

Master Thesis

Master's Programme in Digital Service Innovation, 120 credits



Exploring User Experience designers experiences working with Machine Learning

Informatics 30 credits

Halmstad 2021-06-04
Emil Bergström



Exploring User Experience designers experiences working with Machine Learning

Emil Bergström

Emiber16@student.hh.se

Master thesis in informatics

Master's Programme in Digital Service Innovation

Halmstad University, Sweden

Abstract. The user experience (UX) design practice (c.m.p interaction design practice) has started to make profound changes in designing intelligent digital services using Machine Learning (ML) to enhance the UX. ML has the capability to enhance the user's experience, for example, facilitating more accurate decisions or improving efficiency in achieving one's goals. However, research suggests that ML is a challenging design material in design practice, such as not envisioning the best-suited solution because of not comprehending data dependency when prototyping or the lack of tools and methods for evaluating the solution. Without a doubt, ML opens new doors for UX designers to be creative in their practice. However, research indicates that lack of knowledge transfer into UX design practice may hamper this potential. This paper explores how UX designers experience ML. The findings resulted in 5 experiences: 1) Absence of competence, 2) Lack of incentive for competence development, 3) Challenging articulating design criteria, 4) Mature vs. Immature customers, 5) Lack of support for ethical concerns. I discuss the implications of these findings and propose how we can understand UX design practice and opportunities for additional design research to support designers working with ML.

Keywords: Machine learning, design material, UX design practice, interaction design

1 Introduction

During the past decade, user experience designers (UX) have started to use machine learning (ML) as a design material to expand their creative capacity to design intelligent services. For example, Spotify improves the UX using personalized music feeds based on what users listen to. Lysa uses ML-empowered stock robots that automatically invest one's money. Lysa bases its investment method on historical data and statistics. Apple's iOS can make menstrual predictions based on data the user logged from previous menstrual cycles. Researchers and digital designers recognize that the ML trend has become especially interesting since it opens many new design opportunities for UX designers (e.g., Holmqvist, 2017; de Miranda, 2019; Yang et al., 2020c).

Yang et al. (2016) suggest that ML is the new UX. Even though ML has shown capabilities to empower the UX in today's services and products, researchers imply that the UX design practice underlies complex challenges handling ML as a design material (e.g., Dove et al., 2017; Yang, 2018; Xu, 2019). Yang et al. (2018a) published an overview of identified challenges of UX designers working with ML as a design material. For example, UX designers struggle to work with data scientists proactively, and they do not acquire the methods or the right skills to sketch or prototype when working with ML as a design material. Yang et al. (2018c) suggest that current UX design education and the design practice are not prepared to work with ML as a design material. For example, ML is too technically knowledge-demanding design material for UX designers, and that the current design process consequently could change due to the lack of design tools and methods to test the viability of ML-empowered solutions. Dove et al. (2017) claim UX designers' challenges in a survey on their situations working with ML. For example, UX designers are concerned if they create something ethical and purposeful. They also suggest that UX designers' challenges working with ML hamper their potential for innovation and to ideate beyond the less obvious design solutions. Moreover, there has been an ongoing discussion in research about approaching UX design practice while working with ML as a design material (e.g., Amershi et al., 2019; Dove et al., 2017; Yang, Nikola & Zimmerman, 2018).

Goodman et al. (2011) discuss the UX design practice as professionals who design digital things for people's use, designing for the user experience. Research describes UX design practice as rather complex as it involves tackling ill-defined design problems (Cross 1982) and wicked dilemmas (Stolterman, 2008). Thus, the research describes UX design practice complexity depending on several factors, such as type of context, customer (Stolterman, 2008), design material (Fernaes & Sundström 2012), social and societal impact (Löwgren, 2012). Stolterman (2008) discusses how a UX designer needs to be prepared for complex design dilemmas and not guided through one. UX design practice does not involve any prescribed design process that would lead a designer to a particular result. He gives an overview of rigorous and disciplined aspects, describing that despite design complexity, a "good" designerly approach can lead to successful or even innovative results. Designers need to comprehend the right competence and tools to support them in approaching a complex situation.

Many of today's papers aim to inform how ML affects society within different contextual circumstances. For example, challenges of designing for explainable AI (Zhu et al., 2018) and critical advances in recommender systems (Konstan & Reidl, 2012). Research illustrates several challenges that can interrupt UX designers during their design practice (Amershi et al., 2019; Dove et al., 2017; Holmqvist, 2017; de Miranda, 2019; Yang et al., 2018abc; Yang et al., 2020). Thus, there have been previous concerns that less research aims to influence UX designers' practice concerning how to improve their situation of handling design problems (Stolterman, 2008; Goodman et al., 2011). This study explore the designer's reflection on their experience of using ML during their practice. Therefore, the research question in this paper is: *"How do UX designers experience ML as a design material?"*

This paper contributes to UX design practice from how UX designers reflect on their experiences working with ML as a design material. The contribution aimed to build on how research currently understands UX design practice and explores confrontation with real-world situations. To contribute with insights and understanding for the research community and UX design professionals to work more effectively and make more sustainable choices for society. My findings resulted in 5 experiences: 1) Absence of competence, 2) lack of incentive for competence development, 3) challenges articulating design criteria, 4) mature vs. immature customers, 5) lack of support for ethical concerns.

The following section provides a literature overview of UX design practice and design materials and how research addresses ML as a design material. Following, I describe my research approach and the development of these study findings from interviews on how UX designers reflect on their experience working with ML as a material. My findings illustrate that designers stand in for different design experiences that seem to disrupt their design practice. Finally, I discuss the findings and ML as a design material in UX design practice.

2 Literature overview

The literature overview describes: User experience design practice and design material and Machine learning as a design material.

2.1 User experience design practice and design material

The user experience (UX) design practice is to design products or services by understanding how users interact with them to design for the UX (Goodman et al., 2011). Löwgren (2012) proposes that UX design practice explores possible futures, often using participatory methods. A UX designers' education regarding design practice includes understanding the design process (Getto & Beecher, 2016). There are different design processes: Goal-directed Design (Cooper et al., 2014) and User-centered design (Courage & Baxter, 2005). In general, education teaches practitioners a design process where the user of the product or service is in focus (Getto & Beecher, 2016). In other words, the user's goals and needs are in focus.

During the past decades, research has discussed design practice as a rather complicated task. According to Cross (1982), design problems are often recognized as ill-defined and ill-structured. Recent research argues that this is the case (Stolterman 2008; Goodman et al., 2011). Stolterman (2008) describes the complex situations designers encounter with digital design as “*wicked problems*”. The UX designer encounters “infinite” different factors in the design decisions, such as the type of the customer, the product's societal impact, or identifying user needs. The UX design practice involves assessing alternative designs in parallel to present arguments for a solution. The UX designer's practice requires addressing projects that seem to be poorly structured, subjective, and fuzzy to be rigorous and disciplined. A rational and disciplined designer should know what tools and methods to use to reach design rationality, as it is necessary to articulate the criteria for the assessment. For example, to achieve the users' goal or to fulfill a business value. The decisions a designer takes during the design process could significantly impact the UX of a service. Stolterman (2008, p. 63) prescribes different kinds of support that designers use to manage complex situations. The list is not exhaustive but illustrates a general overview based on previous studies in UX design practice:

- Precise and simple tools or techniques (sketching, prototypes, interviews, surveys, observations, etc.)
- Frameworks that do not prescribe but that support reflection and decision-making (design patterns, ways of using prototypes, styles of interaction, etc.)

