a computer. The user interface was designed for the touchpad Apple iPad Pro with the 12,9-inch screen, so viewing the prototype on a computer might have reduced the size of the user interface to make it fit on the screen. Strangely enough there was an issue with a re-used symbol from the old work order. This symbol indicated a manufacturing error and was placed in the user interface at the same position as it would be found on the paper order, at the far-right section of the page. Only one participant managed to notice it when asked about it.

The anticipated efficiency of the digital application had both positive and negative statements from the AxE-evaluation. The negative statements often referred to navigation issues or learnability, while the positive statements referred to better organized information and reduced paper waste. During the user test on the final prototype, one participant answered: *"It's going to make things easier /---/ there's usually too much paper handling, but with the touchpad you've got everything saved. You no longer have to go searching the paper bins to find old work orders".* Another participant said *"this will be much easier; I get that feeling straight away. This shouldn't be as time consuming since you don't have to handle paper and printers".*

The last question of the user test regarding if the prototype made them consider the new work process to feel more forced or if they still had the same freedom as with pen and paper must be explained in the context of what it refers to. The quality gate unit works with a set of standards that are supposed to create consistency in the process of each cabin inspection. However, human errors open the possibility that the standard is not followed with full certainty. Because of this there was a request by the stakeholders to add a feature that enforced the use of the standard to make sure it was always followed to avoid unconsciously made mistakes. While the AxE-evaluation and concept hinted slightly at

this new addition, the interpretations were mostly towards the concern that the choices would be restricted or that it would be more difficult to correct errors as easy as with a pen. The answers from the user test of the final prototype acknowledged this new addition but with relative ease and instead focused on the added benefits of ensuring better overall quality of the inspections and the decrease of anxiety of making unintended errors: *"There is no more room for the mistakes that can happen with pen and paper. You can't proceed from the inspection process before you've confirmed that all tasks are done now. Today, there is a risk with sloppiness, but this should eliminate that risk".*

7 DISCUSSION

7.1 Limitations of anticipated user experiences

The results of the anticipated experience evaluation showed that a limited number of experiential qualities could be gathered through interpreting the positive and negative statements from the participants. Since the participants used their imagination to freely interpret the concept, the level of detail toward function and feature perceived by the participants varied depending on how far they chose to stretch their imagination. This is not necessarily an unwanted outcome, since the ambiguity of drawings can help participants overcome fixation of existing ideas [8]. But it also means that the more nuanced experiences of interacting with a prototype isn't picked up. For instance, how it "feels" to interact with the touchpad. The anticipated experiences evaluation did not gather any feedback of how it would feel to touch the digital interface, press the buttons, or hold the touchpad. The argument that user experiences first becomes visible when the user interacts with the product seems to be correct in this sense [26, 37]. Instead, the feedback from anticipated experience evaluation covered a bigger picture of the experience. This included both behavioral changes, emotions, and the overall expectation of the whole process.

7.2 Usefulness of early-stage evaluation

The anticipated experiences differed from the feedback gathered in the tests of the final prototype. However, the anticipated experiences did bring forth expectations and concerns that could be interpreted as user needs and pain points. According to Gegner and Runonen [16], the importance of exploring experiential aspects during concept development is to mitigate the risk of unsuccessful design choices and avoid costly corrections in later stages of development. The AxE-evaluation activity in this study unveiled unspoken concerns that the participants had not expressed earlier in the user research. This shows that it can be

useful to combine the AxE-method together with user research if the purpose is to gather those additional pieces of user needs that could otherwise be hard to find. However, it's up for debate if it could prove useful in other projects that could instead benefit from more extensive user research. A speculation of why it gave satisfactory results in this study is that it might have depended on the fact that the involved participant did not have any comparable products to relate to, which made it difficult to identify these unspoken concerns beforehand.

7.3 Details of storyboard and narrative

What was noticed during the AxE-evaluation was that the level of depth and details in the narrative and storyboard affected how the participants interpreted the concept. However, even though the less detailed narrative and storyboard made room for more open interpretations; it was also slightly less focused on the presented concept. There is a balance between choosing ambiguity and distinct features when presenting a concept in this way.

7.4 Difference between storyboard and high-fidelity prototype

The high-fidelity prototype closely resembled the digital application from the drawings included in the storyboard. However, it did not share the same amount of information about the surrounding work process. The storyboard included more information about the context of the digitalized work process while the high-fidelity prototype gave more information about the details of the user interface. This might have affected the feedback received of the final prototype, since a lot of raised concerns were directed toward the change of work habits. Due to the time limitations of the project and limitations of operating in an uninterruptible production facility, the high-fidelity prototype could not be tested in the correct environment. Having said that, the evaluation of the final prototype was still structured to resemble a realistic situation, where each step of the evaluation followed the correct sequence of tasks done in a regular cabin inspection. Additional testing would have been valuable to make the feedback of the final prototype compare better to the storyboard and narrative. These additional tests should then have been performed in the same context as presented in the storyboard, preferably with an actual touchpad instead of a computer.

