UX Toolbox for Software Developers

Methods and Training

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METHODS AND TRAINING

BY
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DISSERTATION SUBMITTED 2016

AALBORG UNIVERSITY
DENMARK

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Dissertation submitted

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ABSTRACT

The aim of this thesis is to investigate how agility can be achieved when performing UX work within an agile, industrial software environment. Thus this thesis investigates how UX work can be conducted by software developers while following and supporting the sprint rhythm.

Three research questions are put forward. These are answered by an interview study performed within the Danish industry, and by an initial explorative study and two action research studies. These studies were concerned the iterative processes of the development of a UX Toolbox. This toolbox contains selected modified UX methods, combined with supporting materials in the form of guidelines and templates. The thesis furthermore addresses the development of training procedures and –materials. By applying structure to the usability and UX methods, minimizing the load of in-depth analysis and by developing supporting materials the toolbox proved feasible to fit the sprint rhythm.

This work has been described in five research contributions, which are included in the present work. The overall result of the studies is positive and it is found that by using the developers' feedback in the modification process, the methods have truly become applicable within an agile, industrial setting. The supporting materials and training have induced the developers to feel confident in independently performing this type of work. Furthermore, the application of the toolbox has entailed more transparency when working with UX, a shared language in the development team and a way for the development team to reduce UX bottlenecks.

RESUMÉ

Formålet med denne afhandling er at undersøge, hvordan agilitet kan opnås, når man udfører UX arbejde i et agilt, industrielt software miljø. Denne afhandling undersøger hvordan UX arbejde kan udføres af softwareudviklere mens de følger og supporterer sprint rytmen.

Tre forskningsspørgsmål er fremsat. Disse er besvaret ved hjælp af en interviewundersøgelse foretaget i den danske industri, og ved en indledende eksplorativ undersøgelse og to action forskningsundersøgelser. Disse undersøgelser omhandlede de iterative processer i udviklingen af en UX værktøjskasse. Denne værktøjskasse indeholder udvalgte modificerede UX metoder, sammen med understøttende materialer i form af retningslinjer og skabeloner. Afhandlingen omhandler desuden udviklingen af træningsprocedurer og -materialer. Ved at applikere struktur til usability og UX metoder, minimere byrden af dybdegående analyse og ved at udvikle understøttende materialer, viste det sig at værktøjskassen passer sprint rytmen.

Dette arbejde er blevet beskrevet i fem forskningsbidrag, som indgår i det foreliggende arbejde. Det samlede resultat af undersøgelserne er positivt, og det konstateres, at ved at bruge udviklernes feedback i modifikation processen, bliver metoderne virkelig anvendelige i det agile, industrielle miljø. De understøttende materialer og træningen har gjort at udviklerne føler sig sikre i at udføre denne type arbejde på egen hånd.

Endvidere har anvendelsen af værktøjskassen medført større gennemsigtighed, når der arbejdes med UX, et fælles sprog i udviklingsteam og en måde for udviklingsteamet at reducere UX flaskehalse.

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Part I

Part II: Papers

ABBREVIATIONS & DEFINITIONS

KPI	Key Performance Indicator. KPI is a measurement tool, evaluating the success of an organization or of a particular activity in which it engages.
POC	Point of care. POC is the location at which patient services are delivered.
Sprint rhythm	Normally two to four weeks. In the present work three weeks.
Study	In the present work a study refers to training and evaluation of one UX method within a company. The thesis consists of six studies – three carried out at Radiometer, two carried out at SenDx and one carried out at TC Electronic.
UX	User experience. In the present work UX is a broader, superior area, which includes usability as well.
UX method	User experience method, which includes usability methods cf. above.

LIST OF PAPERS

This thesis investigates how UX work can be conducted in an agile software development environment while following and supporting the sprint rhythm. This is done by modifying UX methods, developing supporting materials and by training software developers to perform this type of work. The thesis consists of this summary and the five individual paper contributions listed below:

[1] Øvad, T., Larsen, L.B., 2015. *The Prevalence of UX Design in Agile Development Processes in Industry*. In: Proceedings of the 2015 Agile Conference (Agile 2015). IEEE Computer Society Press, pp. 40–49.

[2] Øvad, T., Larsen, L.B., 2014. *Experiences from Training Agile Software Developers in Focused Workshops.* In: Proceedings of the 2014 International Conference on Interfaces and Human Computer Interaction. IADIS Press, pp. 397 – 401.

[3] Øvad, T., Bornoe, N., Larsen, L.B., Stage, J., 2015. *Teaching Software Developers to Perform UX Tasks.* In: Proceedings of the 2015 OzCHI Conference. ACM Conference Proceedings Series, pp. 397-406.

[4] Øvad, T., Larsen, L.B., 2016. *Developers Love Their Templates – or How to Train Software Developers to Perform UX Tasks*. Peer reviewed book chapter in: Integrating User Centered Design in Agile Development. Springer.

[5] Øvad, T., Larsen, L.B., 2016. *How to Reduce the UX Bottleneck by Training Your Software Developers.* Submitted to "Journal of Behaviour & Information Technology", Taylor-Francis 2016.

This thesis has been submitted for assessment in partial fulfillment of the PhD degree. The thesis is based on the submitted or published scientific papers which are listed above. Parts of the papers are used directly or indirectly in the extended summary of the thesis. As part of the assessment, co-author statements have been made available to the assessment committee and are also available at the Faculty. The thesis is not in its present form acceptable for open publication but only in limited and closed circulation as copyright may not be ensured.

ACKNOWLEDGEMENTS

During these three years of research I have received valuable advice, comments and encouragement from my family, friends and colleagues. I am very grateful for your support.

A special thank you to my supervisor, Lars Bo Larsen, for support and constructive supervision while developing the UX Toolbox and writing the research contributions.

I also wish to thank my colleagues at Radiometer for all your support and encouragement, and for participating as guinea pigs in my research - it has been a pleasure working with you guys. The same goes out to my colleagues at SenDx during my stay in the US.

Furthermore, I wish to thank my colleagues at the Signal and Processing (SIP) section at the Department of Electronic Systems at Aalborg University for some great and fun years.