- Individual concepts that are intriguing and open for interpretation and reflection on how they can be used (affordance, persona, probe, etc.)
- High-level theoretical and/ or philosophical ideas and approaches expand design thinking but do not prescribe design action (reflective practice, human-centered design, experience design, design rationale, etc.).

Design material includes hardware and software such as a smartphone or laptop and the components that the digital thing is made from, such as sensors, algorithms, or touch screens (Fernaues & Sundström 2012). According to Fernaeus and Sundström (2012), it is unrealistic that one designer should understand all different materials and how they interact with each other. Also, the design practice always differs in one way or another, either in a new context, limited by resources, type of customer, the user, or different types of design material (Löwgren & Stolterman, 2004). A UX designer's practice involves exploring relationships between different design solutions involving different design materials (Stolterman, 2008). He argues that a designer needs to be prepared for action rather than guided-in-action. They should respect and understand the complexity and richness of a design situation with the support of tools and methods and a positive state in mind. Rather than follow a prescriptive procedure. Cross's (1982) paper illustrates the complexity a designer encounters that it is challenging to determine, that the "correct" knowledge informing the solution is not always to be found. Stolterman (2008) argues there is no such thing as a "right" way of proceeding with the design practice, which indicates that there could be more than one combination of design materials that could solve a design dilemma.

Holmquist (2017) compares a UX designer deciding design material to a product designer who would need to be aware of the physical characteristics of materials such as plastic, wood, metal and how these components fit together. To fit the components together so that it, for example, looks aesthetically pleasing and so that it meets the user's expectations of what is experienced as ergonomic. A particular design value comes from the quality of a service or product fulfilling or exceeding the users' expectations. Löwgren (2012) discusses the dilemma of responsibility from the UX designer and how design changes people's experience of things by shaping and implementing digital services and products into someone's life. Goodman et al. (2011) illustrate the UX design practice as the middle-man or the translator between people and with actors with different educational and professional backgrounds. That there is not just the users' needs and goals to meet but also the other actors involved.

Researchers (Stolterman, 2008; Goodman et al., 2011) claim that research should not just focus their study on the user's experience. They claim that the aim to influence professional design practitioners is equally important. Goodman et al. (2011) acknowledge three main concerns from research about influencing professional design practitioners: 1) the lack of knowledge transfer from research to design practice, 2) design practitioners do not apply theories or methods because of time, cost, or workplace constraints, and 3) The latter is that researchers misinterpret how designers perceive or experience design problems, which has led to the result that methods, tools, and techniques researchers contribute with sometimes are irrelevant for designers. This opens up the gap of understanding the designer's reflection on their experience using new design materials during their practice.

2.2 Machine Learning as a design material

In the past decades, customers and UX designers have started to notice the potential of MLs UX-empowering capabilities, such as facilitating more accurate decisions or improving efficiency in achieving one's goals (Yang, 2018a). As a subcategory of AI, ML includes sets of data algorithms that learn to predict and classify data in a continuous process instead of programmed once and for all (de Miranda, 2019). It learns from creating a map of different labeled data sets from input data. In this

way, it can separate different weather conditions and register them from different capabilities. According to de Miranda (2019), designers ideate from the main types of ML algorithms:

- *Supervised learning* learns from labeled data that the designer wants the system to look for. For example, to forecast the weather or help predict pregnancy risks based on historical data.
- *Unsupervised data* are trained systems on unlabeled data without any guidance. The system is given input data from different stakeholders and labels it on similar capabilities. It is used for ML-empowering UX to discover underlying patterns and used in designs such as recommendation systems or anomaly detection.
- *Reinforcement learning* is a system that does not get to learn labels but learns from if it has labeled something correctly or not, based on rules. It is often used in mechanical design, for example, for a robot vacuum cleaner to learn where the walls in a room are.

Even though de Miranda (2019) illustrates that ML has capabilities to empower the UX in today's services and products, other researchers claim that the design practice underlies complex challenges handling ML as a design material (e.g., Dove et al., 2017; Yang et al., 2020; Xu, 2019). Designers face challenges understanding MLs limitations as it goes outside a designer's education and competence, that they have to rely more on data experts (Dove et al., 2017). Yang et al. (2018c) also indicate that ML as a design material has shown to question the designer's education and design practice, or if ML is too technically knowledge-demanding design material for designers and if a designer's education and current competence are enough to work with ML as a material. They claim that UX education needs a more data-driven culture to learn the basics of data science terminology. This would enhance designers' experience and open new doors for creativity, such as understanding user behavior through data or identifying design goals through telemetry data visualizations. Yang et al. 2020 also raise the importance of environmental constraints, laws, and regulations when proposing a real-world ML solution. For example, to know who is responsible for the data or regulations depending on the target group. Dove et al. (2017) claim that the complex technical knowledge with ML drives design-led innovation to become rare because designers need to focus more on collaboration with data scientists, which has led to designers having a more challenging time seeing ML features that are less obvious, imagining something in addition to previous ML trends.

Another challenge is the lack of existing tools and methods when working with ML. Yang (2018a) mentions the challenges to ideate with sketching or prototyping with large datasets, computational power, time, and dependency on data scientists. That "fail fast and fail often" does not apply to current design practice with ML as a design material. The effort of working with ML is too demanding. Designers have tools for prototyping responsive web services, and that makes it easy to simulate the behavior of an app on the smartphone, but they have nothing that helps them quickly prototype and understand the UX impact of false negative and false positive responses from an ML service (Yang et al., 2020). Yang et al. (2018c) question if the current design process should change to the lack of design tools and methods to effectively test the viability of ML-empowered solutions. Dove et al. (2017, p. 2) mention that digital designers usually do not have an effective way of working with ML features, that they sometimes simply just apply it at the end of the project. "*Design teams simply put lipstick on a pig*". Dove et al. (2017) also mention the lack of ways to ideate and evaluate interactive prototypes, that they currently work with storytelling, narratives, or films to prototype the experience of products that yet do not exist. He claims that designers clearly demand new ways to work with ML as a design material. Amershi et al. (2019) claim that ML can bring with it everything from costs to benefits or uncertainties in a designer's practice and describes the designer's routine job to handle such trade-offs. They emphasize the concerns of designers requiring support to work efficiently with ML, which does not currently exist. Another challenge that there is a risk that the design process gets constrained by available data and its quality from the current design project (Yang et al., 2018c).

Another challenge is designers' concern if they create something ethical and purposeful (Dove et al., 2017) claim that we need to bring the human voice into the solutions to facilitate understanding the ethical impacts. Yang et al. (2020) point out the challenges to design for unpredictability. Such as trespassing integrity data or designing to prevent users from losing control because of the ML features. For many non-technical digital service users, an ML-based system is a black box (Xu, 2019). This black-box phenomenon can cause the users to question the system's decisions. This reflexive skepticism can directly affect users' trust and decision-making efficiency, affecting the adoption of ML-based solutions, affecting the design decisions for designers.

Yang (2018a) argues that designers do not recognize where and how knowledge of ML can add value to their practice. Knowing how to work with ML must be better integrated into design practice for designers to understand the value of understanding it more fully. As it currently stands, designers face various challenges to exploit their full potential.