7.5 Challenges and limitations

7.5.1 Participant commitment

A challenge with this study was the level of participation and engagement from the employees of Quality Gate. Since the AxE-

method is quite experimental and unusual, it is difficult to present it in a way that participants take it seriously. The level of commitment was clearly more visible when engaging in questions and activities aimed at pragmatic attributes and objective truths than when asked about hedonistic qualities and stimulation. The outcome would have been different if it was tested with experts and UX scholars who find interest in knowing more about the method. This aspect might have affected the answers negatively, but it was mitigated in some sense by a clear explanation of the intended outcome. Follow-up questions also played a significant role in activating and engaging the participants to keep on trying to express and formulate anticipated experiences. It is clear that the active role of the facilitator is important in these situations. The awareness to the relationship between facilitator and participant that Dearden and Rizvi [12] point out can play a big role in how effective participatory methods like this can be. According to Dearden and Rizvi [12] establishing trust and understanding is a key factor to effectively be able to identify problems in participatory approaches. And in this case that proved to work. I believe that the small bribe of coffee and snacks that was given to the participants also helped to motivate them in this matter. Showing gratitude and working towards a better relationship between facilitator and participant can sometimes be as easy as offering coffee and a cinnamon bun.

7.5.2 Attitude towards digitalization

Willingness to change work habits was of course another factor that played into participant commitment in this study, since some participants were unmotivated toward the digitalization happening within the department. However, the biggest issue here was not their reluctance for change, but it was mostly their understanding of the researcher's role. Because of this, it was important to underline the motivations behind the study early and to overstate that the approach was user centered and based in empathy and understanding to make the product suit their needs as well as possible.

7.5.3 Miscommunication

Language barriers were also a challenge to overcome. A few participants did not have either Swedish or English as their main language. This made it harder for them to express their thoughts and harder for me to interpret what they meant. Some level of uncertainty is therefore included in this project, which is caused by back-and-forth interpretations between participant and activity facilitator. This might also have affected the questionnaire since the questions and UX-attributes might have been interpreted in different ways. A straightforward language was used throughout the entire study to avoid any confusing jargon, but if this was enough is unclear.

7.5.4 Environment and time

In this project, a limited amount of time could be set aside to interview and meet with the participants during work hours. The manufacturing of cabins was constantly active at the production facility during the project, which made it difficult to move freely or perform tests at the production lines.

7.6 Alternative methods

Alternative options of exploring experiential qualities in early development processes can be through the use of the Wizard of Oz-method (WoZ) [7, 31, 43] or paper prototypes [7, 8]. These methods might be a viable option if there already exists a tangible artifact to be evaluated. However, methods of role play and bodystorming [7, 25] are alternative methods that can be explored on early conceptual stages as well. Embodied design methods, such as bodystorming or role play, can help designers and researchers to better understand the experiences that might emerge from a concept or idea [29, 33]. As these participatory methods require the right conditions and volunteers to be successful, they might not always suit the situation. Establishing enough comfortability for the participant is important in embodied interactive activities and using the correct environment which the activity can take place might be equally important to establish the right kind of context for the situation [6, 29]. According to Buchenau and Suri [7], bodystorming can enable researchers to gain insight into unexpected scenarios as well if improvisation is included into the method. Bodystorming and role play embodies the interactions into tangible and real world scenarios, equivalent to testing and experimenting with prototypes, in which experiences emerge [7]. However, if it leaves as an equal amount of space for free interpretation as the AxE-method is up for debate. As Buchenau and Suri [7] mention, users might find it difficult to provide low-fidelity improvisation prototypes of enough quality to enable experiences to emerge in a naturalistic context without supervision and at the same time the active involvement in a participants role-playing session might affect the perceived experience.

8 CONCLUSION

The study was conducted toward the project case: "*User experience as an enabler in production*" at Scania AB in Oskarshamn, Sweden. In this project case, the practical aim and application of the UX perspective was to show the value that it could contribute to aid the digitalization of an analog, pen and

paper, work process at Scania's vehicle manufacturing facility. The part of the vehicle manufacturing facility that was targeted was the Quality Gate unit, which is a department that focuses on quality inspections at the end of each production line. During this study, an investigation of the usefulness of evaluation and testing interactive products early in development processes towards user needs and pain-points was conducted. The main issue of this investigation was that the employees were facing a rapid change of technology due to the digitalization of tools and work process, which made it difficult to uncover future needs. Therefore, visual stimuli in the form of storyboard with narrative was proposed to engage them in speculative scenarios to help them express anticipated experiences. The investigation of anticipated experiences made it possible re-interpret the participants expectations and speculations into user needs and pain-points. Conducting anticipated experience evaluation could therefore be of use in similar situations. The goal of this study was to build upon the existing knowledge within the field of HCI and UX-research of early-stage experience evaluation methods.

To conclude the research question "How can experiential design insights gathered from anticipated user experiences guide future design decisions?", the method of Anticipated eXperience Evaluation (AxE) [16] has been investigated. The investigation of anticipated experiences has highlighted the importance of adhering to expressed concerns by users and how they can be extracted by evaluating fictional scenarios and narratives. By interpreting positive and negative user expectations of storyboards and narratives through the AxE-method, it's possible to unveil additional user needs and pain-points, which can either support the design choices that meet the user needs or help to avoid the design choices that doesn't. However, the extent of experiential qualities gathered from the AxE-method did not reach into human sensations such as touch and feel, instead it covered a more general expectation of the concept, the behavioral changes it could bring, and the emotions attached to it. The storyboard and narrative made It possible to anticipate experiences that included the surrounding context of the future concept. Compared to the high-fidelity prototype, that mostly presented the features, functions and details of the digital artifact, the storyboard and narrative created space for interpretating the whole work process instead. However, further research is needed to investigate how to include sensory qualities in user experience evaluation before interaction occurs at concept-stages.

Another insight that this was found in this study was that the level of detail included in the storyboard and narrative affected the interpretation of the presented concept. Less details made space

for more imaginative scenarios. But more testing would be required to fully understand what level of details included in a storyboard and narrative can leave enough space for free interpretation and imagination while not creating fixations of existing ideas.

9 ACKNOWLEDGMENTS

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