Last but not least, a big thank you to my family and friends for being there no matter what – your support made me stay sane during these three years of research and traveling.

Love you all.

Tina Øvad

Copenhagen, January 2016

You can't gather all the requirements up front.
The requirements you do gather will change.
There is always more to do than time and money will allow.

The Agile Samurai, (Rasmusson et al., 2012)

Part I

CHAPTER 1. INTRODUCTION

Focusing on user experience (UX) design in product development can lead to great business benefits, such as more satisfied customers, decreased training and support costs, reduced development time and costs, decreased user errors, etc. resulting in increased sales and revenue, etc. (UXPA, 2013).. Consequently the focus on UX design has increased within industry in recent years (i.a. Øvad and Larsen, 2015). However, the discussion of "a gap" between UX methods developed in the academic and how the industry employs these methods, have floated back and forth for years. More than a decade ago Wixon stated that *"The literature evaluating usability methods is fundamentally flawed by its lack of relevance to applied usability work."* (Wixon, 2003). A couple of years ago Moreno and colleagues stated that *"...the integration of usability engineering methods into software development life cycles is seldom realized in industrial settings."* (Moreno et al., 2013)

Methods addressing usability and UX are often mentioned in research papers, but rarely applied to the current practice of software development (Ardito et al., 2014). This in itself is a major problem, but a new obstacle has arisen following the popularity of agile development (i.a. Ambler et al., 2014; Larusdottir et al., 2010; Øvad and Larsen, 2015). Even though different steps have been taken to both reduce the gap between academia and industry (i.a. Bornoe and Stage, 2014; Bruun and Stage, 2014; Dittrich and Lindeberg, 2004; Kautz, 2010; Moreno and Yagüe, 2012, 2012; Rönkkö et al., 2008) and to facilitate integration between UX design and agile development (i.a. Ardito, Buono, Costabile, & Lanzilotti, 2013; Bruun & Stage, 2014; Kollmann, 2008; Meingast et al., 2013; Miller, 2005; Schwartz, 2013a, 2013b; Silva, Silveira, & Maurer, 2012, 2013; Singh, 2008; Sy, 2007), industry still finds this type of work challenging.

The first problem is related to usability and UX methods and originates from an academic tradition and as Wixon (2003) stated *"... flawed by its lack of relevance to applied usability work".* The focus has been on developing the best possible usability and UX methods with no or little regard to time, money and sometimes relevance. For example, even though companies rarely have time to fix more than the most pressing usability problems, methods are still aiming to capture as many flaws as possible.

Secondly, many of these methods were designed when almost all software development was developed in a waterfall environment. This approach made it possible to perform extensive user studies in the beginning of the development process and large usability evaluations in the end. By introducing the agile

framework in the development processes, new demands arose for the usability and UX methods – especially if this work had to follow the rhythm of the sprint cycles.

It seems indeed possible to combine the agile development processes with the methodologies of usability and UX design and have them become integrated parts of the development process. However, agile software development processes are still lacking UX awareness in their development lifecycles (Hussain et al., 2009) and little guidance exists on how to integrate these two in practice and the day-to-day work in which the processes are used are uncharted (Ferreira, 2012).

I therefore challenge the usability and UX community by stating that the existing usability and UX methods have to be tailored in order to be applicable in the agile development framework. This should be combined with development of new methods as well, suitable to this new development pace. By doing so, we can potentially secure focus on usability and UX throughout the products' agile development process. There is a lot to gain by performing usability and UX work in an agile framework - in addition to the classical agile benefits e.g. transparency, always something to show to the users, etc. (Sutherland and Schwaber, 2011). We can potentially make the development process truly user centered by applying user feedback to every development sprint.

In this thesis I propose to aim towards being truly agile, meaning everyone being able to perform every work task on the development team. I propose to let software developers conduct certain usability and UX tasks independently of UX specialists. This might seem a bit radical. However, by using the software developers as a UX work resource, we can facilitate a permeation of UX throughout the whole development process. Working with UX will become more transparent, we will facilitate a shared language in the development team and we will minimize potential UX bottlenecks. By letting the software developers perform some of the more formative UX tasks, the UX specialists in the organisation will have more resources to focus on user research prior to the development phases and to perform more extensive usability evaluations at the end of the development process. This should be seen in the light of earlier studies have not succeeded in being agile in these phases, when the developed product has a certain complexity.

The thesis introduces the iterative development of a UX Toolbox. This toolbox is to be used by software developers to perform certain UX task independently of UX specialists. The toolbox contains usability and UX methods modified to be applied in an agile, industrial setting, combined with supporting materials. The developers are trained in the different methods to prime them to perform this work.

To lay a foundation for the iterative development of this toolbox, I made a definition of UX for the present work. This is followed by a presentation of the study settings. To finish the introduction, I briefly present other approaches to

integrate UX and agile development, and finally the research objective and questions are presented.

1.1. DEFINITION OF USER EXPERIENCE FOR THE PRESENT WORK

UX is often perceived as the same as usability. This is not the case, but they closely relate to each other. Moczarny et al. (2012) observed that UX and usability can relate to each other in three different perspectives, see Figure 1.

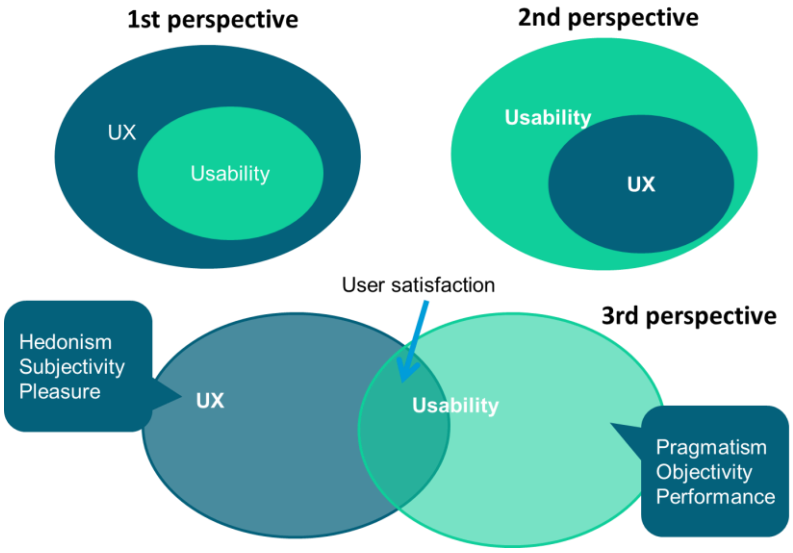

Figure 1. Three different perspectives on how usability and UX relate to each other. Addapted from (Moczarny et al., 2012).