3 Method

I adopted a qualitative approach of research for design (Stappers & Giaccardi, 2017), an approach to studying and informing complex situations in doing design. I conducted an exploratory interview study with professional UX designers. My intention of choosing an interview study was to get a deeper insight into the current UX design practice and a general overview of what is now an arising research area.

The methods used during this study are further described below and summarized as: A literature overview that focuses on UX design practice and their use of design materials, and ML as a design material. Next is how I conducted the interviews, which includes a representation of the participating UX designers. Finally, I systematically demonstrate the thematic analysis for the development of this study's findings.

3.1 Literature overview

The literature overview presents how research describes the UX design practice and its use of design material. Even though it is not an extensive review, it gives a general overview. The literature overview also presents how research currently identifies ML as a design material. I organized the search for literature following Webster and Watson's (2000) approach. I based the search of the literature on the research question, "How do UX-designers perceive ML as a design material?". I chose the keywords Machine learning, UX design practice, design material, and interaction design. I used the keywords in different combinations when searching. The use of keywords also limited the study and numbers of found papers. Two databases were primarily chosen during the search process of relevant literature: Google Scholar, Scopus.

The initial step of selecting literature was based on the title and abstract of the paper. If I considered the paper seemed interesting for the study, the paper continued to selected the literature. The next step was to filter papers considered irrelevant for the selection of literature, which was done by reading the introduction and conclusion. After the step of filtering, I read the papers more carefully. I judged the papers on the content and relevance of the study. During the search process and when reading papers, forward searches were conducted to see which papers referenced the original paper or the authors' previously published papers. A backward search was also conducted where interesting papers were explored in the reference list as relevant literature for my research area. The literature search was an iterative process, meaning that even though there was a specific period during the study when I searched for initial literature, I could go back to look for more relevant literature.

3.2 Interviews

This study's empirical material consisted of exploratory interviews with nine professional UX designers carried out online on Zoom during spring 2021. ML has been recognized as a new and unexplored design material in design practice (e.g., Dove et al., 2017; Yang et al., 2020; Xu, 2019). I therefore chose to conduct exploratory interviews with UX designers. I wanted to generate a representative empirical overview of how designers currently experience ML as a design material to establish an open and not-guided empirical material.

The interviews were designed to be approximately one hour long and were audio-recorded. All interviews were recorded with informed consent. The interviews lasted as long as there was interest to continue from both parties (See table 1). The preparation of the interviews followed Myers and Newman's (2007) way of discussing qualitative interviews. For example, I prepared the interview environment welcoming, peaceful, and professional to stage the interviews. The stage was set already through the email conversation, during the interview via Zoom, until the end of the interview. I designed the script of questions to mirror the designer's language to facilitate understanding and prevent misinterpretations. The questions were therefore evaluated beforehand by other fellow UX designers if any questions were to change. I designed the interview questions to be open and explorative. For example, *"How would you describe ML?"*, *"How did you learn about ML in the design?"* or *"Could you describe the process of considering ML in the design?"*. The openness also meant that I could improvise if anything interesting were discussed.

Table 1 summarizes the designers' backgrounds and the type of projects they described during the interviews. All designers had experience designing products or services that enhanced UX with ML in at least one project. Only one designer had any education in designing services with ML, and two others had taken one course about ML. All designers described that they mainly learned about designing with ML when working with it in a project. One of the designers worked as a UX and AI development director and had both done the research and worked on several projects with ML. The others worked with UX- or switched to service designers as the definition of UX designer sometimes shifted depending on the project they were working with. The recruitment was done with different design agencies to get various representing voices.

Designer ID	Interview length	Education with ML	Example Design Project	Exp. with UX	Exp. with ML
1	17 min	None	Recommender in clothing app	8+ years	1-2 projects
2	54 min	Learning by working & self-interest	Monitoring of production process	6+ years	1 project
3	40 min	Learning by working, self-interest & through the working environment	Crossword puzzle maker	5 years	3+ projects
4	45 min	Learning by working, self-interest, through work environment & 1 course	Decision support app	5+ years	2+ projects
5	35 min	Learning by working	Robot monitoring process	1+ years	1 project
6	43 min	Learning by working & work environment	Intelligent conversation robot	10+ years	2+ projects
7	52 min	Learning by working & Self-interest	Intelligent customer surveys	3 years	4 projects

8	54 min	Some education, self-interest & learning by working	Medical facilitation service	4+ years	1 project
9	56 min	Research, learning by working, self-interest & through the working environment	An adaptive speaking dialogue system	10+ years	5+ years

Table 1. Interview with designers.

3.3 Thematic analysis

The gathered empirical material was analyzed using the thematic analysis method described by Braun and Clark (2006). I considered this a suitable method for organizing and identifying patterns in the large empirical data set. I sought to provide a rich thematic analysis of the entire data set so that the themes would represent how UX designers experience using ML as a design material. The themes were identified inductively, meaning that they were strongly linked to the gathered empirical data and not towards any theoretical framework. First, the recordings were transcribed, read, and listened carefully to identify meaningful units of text relevant to the research question. Second, units of text were analyzed and given codes. The coding was conducted to show patterns from semantic content, meaning that there was no attempt to theorize or analyze the broader meaning of the text units. See table 2 for an example of the coding process.

Data extract	Coded for
“it’s a pretty big knowledge threshold to be able to feel comfortable putting things up in Github and testing things out.”	1. Knowledge threshold
“Today you are not rewarded for taking risks, but you are rewarded for not doing anything and then you do nothing”	2. Not rewarded for taking risks
“It is often based on a trust that one must earn”	3. Trust is something you earn
“the customer needs to understand, what an AI can do and not do?”	4. Teaching the customer

Table 2. Data extract, with codes applied

Third, I systematically grouped the codes into categories that were dealing with the same issue. For example, codes about education related to ethics were grouped up in “*education about ethics*”. The same code could reappear in more than one category. Grouping the codes together were relatively flexible in that it relied upon what I interpreted as interesting. This was an iterative process, going back and forth about how the codes related to each other. Fourth, the thematic analysis resulted in 45 categories that I grouped into five themes. The theming process was done by grouping categories that were related to each other. I placed the categories that related next to each other, and then I tried to write what was considered as a theme. See figure 1 for a visualization of how the grouping of categories into themes looked like. Fifth, the themes were reviewed following Braun & Clarke’s (2006) two level process: 1) reading the collected data in each theme, considering a coherent pattern. If the pattern seemed coherent, it proceeded to the second level, and 2) at this level of reviewing, I wanted to check the validity of the themes, meaning that they reflected the meaning of the collected data as a whole. At the sixth step, I had a satisfactory theme. At this point, I tried to define the essence of the theme. This was done by analyzing and refining the data and giving the theme its final name, a short sentence that was obvious and clear. The final step was reporting themes which can be read in chapter 4, Findings. To write down a logical and coherent story that describes the themes and shows

trustworthiness, to provide sufficient evidence of the themes related to the research question (Braun & Clarke, 2006), “*how do UX designers perceive ML as a design material?*”

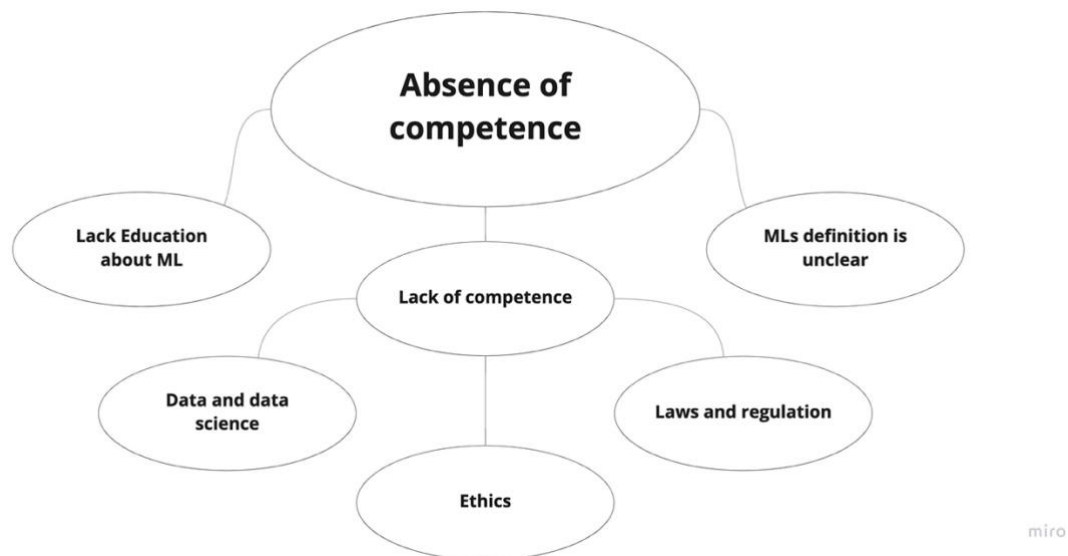


Figure 1. Example of grouping categories into themes process.

3.4 Method discussion

The interviews were conducted with nine UX designers who had experience working with ML as a design material. One of the UX designers had formal education designing with ML, others did not have any education designing with ML as a design material. The designers who participated in the interviews also had difficulty distinguishing between AI and ML and they therefore commuted between these two during the interviews. This also indicates some type of ignorance. Therefore, the quotes under findings may describe AI while describing ML as this has not been changed.

4 Findings

The thematic analysis identified five themes in the empirical material: absence of competence, lack of incentive for competence development, challenges articulating design criteria, mature versus immature customers and lack of support for ethical concerns.

4.1 Absence of competence

8 out of 9 UX designers stated that they had no school education on how to work with ML in UX design practice. They shared that they learned about it from the design project they were working on, or that they tried to learn about it in their free time like reading Medium articles and watching YouTube clips.

I had with me quite a lot of knowledge in general from the academy. (P9)

It's really just experiences from different companies where you have worked with it a little bit. (P4)

Easily accessible stuff like that written on Medium. (P2)

I learned about it partly through lectures on YouTube from MIT linked to human-centered AI. (P7)

The majority of the designers expressed that working with ML as a design material required new methods and tools to learn to be able to work with it effectively. For example, sketching ideas during UX design practice involving ML as a design material, it becomes more like a dialog. P3 stated it as:

You get a completely new material presented in front of you, so say that I may be very good at painting watercolor. It makes me have a feeling for color and shape and shadows. Then someone puts a lump of clay in my lap, says: Do something nice as well. And then I can say that I still have a sense of color and shape, but I do not know the material. [...] When I sketch with other design materials, I think this is how it comes out. But when I draw something for AI, I rather think that and try to convey that this is a scenario, this is what a dialogue could look like. (P3)

The majority of the designers also expressed that UX design practice involving ML requires competence in data and data science, in the design team but also that designers require competence within it to work with it effectively.

You need to understand this data somewhere to be able to design for it [...] What is different is that the design team involved must be competent in AI and that data scientists are involved. (P7)

By communication, I do not mean one way but both ways. You as a designer must also be able to explain why onboarding is important, the other is that you must also listen. You also have to listen to the developers, aha! can you do such a regression or clustering, then we can build this functionality. (P9)

UX designers that had some competence with data and data science expressed how helpful it was learning about the basics of technical techniques and methods. This is how P4 stated it:

This with clustering for example, and I do not know everything but more the technical perspective, or mathematical. I felt I gave myself this base to know those kinds of words a little more and I did not feel afraid of it really, before it felt very strange and difficult, as well as very distant.

Becoming more aware of how data science P4 indicated that it boosted her confidence as a UX designer to work with ML in UX design practice.

A majority of designers raised ethical concerns as an important subject to have competence in working with ML as a design material. The designers shared different kinds of ethical concerns and its complexity and stated uncertainty how to work around complex ethical questions and expressed if it even was within a UX designer's responsibility to handle these kinds of questions.

How do we relate to the fact that intellectual work will be replaced by machines? [...] Just because you are a decision maker in something does not mean that you understand the consequences of the decision that is made. (P7)

It is difficult for users to understand how different it would be as they might not even need to be in the workplace, they might lose their jobs [...] I understand the complexity. But not at an application level. But you have to draw the line somewhere. What it is you are supposed to know. (P2)

The majority stated that ethics was more of a discussion and that they did not have a particular method to work with it.

We do not have such an established process around ethics, which you may feel that we should have [...] It is more of a thing that you discuss with colleagues. (P2)

We do not have a framework that we directly relate to, but it is more that [...] I would not say that it is a feeling either. But it becomes more of an approach to our design, that it should be a basic principle [...] The discussion is taken up. (P1)

7 out of 9 UX designers also raised laws and regulations as one competence outside their own competence regarding ML as a design material. And that the absence of competence with laws and regulations makes UX designers hesitate, which leads them not to dare to take any chances. P6 expressed it as:

I think it is above all the legal aspect and that it is what makes companies hesitate and invest [...] Machine learning is like the GDPR, like a big paper dragon that everyone just pulls out and no one really knows what the GDPR is. But everyone knows it's scary, stupid and bad. As soon as someone says GDPR, everyone else in the room is silent [...] Today you are not rewarded for taking risks, but you are rewarded for not doing anything and then you do nothing.

P8 stated the difference working within projects where people are aware of laws and rules and expressed that it affected how they would design a service.

It is a huge difference to work with a company that is aware of what we do and how it affects people and the ethical [...] There, the company that I then designed for, actually wanted to create this security. It is something that of course affects the design.

All but one UX designer had any formal education of how to work with ML in UX design practice. The majority of the UX designers shared that working with ML required understanding within other areas than they had competence in such as data science, laws and regulation, and ethical concerns. The overall picture was that UX designers working with ML expressed uncertainty because of absence of competence with it.

4.2 Lack of incentive for competence development

The majority of the UX designers expressed that the absence of competence was that ML was quite new in their design practice. The UX designers expressed that the incentive for UX designers to develop competence with ML is not clear yet but that it might require them to sit down at the school desk again. They also shared that they recognize that the desire to use ML has become much greater from customers but there is no responsibility for competence development. They expressed that the responsibility currently lies on the companies the UX designers work for.

All major apps and such use machine learning in some way. Social apps like Facebook or Instagram, it is quite clear that it's useful [...] You might need to build up a department and continue working with ML. You probably need to bring that competence into your team. (P1)

There is a certain trend level of machine learning [...] It can definitely be an area that will be much stronger. There is an ambition. But you get stuck in the fact that it's actually quite difficult. You need to try to sell through it to customers and meanwhile build up competence around it. (P2)

The competence is not particularly widespread [...] It's like building the ship as best it can while it is sailing at the same time [...] When technology goes fast, it is difficult for all agencies to keep up and not all senior designers are comfortable sitting at the school desk again, but it does require it. (P9)

The majority of the UX designers stated that they instead learned about ML working with it in their current design projects, or that they tried to learn about it during their free time on the internet.