In the present work I choose to align myself with the 1st perspective in Figure 1; That UX is a broader, superior field, or umbrella, which includes usability. Hence, the notion UX method includes usability methods as well. Consequently the term UX will be used in this respect in the following sections.

1.2. INTRODUCTION TO THE STUDY SETTINGS

The study was initiated by the Danish medico company, Radiometer. Radiometer is a global provider of solutions for acute care testing and a leading provider of technologically advanced solutions that simplify and automate all phases of acute care testing. Radiometer provides solutions for blood gas analysis, transcutaneous monitoring and immunoassay testing for cardiac, coagulation, infection and

pregnancy markers and the company is the market leader in the field of blood gas measurements ("Radiometer Medical ApS," 2015).

At the study onset, Radiometer was faced with two problems. Firstly, the strict regulatory demands from the U.S. Food and Drug Administration (FDA), to be in compliance with the usability standards e.g. ISO (2010). To manage this, Radiometer had focused on usability and UX design for a number of years, but had experienced problems in this work and when launching the latest released analyzer, usability work was conducted on trailing edge. This had been an eye opener for the company. Secondly, at the release of its latest blood gas analyzer Radiometer had experienced a change in the user groups handling the devices. This new analyzer was lightweight, easy to place and had a whole new way of maintenance, making it truly a point of care (POC) device. This meant that the user group operating the analyzer had changed.

The analyzers had up until then been placed in laboratories, here they were primarily operated by specialized technicians. The analyzers were now placed in POC, close to the patients. Now nurses became the primary operators. This called for a design that induces security and confidence even for intermittent users – and to provide good UX for a larger user group. These two challenges made it clear for Radiometer management that the company did not have the maturity level regarding UX they would like to have. Hence, management decided to initiate different initiatives to elevate the UX maturity within the organization. Firstly, it was important to secure the right competences in-house, hence more usability and UX specialists were hired. Secondly, Radiometer wanted to focus on UX when developing embedded software for medical devices. The goal from management was to make the software team more self-sufficient and less dependent on UX specialists when having to decide on minor UX and usability questions.

Consequently, Radiometer has a dedicated UX team. But they intend the software developers to perform minor UX tasks independently - particularly more formative tasks. Thereby facilitate a permeation of UX through the whole development process, develop a shared language and minimize potentially UX bottlenecks in the software development.

1.2.1. COLLABORATING COMPANIES

In addition to Radiometer, I have had the pleasure of collaborating with two other companies; TC Electronic and SenDx Medical.

TC Electronic: TC Electronic manufactures audio equipment, primarily for the music industry, e.g. guitar and bass amplifiers, guitar pedals, sound and picture production systems, and broadcast systems. The company's headquarter and main R&D facility is located in Denmark. TC Electronic has no dedicated UX team and

the company has no plans to build one, but intends the R&D teams to carry out UX tasks. ("TC Electronic," 2015)

SenDx Medical: SenDx is a subsidiary to Radiometer and develops medical devices, with a focus on blood gas analyzers. The company is located in California, US. SenDx is under the same regulatory demands as Radiometer concerning the usability standards put forward by FDA and have faced the same obstacles as Radiometer concerning this. SenDx has people working with usability, but relies on Radiometer's UX team concerning UX tasks. This is partially due to a demand to be aligned design-wise, hence having a recognizable product family. However, by upgrading the developers' UX skills at SenDx, they can perform minor usability and UX task on site instead of always having to s rely on the Radiometer UX team. ("SenDx," 2015)

I had the opportunity to work as a UX designer at Radiometer five months prior to the initiation of this study. Furthermore, I worked as a UI designer at SenDx for three months during my stay in the US.
The thesis consists of six studies – three carried out at Radiometer, two carried out at SenDx and one carried out at TC Electronic. These are addressed throughout the thesis.

1.3. DEFINITION OF AGILE DEVELOPMENT

All three companies are agile in their development processes and all use Scrum. Radiometer has used Scrum for five years, TC Electronic for four years and SenDx for five years. However, Scrum was not perceived as "pure" in neither of the companies.
All three companies use three week sprints. Thus, one of the requests from the companies was that the UX methods should fit into the Sprint rhythm.

To understand agile development, we have to understand what tradition it breaks with. If a software project adapts a traditional development framework e.g. the waterfall approach, all requirements have to be defined upfront. Nowadays, this can be a problem, since requirements for a product can change from one day to another, new technologies can emerge, etc. This potentially can give problems with deadlines and can end up causing large unexpected expenses.

Agile software development processes are a family of development frameworks e.g. Scrum and XP. These development frameworks share a common philosophy, stated in Agile Manifesto (2001). The four main values are:

- *Individuals and interactions over processes and tools*
- *Working software over comprehensive documentation*

- *Customer collaboration over contract negotiation*
- *Responding to change over following a plan*

Agile Manifesto (2001)

By employing an agile development framework, a company has the ability to respond to shifting requirements in a project. Furthermore, the collaboration between the development team and the customer becomes transparent since they collaborate closely, combined with the possibility to have the customer provide continuous input and feedback to the development process. ("Agile Manifesto," 2001) This is something UX can benefit from as well.

1.3.1. SCRUM

Scrum is an iterative and incremental framework, developed to optimize predictability and risk control. (Sutherland and Schwaber, 2011) Scrum has been used in software development since the beginning of 1990's. It is important to note, that Scrum is not a process or technique for building products, but a framework where it is possible to apply different processes and techniques within. (Sutherland and Schwaber, 2011)

The premise for Scrum is that software development can be a very complicated and unpredictable process. (Schwaber, 1997) Hence, the foundation of Scrum is based on empiricism, meaning that knowledge should come from experience, and decisions should be based on what is known. (Sutherland and Schwaber, 2011) Figure 2 shows the Scrum process.