It's really just experiences from different companies where you have worked with it a little bit. (P4)

I learned about it partly through lectures on YouTube from MIT linked to human-centered AI. (P7)

4 out of 9 the designers stated that their company had introduced how to design with ML in their work culture which included meetings and communication channels dedicated to learning about ML. They expressed that it encouraged them to develop their competence in ML, they appreciated their workplace more, and they became more comfortable working with ML.

Working at (the company) I experience it's like studying and working at the same time. Because we have so much competence development [...] It's awesome. This is perhaps the best thing about a job at (the company). That's why I'm here. (P3)

It has been seen as a strategic area within (the company) [...] We have a channel on Slack and everything like that[...]I felt that it gave me the basis to know those kinds of words more and I do not feel afraid of it really. Before that, it felt very strange and difficult, as well as very distant. (P4)

However, the majority of UX designers expressed not being fully aware of what their role in UX design practice was when working with ML, what competence they are expected to possess, if they even needed to increase their skills or if they could rely on others with the right competence.

Knowing what you do not know is one of the most important strengths when working as a designer. Sometimes you think it would have been good if I could code frontend, then I could have fixed this, but I will not be a better designer because I learned to code a little bad frontend [...] There needs to be more expertise in this area with which one can cooperate, so to speak. (P2)

It's a little too abstract and it's a little too much to understand for me to want to broaden my own toolbox with it right now [...] But if something happens? Who is responsible? It still goes a bit beyond my role. (P6)

A majority of UX designers expressed different incentives with competence development with ML. The UX designers shared that it is important with competence within data and data science working with ML. P3 expressed how important it was with the competence to understand and explore the data from the existing digital service, to be able to articulate the criteria of the assessment, that working with data dependency differentiated between working with other design materials. P3 stated:

The most important thing is that you need to check with those who work with the data. Can we build this? Do we have data for this or do we need to collect it? [...] The biggest difference is that you need to relate to the new variable of what data we have. It's almost like the question: how much clay do we have? How big a sculpture can we build?

Other UX designers stated that competence development with ML would save time communicating with the developers and that it would facilitate testing design solutions. Also, that ML was expressed to involve a lot of complex legal questions that the majority of the UX designers did not have competence within which resulted in that ideas were missed out on.

It may require that you as a designer need to orientate yourself a bit about data science and machine learning and understand the vocabulary there[...]To make the design concepts so concrete that they are helpful to a programmer[...]You can save 1 month of time without understanding what they actually mean if you understand coding. (P9)

I would definitely like to build my own dataset to investigate, but so far there are not really the visual interfaces that I feel I get support from[...]it's a pretty big knowledge threshold to be able to feel comfortable putting things up in GitHub and rowing around[...]We've rounded that up already at the idea stage[...]This means that, unfortunately, ideas have been put forward that could be incredibly helpful[...]In addition, if there are legal concerns, it may be that we do nothing. (P6)

A majority of designers also expressed how developing competence with ML would facilitate various confidential skills as a professional designer. To be trustworthy in your design decisions that there is a business value for the customer. The designers stated that showing competence with ML establishes trust with the customer.

You can talk, but you also have to deliver [...] It is often based on a trust that one must earn [...] Having the vocabulary for adaptivity, prediction and data strategy, training of data bias [...] You need to prove that you understand their business problems. (P9)

It was thought that I would sit and design 60% of the time, no, no, no. You will not do that, you will have to nurture relationships 50% of the time then will work 50% of the time at work. (P3)

The UX designers expressed that the lack of competence development made them miss out on ideas that could be valuable, that they do not dare to go ahead with something they do not fully understand. The UX designers also expressed that ML is a new and demanding design material compared to their current design expertise. Customers' need is not enough, but it needs to be in the strategy that the company they work for interests.

4.3 Challenges articulating design criteria

A majority of the designers expressed that they experienced challenges in designing for MLs unpredictable capabilities. They shared that ML involved anticipating users' actions and simultaneously the ML action. They expressed that it was challenging to articulate the design criteria for a design solution involving MLs unpredictable capabilities.

We do not know what the ML will show. For example, in a chatbot, do we have to take into account that it will show graphs, images, sound clips, text? We do not really know. (P3)

What happens if you unleash an algorithm that is supposed to make decisions that can affect someone's health or affect someone's life or affect someone's finances. (P1)

Things can come out that are not desirable, even if no one meant anything bad when building it [...] The computer can sometimes give completely unpredictable results and they can be negative. (P9)

A majority of designers expressed that when UX design practice involves MLs unpredictability capabilities some design criteria become more prioritized. Such as traceability and transparency, because the user of a service needs to be aware of MLs actions and how it bases its actions, also that it involves designing for the user's experience to feel comfortable with the ML solution. The UX design practice involving ML is expressed entailing articulating design criteria that is based on anticipating users' expectations and needs, which was expressed as challenging.

Everything is extremely black boxed, and the end users have very little idea of what is actually happening[...] We need to understand traceability to see how there should be transparency. (P7)

I think that is what also makes UX have a very important role as a change agent, to include these fears and to be able to address them early in the process. If you feel that this does not feel good. This will be a threat to my integrity. It feels stressful because I'm being monitored. Then it will not be a good project. I think that you as a UX designer need to consider this more than in other digitalization projectors that I have worked in [...] But, users have no problem sending social security numbers, home addresses or first teachers last names to all sorts of places. But we get really scared if they are going to take a picture of us, also quite strange. (P6)

P6 statement also mentions the complexity of articulating assessments based on what the general public thinks is okay or not regarding trespassing a user's integrity.

The UX designers expressed different design dilemmas that ML entailed. Involving anticipating a user experience of a service, preventing the user from becoming afraid of the MLs unpredictable capabilities. The UX designers also stated that it creates communication issues of what it can possibly do, they described ML as disruptive, that it is challenging to articulate the project's service, what it should and should not do, or if it is needed at all.

There is no pretty clear limit when the robot just gets creepy and it just gets scary. (P6)

You need to be able to communicate what an AI does, that you work with an unpredictable design where you cannot count on all the value and how to design for something that I cannot count on the value is tricky, to say the least. (P7)

We design what it should do if something goes wrong, but what happens when everything goes well? [...] There is no one who wants to sit and watch something that says that everything is good all the time, what do you show then[...] I would call it disruptive. It changes the conditions in many different ways. An app project may no longer be an app project, you realize after a while. Why should I have an app when[...] Do I need an interface or? (P2)

The UX designers expressed different unpredictable design dilemmas that they encountered during design practice involving ML. The unpredictability entailed challenges to articulate what design criteria that was needed to fulfill for what would be a successful design project. Some concepts was expressed as more prioritized when working with ML, transparency and traceability or to design for making the user comfortable with solutions that trespassed a user's integrity. Also, MLs unpredictability could also involve articulating criteria if the design solution brings with it enough value to be used at all.

4.4 Mature versus Immature customers

All of the designers expressed that they had experienced ML becoming “a big trend” or a “buzzword”. The UX designers stated that this has caused the customers to become more interested in design projects that involved ML. Also, the UX designers expressed that ML was more interesting to use because it opens up a lot of new value possibilities.

There is a certain trend level of machine learning[...] I think the great interest in AI is like magic, that is, with machine learning. It feels like magic. (P2)

There is a need to automate the industry. You want to use it because it is a way for you to produce more. It's faster, it's better. stop and cost money. (P5)

There have been many, many more AI missions now. It has kind of boomed this year. (P3)

A large number of designers expressed a pressure from the customer to use ML in their design solution. P5 was asked: “Why do you choose to use their lead in the design?” and said: “Because customers demand it”.

More that it comes from them than it comes from us or from the designers. (P2)

The majority of the designers expressed that the relationship with the customer is important and that it is the designer's responsibility to help them understand what ML can and cannot do.

You need to prove that you understand their business problems[...] AI is just an enabler; we have to go into strategy and business value. (P9)

The customer needs to understand what an AI can do and not do. You are the one who needs to help with the conditions with what is possible and what is not possible. How do they need to think about data and then also present what it looks like when an AI makes a decision? (P7)

A majority of the designers expressed that the experience working with ML could change depending on the digital maturity of the customers.

It probably goes hand in hand with how digital the customer is[...] If the customer already has a product that is very adapted for abstract things, then this will just be another[...] Some work more old-fashioned and are perhaps a little more conservative, then this will be another scary thing. Yes, there is a very big difference. (P6)

P9 and P6 stated that a more mature customer could be if they already acted in an industry and was used to working with data, and if they already had an stable infrastructure within the company

Some are quite mature because they operate in such an industry[...]Some already have robots in other domains and just change their domain. (P9)

As if you work with an insurance company where you are used to and work a lot with data, where you are used to calculated risk and so on. They think we already know this. Then it will be quite easy[...]It is easier for companies that already have the infrastructure where this can just be pushed in, so it is much easier to find both who owns the data, who should be the security, classification of the data and all such things that it can be. (P6)

P7 and P8 expressed the contrast of a UX design practice that involves working with more mature and less mature customers. Upper sentences state more mature customers.

You teach them about what it actually means and what aspects we need to think about? What is possible and what is not. (P7)

Oh AI sounds cool, what can we do with it? [...] They think an AI can do anything. But it cannot. (P7)

There is a goalkeeper in goal. There are laws and rules that one must abide by. Because it is a huge difference to work with a company that is aware of. What we do and how it affects people and the ethical. (P8)

A company that has no scruples at all, but just wants to make more money. (P8)

A majority of designers expressed that the UX design practice differentiated with the more immature customers, they needed much closer contact and more guided communication. Also, to inform the customer about the requirements about ML, and what the ML can and cannot do.

*Others may understand that they need to address AI but they may not really have that knowledge yet. (P9)
Holding the customer in the hand, especially those customers who do not have the knowledge.*

For them it is a bit scary and new and they are afraid that the budget will run away. (P4)

From the beginning, a data-driven service will not be great, because it needs to collect data for it to be good. (P4)

The majority of the customers expressed that their practice changed depending on the customer's digital maturity, that implies for example, if they have an already working product or if they work in an already similar industry.

Some may understand that they need to address this but they may not really have that knowledge yet. Sometimes it's maybe more about them ordering inspiration workshops or training from us so that they understand what to order next. (P9)

If I were to design a regular app, I can draw this, we will build and we will build this tomorrow, but if you want to build an AI app, you need to make sure that the data is in place. One sketches a future scenario. I think we should do this, so now we have to collect data so that we can do it in about three or four years as well. (P3)

4.5 Lack of support for ethical concerns

A majority of the designers expressed that they tried to work from putting the user in focus, identifying the user value, and that they wanted to enhance the user experience rather than automate.

We talk a lot about human centered AI rather than just designing for AI. (P7)

I see it a lot from the perspective of simplifying for the user and removing unnecessary steps, but then also in the extension that you want to strengthen, so you feel more competent. (P4)

The majority of the designers also expressed that the ethical concern often was neglected due to no ways to communicate about it during design practice, that it ended up more of a discussion regarding their own moral values and knowledge and that it less often was followed up. That the ethical consequences were more of an approach or a basic principle

We do not have an established process around ethics, which you may feel that we should have [...] It is more of a thing that you discuss with colleagues. (P2)

We do not have a framework that we directly relate to. I would not say that it is a feeling either. But it becomes more of an approach to our design that should be a basic principle [...] The discussion is taken up. (P1)

P3 stated that it is the designer's responsibility to communicate ethical concerns. P4 stated that there were no ethical consequences in their design practice working within the robot industry.

We have no work documentation for ethics, what I know in any case, but it's our own responsibility. And our communication with customers and users. (P3)

In our project it does not become as ethical. Because it's a workplace with robots. (P4)

A majority of designers expressed concerns about the UX design practice involving ML and mentioned things like "dark patterns". The UX designers suggested several different examples where other companies had used so-called dark pattern design where ML was involved.

Not to design according to dark patterns and other such ugly tricks it is. [...] Google's face recognition identifies dark people as something other than a dark person, so to speak. And that must not happen. (P1)

More dark patterns and stuff in the design. [...] Sometimes it can go to the forest, as well. The same with the one-on-one robots that Microsoft had, which they managed to get very racist. (P2)

The majority of the designers often referred to the company they worked for when it came to ethical considerations, relying on the ethical standards from the company, and they expressed that they could say no if they did not want to work in a particular project with unethical intentions.

If I do not want to work with things that I might think would restrict people's free will. I do not have to do that. (P6)

But (consulting firm) as a company does not take any project either, because we have an image that we should be this company that makes the world better so we never take those assignments either. So there are usually never any worries about it. (P3)

At the same time, a majority of designers stated that MLs ability to empower a business value might be so forceful that a designer can't say no. That it often falls on how someone can earn a business value on the solution. P2 stated it as:

Some features may be so heavenly good that it does not really become a user value but more a business value. That the user disappears. (P2)

P8 expressed that MLs ability to enhance the business value could lead UX designers to make decisions they do not honestly agree to. That there is an external pressure such as salary and design repetition that could affect the design decisions they make. A majority of designers expressed that a UX designer needs to be able to communicate human value before business value.

It affects the design. We design things that we may deep down feel this does not feel good. But I have to get my salary and in other countries it may even be my insurance [...] You represent a designer in some way [...] It is unreasonable to demand this from completely green and young designers; how should you be able to resist a customer? (P8)

You need to be able to communicate what an AI can do. You cannot always count on all the outcomes and how to design for something that I cannot count on what value is tricky, to say the least. (P7)

That you not only say AI and then you say a lot of complicated words [...] but we have always focused on how we can create value with it, business value? but also a lot for the user. (P3)

P8 also expressed that MLs design solutions could have consequences to society in the long term and expressed that society needs to take their responsibility and form rules or regulations, which the UX design practice can back up their arguments towards. P8 had worked with ML in areas with already existing boundaries and experienced this as helpful in his design practice.

What knowledge are we as a society prepared to lose? Are we okay with doctors in the future not knowing how to manually calculate a cancer diagnosis? Society and politics have a huge responsibility to produce rules and laws, and for us to have a system that actually means that the algorithms do the right things for us [...] Data is used in ML. This benefits the company with no ethical rules. There are no rules so the plan is open. There is no goalkeeper in the goal[...] The good thing about working in the medical field in particular is that there are a lot of ethical rules. In that way, it affects my design. How do I visualize, what functions should I build in to make it feel safe for the doctor to use the algorithm to make a diagnosis?