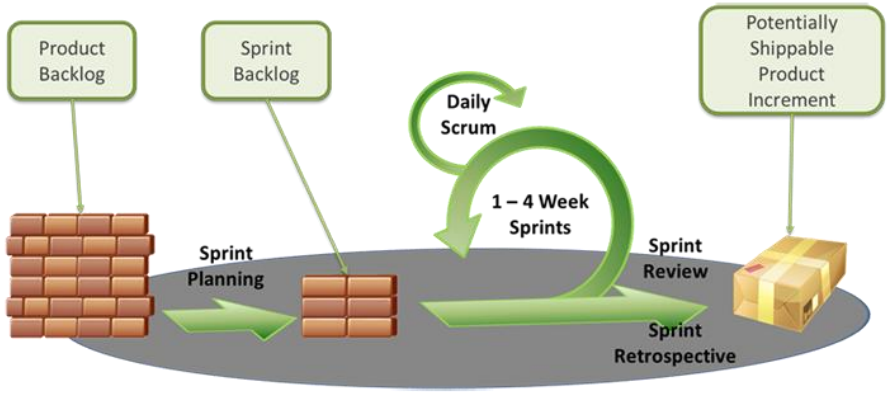

Figure 2. The Scrum framework (Broomfield, 2005)

The Scrum framework has four ceremonies: Sprint Planning; Daily Scrum (Daily Stand-up); Sprint Review; Retrospective, these are not of scope for the present work and are therefore not further elaborated on.

A Scrum Team consists of three roles: the Product Owner, the Scrum Master and the Development Team. Below is a short description of the different roles, with a focus on the relevance for the research study:

- **The Product Owner** is one person, not a group of stakeholders. The Product Owner is responsible for managing the Product Backlog, and maximizing the value of the product and the work performed by the Development Team.
- **The Development Team** is self-organizing, cross-functional by having all acquired skills in the team and they manage the work within the team. The synergy from this optimizes their overall efficiency and effectiveness.
- **The Scrum Master** serves the Development Team by removing external hurdles, coaching in Scrum theory, self-organization, cross-functionality, and in creating high-value products

(Sutherland and Schwaber, 2011)

The focus in the present work is on the Sprint rhythm and how the Development Team can be equipped to perform minor UX tasks.

1.4. AGILE DEVELOPMENT AND UX

As stated in the beginning of the chapter several attempts have been made to work with usability and UX in agile environments. When looking at more applicable approaches, three approaches stands out: The parallel approach (i.a. Beyer et al., 2004; Kollmann, 2008; Miller, 2005; Sy, 2007) the satellite approach (Kollmann, 2008) and UScrum (Singh, 2008).

1.4.1. THE PARALLEL APPROACH / SPRINT ZERO

(Øvad and Larsen, 2015) This approach is described by i.a. Beyer et al., 2004; Kollmann, 2008; Miller, 2005; Sy, 2007. The parallel approach can be seen in Figure 3.

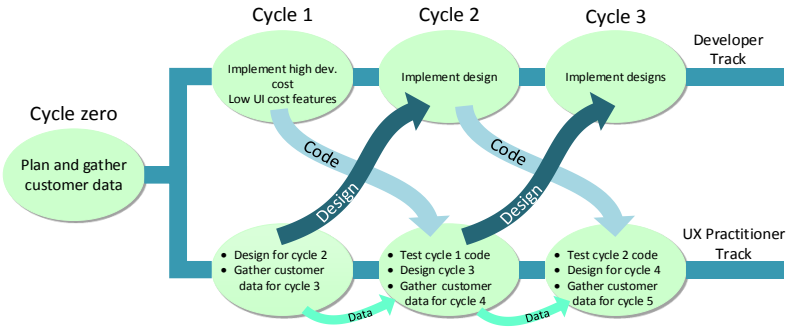

Figure 3. The parallel approach as described by (Sy, 2007).

In the parallel approach the UX specialists introduce a cycle or sprint zero, where they plan, gather user information, user requirements, etc. UX specialists are thus able to run some sprints ahead of the rest of the development team concerning design and some sprints behind regarding user tests. This framework is a very good transition model. However, if the aim is to be truly agile this is not a permanent solution due to the UX specialists often not working agile. In addition, the development process will never realize the full benefits of cross-functional synergy of different professions working together, because their focus will always be at different stages of the development. (Sy, 2007)

1.4.2. THE SATELLITE APPROACH

Another approach, which is quite popular in industry (Øvad and Larsen, 2015) is the satellite approach. This is shortly described in Kollmann (2008). This approach can be seen in Figure 4.

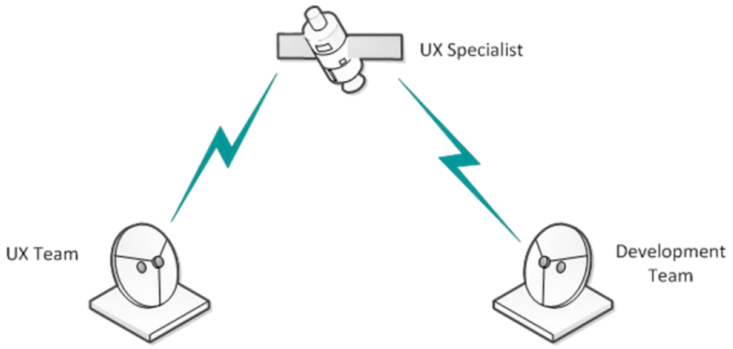

Figure 4. The satellite approach as described by Kollmann (2008).

In the satellite approach the UX specialist is working as a satellite to the development team. The UX specialist is supported by other UX specialists outside the development team. This approach corresponds to having a UX consultant working together with the development team. Different problems arise with this approach. Kollmann (2008) states that a problem can occur if the satellite UX specialist is disconnected from the user experience team and the results from research and tests risk to be disconnected from the whole UX vision (Kollmann, 2008). Furthermore, one could imagine problems of a UX bottleneck, if the UX specialist is working together with more than one development team at a time. Finally, the UX specialist might not be working agile at all.

1.4.3. U-SCRUM

A third approach is U-Scrum described by Singh (2008), see Figure 5.

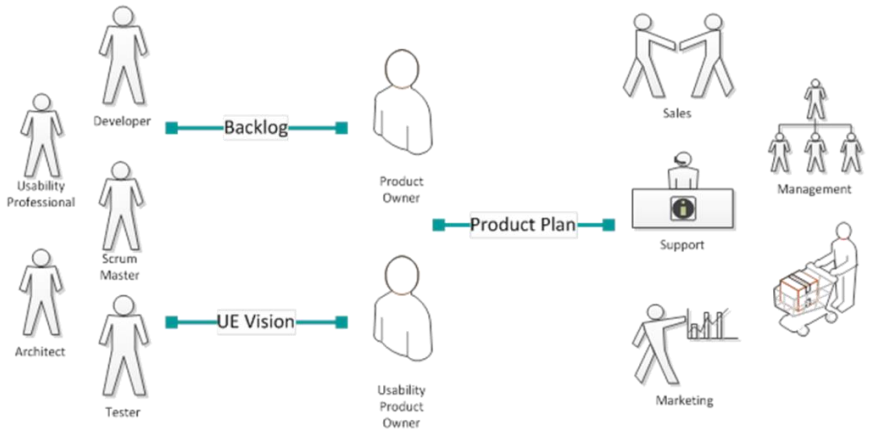

Figure 5. U-Scrum as described by Singh (2008).

With Scrum as the chosen development framework, U-Scrum can be a solution for working agile with UX. In U-Scrum the role of Product Owner is assigned to two peers; one represents the traditional role with focus on traditional functions, and another is focusing on UX. The UX product owner is responsible for establishing the UX vision for the product. (Singh, 2008) Using U-Scrum is beneficial for products which are novel and complex. In less complex cases, the advantage is not big enough due to the coordination overhead between two Product Owners. (Singh, 2008)

The obstacles mentioned in relation to the three approaches are addressed via the present work. A discussion of these three approaches and the UX Toolbox is found in section 5.4.

1.5. RESEARCH QUESTIONS

As stated in the previous section, different approaches have been employed to integrate UX with agile development. But no one has yet succeeded in integrating UX fully with agile development. Hence, this thesis seeks to investigate how and if it is possible to conduct UX work in line with the agile development sprints, with the premise that the software developers should be able to facilitate some of this work. If this can be done successfully, this approach potentially can support the different approaches mentioned above.

The overall objective of the project is to answer the question:

- *How can UX work be conducted in an agile software development environment while following and supporting the sprint rhythm?*

To answer this question three research questions are put forward:

1. *What is the current state of user experience and agile processes within industry?*

2. *Is it possible to tailor existing UX methods in order to plan, conduct and analyse findings within one agile development sprint?*

3. *How can software developers be supported when conducting UX work?*

CHAPTER 2. RESEARCH METHODOLOGY

Conducting research in industry induce an ambition of both wanting to improve the work practices in the companies and at the same time add to the body of knowledge and research within the field. This can be quite challenging. The dual imperative calls for a variety of research goals and activities (Mathiassen, 2002). Mathiassen (2002) states that: *"These goals can be expressed in terms of the types of knowledge that a research initiative intends to create to solve specific industrial problems and to add to the body of knowledge within the systems development profession".* (Mathiassen, 2002) To do so, Mathiassen (1998) adapted the framework offered by Vidgen and Braa (1997). This new framework distinguishes between three different types of knowledge: understand, support and improve (mapped outside the triangle in Figure 6) and three corresponding activities to reach these goals (mapped inside the triangle in Figure 6). This framework and what it represents corresponds very well with the ambitions for the present work.

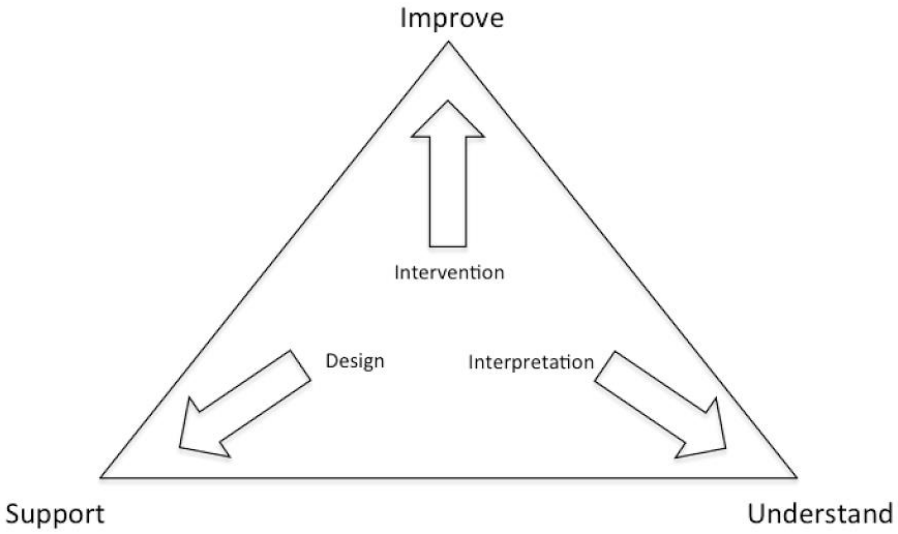

Figure 6. Research goals and activities (Mathiassen, 1998) adapted from (Vidgen and Braa, 1997)

It is possible to pursue each goal independently. However this will reduce the opportunities to learn about practice. The activities support and require each other. Hence, by attempting to change the current practice, a deeper understanding of it emerges. By having this deeper understanding, it is possible to support the practice

by designing new artifacts. When trying to improve the practice, the artifacts and interpretations are tested (Mathiassen, 2002).

Since I had the opportunity to work in two of the collaborating companies, I was able to enter into longitudinal studies to pursue the goals mentioned above. This combined with the character of the research made me chose to frame the study as an action research study.

2.1. ACTION RESEARCH

To initiate this research, I developed an action research protocol. This protocol documented initial thoughts, roles, controls framework, usefulness, documentation, transferability, decisions for each of the action research criteria (Nielsen, 2007).