The majority of the UX designers expressed that working with ML during design practice often involved ethical concerns. However, the UX designers also expressed that it was challenging to work around ethics, that they did not have support to communicate it, but that instead got neglected, or discussed between colleagues. The UX designers stated that they do not have much to rely on when it comes to advising ethical concerns but the company they worked for ethical standards or their own or their colleagues' moral values. P8 expressed the worries of not having some kind of support and that it could even affect the UX designer's personal life.

4.6 Additional remarks/ Reflection

The thematic analysis was carried out from the empirical material that consists of nine professional UX designers describing their experiences of working in UX design practice with ML as a design material. From the empirical material collection, I have identified five themes of experiences. These reflected upon below and summarized in table 3.

The first experience was the absence of competence that illustrates a general overview of UX designers' lack of competence working with ML as a design material in UX design practice. This experience is interconnected in all of the other themes of experiences, which also illustrate the relevance of this experience. The absence of competence also presents several examples of the designers' abstraction of working with ML during UX design practice which had challenging consequences. For example, the lack of data and data science competence creates lots of extra communication hours between the designer and others involved, and how to reason with the ethical consequences, such as replacing a human's intellectual skills even though it could have business value. The absence of competence experience illustrates a lack of education and knowledge within the UX field using ML as a design material. The next experience illustrates an argument why UX designers do not learn more about ML as a design material.

The lack of incentives for competence development was identified because the UX designers did not express much encouragement of wanting to learn more about working with ML during UX design practice. All of the designers expressed that ML had interesting opportunities that could open up new doors for creativity. However, the majority of UX designers said that they missed out on design solutions that could be valuable because of the lack of knowledge on how to handle situations with ML. Moreover, the majority of the UX designers expressed that they instead chose to try to learn to work with ML from working on a project involving ML. The lack of incentive for competence development also illustrates examples of incentives such as a designer's understanding that data and data science entailed credibility as a designer and enhance trust from the customer. Another dilemma that the UX designers expressed concerning lack of incentive for competence development was whether it was within their responsibility to learn about ML. At the moment, they seem to rely on the company they work for to encourage the UX designers to learn about ML as a design material.

Challenges articulating design criteria experience illustrates the challenge for UX designers to articulate design criteria while working with ML. They called the design dilemmas "unpredictable". The UX designers expressed that while working with ML, it entailed disorders in their design practice. Designers gave examples where they were puzzled with different design dilemmas if the ML-empowered solution even required an interface at all or that a design solution could replace a user's intellectual skill, which the designers got confronted by as they were taught to put the user in the center. One of the designers expressed that working with ML included other types of responsibility, including being a "change agent" which means designing a sense of security or credibility in the product or service to trust or feel comfortable with the product. The experience illustrates that MLs capabilities involve articulating criteria that the designer might not have the tools or methods to explore. Consequently, they end up in a design situation where they do not know how to proceed or what is the rational approach. At the same time, the absence of competence illustrates that the majority neither possess knowledge or tools for working with ML.

UX designers experience of ML	Description
Absence of competence	UX designers expressed that working with ML as a design material requires other competencies than they previously needed during UX design practice. The UX designers indicated a need for competence development in: New methods and tools, data and data science, ethics and how to work around laws.
Lack of incentive for competence development	UX design practice involving ML shows to have less apparent incentives for designers to develop their competence. The findings show that competence development within ML in design practice could improve a UX designer. For example, basic knowledge of data and data science can have many significant rewards such as an increased credibility as a designer and an increased trust from his customer.
Challenges articulating design criteria	This finding illustrates the challenges for UX designers articulating design criteria working with ML. Design practice involves dealing with different unpredictable design situations that cause new complex design questions such as how to design around trespassing integrity and how to inform the user without threatening the user.
Mature vs. immature customer	Depending on the digital maturity of the customer the UX designers expressed that the designers need to adapt their design practice. The designers described some of the different characteristics of what is a more mature customer and less mature. Such as a more mature customer who works in an existing business where they are used to working with data such as insurance companies where they make risk analysis based on data. A less mature customer was expressed as someone that does not have a finished product yet or where there is not a stable data infrastructure.
Lack of support for ethical concerns	A UX design practice that involves working with ML was expressed involving complex design situations involving ethical concerns. However, the UX designers expressed not having any tools and support to articulate and discuss ethical concerns, instead they stated that they were neglected or not taken seriously. The dilemma for the designer thus becomes how to handle the responsibility for sometimes large societal questions.

Table 3. Summary of the five identified themes of experiences

The UX designers expressed that more customers want to use ML because of its “magic” capabilities. The mature vs. immature customer experience illustrates that the UX designer needs to adapt their way of working with them depending on their digital maturity. The designer stated some of the different characteristics of a more mature customer versus a less mature. For example, a more mature customer works in an existing business where they are used to working with data, such as insurance companies where they make risk analysis based on data. A less mature customer was characterized as someone that does not have a finished product yet or where there is not a stable data infrastructure. Depending on the digital maturity of the customer, the UX designers also expressed other types of preparation and design questions could vary. The UX designers expressed that the design practice with less mature customers implied more discussion if ML even were relevant, considering the customer's goals and needs. For example, a futuristic sketch of what the ML could do when the service or product had collected enough data. The more mature customers could, for example, appreciate that the designer put the ethical consequences before the business value, or the communication with a more mature customer communication was much more accessible. Overall the majority of the designers expressed that working with ML implied teaching the customers such as, MLs requirements, ethical consequences, or business value.

The subject of ethics was one of the more common subjects to be talked about during the interviews with the UX designers. Even though the majority of the UX designers advocated to put the user in the center during the UX design practice, they indicated a lack of support for ethical concerns. They expressed that the ethical concerns often got neglected and that they did not possess any tools or support for articulating their arguments with ethics. They expressed that it is currently more of a discussion between colleagues about what their moral values were. Lack of support for ethical concerns indicates that the absence of competence can affect a designer's rational design decisions to

build their arguments concerning ethics. They do not have support to back up ethical argumentation in design practice to build confidence for their actions.

5 Discussion

The thematic analysis identified five themes of experiences. The themes of experiences summarize the attitudes and complexities designers have when working with ML in design practice and illustrate opportunities for why we need to understand ML as a design material more thoroughly. The themes of experiences distinguish features to support the UX design practice and build on research regarding designers working with ML as a design material. The themes of experiences were:

1) Absence of competence, which illustrates UX designers expressing missing competencies to work with ML more effectively, 2) lack of incentive for competence development, the UX designers expressed not having enough apparent incentive to learn about ML, 3) challenges articulating criteria, UX designers expressed that working with ML as a design material entails challenges to articulate design criteria for assessment, 4) mature versus immature customers, UX designers expressed needing to adapt their design practice depending on the digital maturity of the customers, 5) lack of support for ethical concerns, the designers expressed that ethical concerns were sometimes neglected and not discussed seriously, that the current UX design practice lack support for argumentation and discussion. My aim with this study was to contribute to how research currently understands UX design practice and contribute insight and understanding on ML as a new design material in UX design practice.

In line with Stolterman's (2008) claim that even poorly structured and fuzzy design projects can be rigorous and disciplined with the right tools and methods, this study suggests that the UX design practice lacks the competencies to handle design situations involving ML effectively. However, in contrast to previous research on ML as a design material in UX design practice (eg., Dove et al., 2017; Holmqvist, 2017; Yang, et al., 2018abc), this study contributes with insights from UX designer's perspective of what we need to understand about ML in UX practice. This study contributes to an understanding of why we need to learn more about UX designer's experiences of incentives to learn more about ML as a design material. This could inform the UX design industry how and why learning more about ML as a design material would be valuable for them. This could also inform educators to approach this from the right direction, whether it should be different from other design materials and considered as a new design material.