My focus throughout the research was not to explore the Action Research paradigm, but to use it. Hence, I will not make a full account of Action Research within this thesis. I chose to make use of the Collaborative Practice Research approach as put forward by Mathiassen (2002). By using this approach it was possible for me to connect the need to understand the current practices of working with UX and agile software development in the companies, with the need to integrate these two frameworks to improve a potential final product. Furthermore, this approach offered structure for the companies by allowing me and software developers to collaborate by combining action research, experiments and more traditional research approaches (Mathiassen, 2002). This approach facilitated firsthand experience of the different work and processes together with involving the developers in the research process as well. A downside to this was the unpredictability and lack of control of the research output. However, I judged that the new insights and new ideas gained by having this close collaboration with the developers compensated for this risk. Via training sessions (Mathiassen would call these experiments) it was possible to assess new practices controlled by me, with a focus on both designing and evaluating different types of artefacts (the materials) and to improve practices (the integration). It could be argued that this approach inclines towards a more field experiment view than action research, since training, especially all the hands-on tasks, were conducted as controlled field experiments, testing on real life tasks. (Mathiassen, 2002) However, the emphasis of the training was twofold: 1. Changing the developers' attitude towards UX work by training them in the different modified UX methods (action research); 2. Designing, integrating and evaluating the developed methods and artefacts (field experiments). (Mathiassen, 2002) One could argue that by supplying the developers with specific artefacts, the training (experiment) to some extent was controlled.

2.2. SELECTING UX METHODS FOR THE TOOLBOX

The number of usability and UX methods is quite high. Ferre et al. (2005) counted 95 different methods and techniques. To narrow down the list and judge which methods would be more appropriate to be used by the developers, further selection had to be done. First, I looked into which methods had been used for this purpose before by other researchers and within other companies. Secondly, the collaborating companies had some wishes and requests for the methods. The methods should:

- Enabling the developers to perform limited formative testing (Radiometer and SenDx)
- Enabling the developers to get to know the end-users (Radiometer)
- Feed directly into the development process (Radiometer and SenDx)
- Provide a simple way to gather insights of user behavior (Radiometer, SenDx and TC Electronic)
- Fit into the companies' agile development process (Radiometer, SenDx and TC Electronic)
- Be fairly easy to learn, plan, conduct and analyze, since non experts were to perform them (Radiometer, SenDx and TC Electronic)
- Training should be conducted within one day (Radiomter and SeDx)

(Øvad and Larsen, 2016)

These selection criteria formed a short list of potential suitable methods:

- Situated observations and interviews e.g. Contextual Inquiry (Beyer and Holtzblatt, 1997; Holtzblatt et al., 2005)
- AB-testing (Rubin and Chisnell, 2008)
- Different lightweight methods such as:
    - Instant Data Analysis (IDA) (Kjeldskov et al., 2004)
    - Rapid Iterative Testing and Evaluation (RITE) (Medlock et al., 2002)
- Heuristic Evaluation (Nielsen and Molich, 1990)
- Cognitive walkthrough (Polson et al., 1992)
- Think aloud test (Lewis, 1982)
- Focus groups (Krueger and Casey, 2001)

(Øvad and Larsen, 2016)

Due to the limited resources available within the PhD study, three methods were selected in consultation with the companies. The methods were the ones the companies regarded as the most beneficial for their current development phases. The methods were:

- Focus group technique, modified by (Øvad and Larsen, 2014). This is denoted Focused Workshop.
- Comparative usability testing, modified by (Øvad et al., 2015). This is denoted AB-testing.
- Contextual Inquiry as described by (Beyer and Holtzblatt, 1997; Holtzblatt et al., 2005) and modified by (Øvad and Larsen, 2016). This is denoted Contextual Interview.

(Øvad and Larsen, 2016)

This shortlist formed the basis for the UX Toolbox and the listed methods are addressed throughout the thesis.

2.3. ITERATIVE DEVELOPMENT PROCESS OF THE UX TOOLBOX

The different UX methods, described in Chapter 2.2 were modified to be more applicable in an industrial, agile development environment. Various materials were developed during the iterative process as well, see Figure 7. For more details concerning the modified methods and the developed materials, see Contribution 2, 3, 4 and 5.

Interviews were carried out to initiate the work with each of the selected methods and after every encounter. The initial interviews were performed to gauge the developers' expectations and knowledge about the given method. The other interviews were carried out to assess the developers' impressions and the suitability of the modified method and developed materials. The quality of the data gathered by the developers was validated by in-house specialists. To ensure the validity in the studies further, three external researchers performed parts of the training. When and where is stated in the corresponding contributions. To strengthen the studies the data collection was triangulated by making use of observations, semi-structured interviews and analysis of the documentation created by the developers during both training sessions and when they conducted the UX work independently. AB-testing was applied at both Radiometer and SenDx and contextual inquiry/interview at Radiometer, SenDx and TC Electronic, see Table 1.