This study indicates that the absence of competence with ML in UX design practice could establish disordering consequences. For example, UX designers need to be able to articulate design criteria for the experience that puts the user in focus. To be able to go forward with ideas that could be valuable for customers and the users. One potential implication would be to prepare the UX design practice with better preparatory means of support. This is in line with Goodman et al.'s. (2011) claim that research needs to influence UX designers' practice. As mature vs. immature customers indicate the characterization of the customer was expressed to be meaningful in how to approach a design project. This study calls for research characterizing customers that tend to use ML in their digital solution more fully. Also, the lack of support for ethical concerns indicates that designers working with ML encounter situations where they express uncertainty in articulating and communicating the criteria for assessment. This study indicates a calling for supporting tools and methods that can back up ethical argumentation in UX design practice, strengthening the designer's confidence and actions. UX designers need to be prepared for action and arrive with the right kind of toolbox for the right design project.

6 Conclusion and Limitations

Previous research suggests that design practice lacks understanding of how to work with ML as a design material effectively and how it can add value to their practice. This study reports an interview study with 9 UX designers' current situation working with ML as a design material. It expands previous research by articulating insights from UX designer's perspectives of what we need to understand about ML in UX practice. It contributes with further insight for researchers studying this domain practice. And hopefully, inform the studied practice itself.

My findings advocate with research that MLs open up new doors for creativity for designers with their "magical" capabilities to enhance the user's user experience. My findings illustrate that UX design practice stands in for challenges that seem to disrupt their way of working effectively. My findings were: *absence of competence, lack of incentive for competence development, challenges articulating criteria, mature versus immature customers, and lack of support for ethical concerns*. However, the findings also inform opportunities that would be interesting to consider for design practitioners and researchers.

This research study investigates an emerging area of design practice and research. The majority of the UX designers participating in this research study had less experience working with ML as a design material. That indicates that some of these experiences have a possibility to come with the newness of working with ML as a design material. This might have affected the result, which also advocates for a follow-up study in the future. Still, this research study accounts for the experience of working with the material in the current time. What is also worth noting is that the UX designers who participated in the study were all consultants. This can affect the outcome of the grants that the study advocates. For example, mature vs. Immature can mostly be seen as an experience that a consultant pays attention to. However, it identifies outcomes for design practice in general.

Acknowledgment

I would like to thank all the schoolmates who have participated in valuable conversations and discussions that have contributed to this study being carried out. I would also like to thank my supervisors Michel Thomsen and Maria Åkesson who contributed to the study staying in the right direction. To all the UX designers who participated in the study. I fought to get hold of you, without you I could not have completed my study and I thank you for that. Last but not least Malin Eriksson who endured with me during the heat of the war.

References

- Amershi, S., Weld, D., Vorvoreanu, M., Fourney, A., Nushi, B., Collisson, P., and Horvitz, E. (2019). *Guidelines for human-AI interaction*. CHI 2019, Glasgow, (pp. 1-13).
- Braun, V., and Clarke, V. (2006). *Using thematic analysis in psychology*, Qualitative research in psychology, Auckland, (pp. 77-101).
- Courage, C., and Baxter, K. (2005) *Understanding your users: A practical guide to user requirements methods, tools, and techniques*, Gulf Professional Publishing, Amsterdam.
- Cooper, A., Reimann, R., Cronin, D., and Noessel, C. (2014). *About face: the essentials of interaction design*, Indianapolis, John Wiley & Sons, Inc.
- de Miranda, L. (2019). *AI och Robotar på 30 Sekunder: de 50 viktigaste idéerna och innovationerna inom intelligent maskinutveckling, var och en förklarad på en halv minut*, Tukan förlag, Västra Frölunda.
- Dove, G., Halskov, K., Forlizzi, J., and Zimmerman, J. (2017). *UX design innovation: Challenges for working with machine learning as a design material*, CHI 2017, Denver, (pp. 278-288).

- Holmquist, L. E. (2017). *Intelligence on tap: artificial intelligence as a new design material*, Interactions, Silicon Valley, (pp. 28-33).
- Löwgren, J. (2012), Interaction Design - brief intro, The encyclopedia of human-computer interaction, *The Interaction Design Foundation*, Retrieved from: <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/interaction-design-brief-intro>
- Löwgren, J., and Stolterman, E. (2004). *Design av informationsteknik: Materialet utan egenskaper*, Studentlitteratur AB, Lund.
- Konstan, J. A., and Riedl, J. (2012). *Recommender systems: from algorithms to user experience*. User Model User-Adap Inter, Minneapolis, (pp. 101-123).
- Myers, M. D., and Newman, M. (2007). *The qualitative interview in IS research: Examining the craft*, Information and organization, Auckland (pp. 2-26).
- Getto, G., & Beecher, F. (2016). *Toward a model of UX education: Training UX designers within the academy*. IEEE Transactions on Professional Communication, Greenville, (pp. 153-164).
- Goodman, E.,
- Stolterman, E., & Wakkary, R. (2011), *Understanding interaction design practices*, CHI 2011, Vancouver, (pp. 1061-1070).
- Stappers, P. J., & Giaccardi, E. (2017), Research through design. In The encyclopedia of human-computer interaction, *The Interaction Design Foundation*, Retrieved from: <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/research-through-design>
- Xu, W. (2019). Toward human-centered AI: a perspective from human-computer interaction. Interactions, Miami, (pp. 42-46).
- Yang, Q., Zimmerman, J., Steinfeld, A., & Tomasic, A. (2016). *Planning adaptive mobile experiences when wireframing*, DIS 2016, Brisbane (pp. 565-576).
- Yang, Q. (2018, March). Machine Learning as a UX Design Material: How Can We Imagine Beyond Automation, Recommenders, and Reminders?, AAAI 2018, Pennsylvania, (pp. ??)
- Yang, Q., Banovic, N., & Zimmerman, J. (2018, April). Mapping machine learning advances from hci research to reveal starting places for design innovation, CHI 2018, Montréal (pp. 1-11).
- Yang, Q., Scuito, A., Zimmerman, J., Forlizzi, J., & Steinfeld, A. (2018, June). *Investigating how experienced UX designers effectively work with machine learning*, DIS 2018, Hong Kong (pp. 585-596).
- Yang, Q., Steinfeld, A., Rosé, C., & Zimmerman, J. (2020, April). *Re-examining whether, why, and how human-ai interaction is uniquely difficult to design*, CHI 202, Honolulu, (pp. 1-13).
- Fernaes, Y., & Sundström, P. (2012). *The material move how materials matter in interaction design research*, DIS 2012, Newcastle, (pp. 486-495).
- Zhu, J., Liapis, A., Risi, S., Bidarra, R., & Youngblood, G. M. (2018). *Explainable AI for designers: A human-centered perspective on mixed-initiative co-creation*, IEEE 2018 (CIG), Maastricht, (pp. 1-8).



It has been a chaotic, exciting, and developing journey in recent years on many different personal levels. Now the next chapter begins, and it will be interesting to see what will happen.
Emil Bergström



PO Box 823, SE-301 18 Halmstad
Phone: +35 46 16 71 00
E-mail: registrator@hh.se
www.hh.se