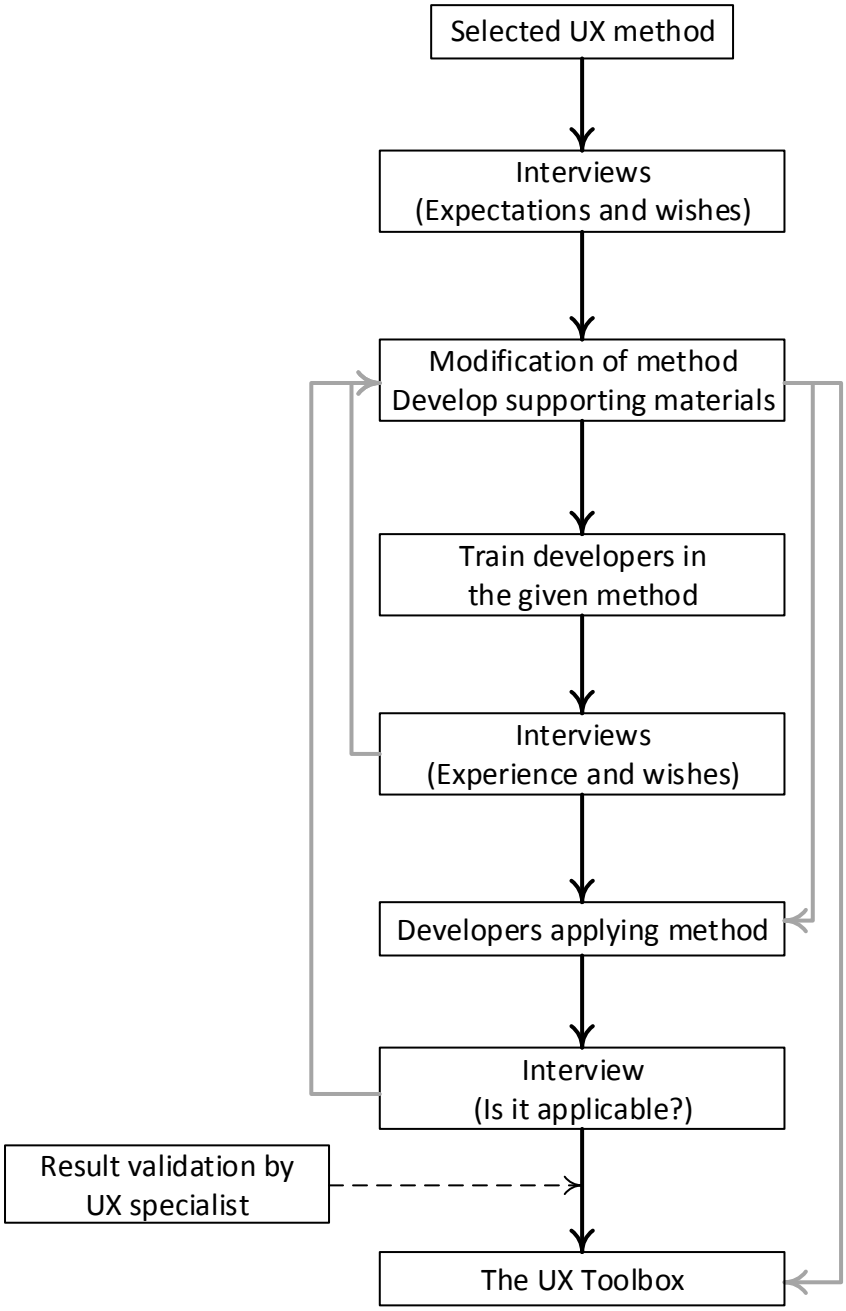

Figure 7. The encounters in the iterative development process

Table 1. Overview of the training and evaluation iterations

	TC Electronic	**Radiometer**	**SenDx**
Focused Workshop		Summer 2014 Summer 2014	
AB-testing		Fall 2014 Winter 2015	Spring 2015 Summer 2015
Contextual Interview	Fall 2013 Winter 2014	Spring 2015 Fall 2015	Summer 2015 Summer 2015

It should be noted that the Action Research protocol was not followed at TC Electronic. The research performed at their site should be looked upon as an initial explorative study.

2.4. TRAINING OBJECTIVES

This section presents the objectives of the training sessions. The goal was to use these objectives to evaluate whether the training had been successful.

To define the objectives and acquire an overview of the training process, I made use of Bloom's revised Taxonomy Table presented by Krathwohl (2002). The table proved useful when wanting to classify objectives, activities, and assessments for the training, and provided a visual representation of my aim. Additionally, the table was used to classify how both instruction and training activities should be used to achieve the defined objectives and how to evaluate how well the developers mastered the tasks defined in the objectives. (Krathwohl, 2002) The objectives for the training were decided in collaboration with Radiometer management:

Objective 1. The developer should be able to remember and understand the terminology used when performing the given method.

Objective 2. The developer should be able to judge in which cases the method can be applied. Furthermore, the developer should be able to create a plan for the execution of the method.

Objective 3. The developer should be able to apply the method to solve a real life task, combined with the ability to analyse the results obtained from this application.

Objective 4. The developer should be able to evaluate the results and the usability of the obtained data and have the ability to use the results to suggest solutions for the further development within the given project.

(Øvad and Larsen, 2016)

While working on the objectives it became clear that knowledge of cognition, awareness, and knowledge of one's own cognition were not on target in the present work. Hence the metacognitive level was not accessed. The objectives for the training are mapped in table 2.

Table 2. Taxonomy Table with mapped objectives.

<table>
<tr><td rowspan="2">The Knowledge Dimension</td><td colspan="6">The Cognitive Process Dimension</td></tr>
<tr><td>Remember</td><td>Understand</td><td>Apply</td><td>Analyse</td><td>Evaluate</td><td>Create</td></tr>
<tr><td>Factual knowledge</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Conceptual knowledge</td><td colspan="2">Objective 1</td><td></td><td></td><td></td><td>Objective 2</td></tr>
<tr><td>Procedural knowledge</td><td></td><td></td><td colspan="2">Objective 3</td><td>Objective 4</td><td></td></tr>
<tr><td>Metacognitive knowledge</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

2.5. TRAINING APPROACHES FOR THE TOOLBOX

Training the developers is an integral part of the approach taken in this work. According to Dreyfus and Dreyfus, two different paths to acquire new skills can be taken:

1. It can be picked up by imitation and floundering trial-and-error.
2. You can seek the help from an instructor or a manual.

(Dreyfus and Dreyfus, 1980).

To identify the best possible approach for this research study, I sat out to try them both.

First the "instructor"-approach was applied and developers were trained in how to conduct a Contextual Inquiry; this is presented in Contribution 5. In Contribution 2, developers observed how to facilitate a Focused Workshop. From these two studies it became clear that the "instructor"-approach was the most beneficial and this approached secured the best end result. This is further elaborated in Contribution 5.

Hence, I continued with this approach combined with the "manual"-approach – in the present work; guidelines and templates. As a result the training of each method (except Focused Workshop) was planned as a one day hands-on training course for each method, with real life tasks.

CHAPTER 3. CONTRIBUTIONS

The work towards answering the three research questions are presented in the five papers included in the thesis. These papers constitute my research contributions:

Contribution 1: "The Prevalence of UX Design in Agile Development Processes in Industry"

Contribution 2: "Experiences from Training Agile Software Developers in Focused Workshops"

Contribution 3: "Software Developers to Perform UX Tasks"

Contribution 4: "Templates – a Key to Success when Training Developers to Perform UX Tasks"

Contribution 5: "How to Reduce the UX Bottleneck by Training Your Software Developers"

I shortly present the contributions and abstracts in the following.

3.1. CONTRIBUTION 1

Øvad, T., Larsen, L.B., 2015. *The Prevalence of UX Design in Agile Development Processes in Industry.* In: Proceedings of the 2015 Agile Conference (Agile 2015). IEEE Computer Society Press, pp. 40–49.

Abstract — The gap between how the academic world develops usability and user experience (UX) methods, and how the industry employs these methods is perceived as both broad and deep. But is that the real picture – and has there been a change in how companies work within these fields over the past two years? By conducting interviews with eight companies, this paper tries to answer these two questions. The companies were initially interviewed in 2013 and by follow-up interviews in 2015 the paper draws a picture of how the companies work with UX and usability in an agile development environment. We identify the challenges they are facing and if, and how the work progresses. We found that the UX maturity during these two years had changed significantly. This was revealed by the fact that almost all of the companies in 2015 had implemented or were in the process of developing a UX strategy together with more formalized UX processes. They also allocated more resources to conduct UX and usability work than earlier. We found that all of the companies made use of low-fi prototyping, followed by usability testing, workshops, personas, expert evaluations, user or customer journeys,

customer visits and user task analyses. Almost all the companies carried out development using the Scrum framework. All of the companies were interested in the idea of agile UX, and found the idea of using the developers as a UX resource interesting. This, together with an idea of modifying existing usability methods to be used in an agile, industrial setting could be a solution

3.2. CONTRIBUTION 2

Øvad, T., Larsen, L.B., 2014. *Experiences from Training Agile Software Developers in Focused Workshops*. In: Proceedings of the 2014 International Conference on Interfaces and Human Computer Interaction. IADIS Press, pp. 397 – 401.

Abstract — Due to increasing focus on usability and user experience (UX) design, with a focus towards medical devices, this paper reports on the experiences of teaching developers to do UX work in an agile software development environment. The taught method is a focused workshop. The case study is not yet finalised, but the current results indicates that the developers support the idea of making some of the UX work themselves, they feel more secure and confident in the method after having been note takers in such a session and that both planning, conducting and analysing the workshop can be done during one development sprint.

3.3. CONTRIBUTION 3

Øvad, T., Bornoe, N., Larsen, L.B., Stage, J., 2015. *Teaching Software Developers to Perform UX Tasks.* In: Proceedings of the 2015 OzCHI Conference. ACM Conference Proceedings Series, pp. 397-406.

Abstract — Good UX design is becoming important within the industry when developing new products. This entails that UX skills have to be available in the development processes. This paper investigates the opportunities of using software developers as a UX work resource in the day-to-day working practice. This is done via an action research study where the developers were provided with material concerning a modified AB usability test, by training them in performing this type of work, and by using their feedback to improve the method and the material. The overall result of the study is positive and it is found that by using the developers' feedback in the modification process, the method has truly become applicable within an agile, industrial setting. In combination with a guideline and template this has induced the developers to feel confident in independently performing this type of work.

3.4. CONTRIBUTION 4

Øvad, T. and Larsen, L. B. 2016 *Templates – a Key to Success when Training Developers to Perform UX Tasks.* Chapter in the book: Integrating User Centred Design in Agile Development. Springer.

Abstract — Working with usability and UX design in an agile development context such as Scrum has been found challenging. Not all companies have the need or resources for a team of dedicated UX specialists. In other cases the UX team is perceived as a bottleneck. We therefore set out to investigate; how companies can perform UX tasks, when no or little UX expertise exists in the organization; if it is possible to perform this work in line with the Scrum sprints and how such work should be facilitated. To do this and since the Scrum framework states that every team member should be able to perform every work task, we trained software developers in three different companies to perform certain selected UX methods. The training was done as one-day training sessions. The developers were provided with materials describing UX methods modified to be used in an agile, industrial environment. These consisted of guidelines, templates and cheat sheets. These materials were refined throughout the training sessions based on observations and feedback from the developers. We found that especially the templates were highly valued by the developers. The templates provided a quick overview of the method, guided them in the work and gave them security and confidence in conducting this type of work independently of the researchers.

3.5. CONTRIBUTION 5

Øvad, T., Larsen, L.B., 2016. *How to Reduce the UX Bottleneck by Training Your Software Developers.* Submitted to "Journal of Behaviour & Information Technology", Taylor-Francis 2016.

Abstract *— Traditional usability and UX methods have originated from an academic environment, which have not taken industrial conditions of especially time and resources into account. Furthermore, usability and UX methods originate from a time when almost all software development followed a waterfall model. These two facts entails that the existing methods are too resource demanding and difficult to applied into today's agile, industrial environments. In this paper we make the statement that methods must be updated and tailored in order to be applicable within an agile, industrial development framework. We therefore pursue a solution, which is to simplify well-known methods and to train software developers to perform the UX work. To do this, three methods are modified via an iterative process together with the development of supporting materials. Software developers in three companies were trained in the methods to assess the approach. We found that it indeed is possible to update and tailor existing usability and UX*

methods to fit into an agile, industrial environment. We furthermore found that it is possible to train developers in performing usability and UX work via one-day, in-situ training using an "instructor"-teaching approach. This should be combined with hands-on exercises and real life tasks during the training. This further boosts the developers' confidence in performing UX work.

CHAPTER 4. ADDRESSING THE RESEARCH QUESTIONS

To support the investigation of how UX work can be conducted in an agile software development environment while following and supporting the sprint rhythm, three research questions were put forward. In the following I address the research questions. At the end of the chapter I present three interviews with Radiometer management concerning the development of the UX toolbox, the anchoring of it and further work with the UX Toolbox within the organization.

4.1. RESEARCH QUESTION 1

What is the current state of user experience and agile processes within industry?

Answered by:

Contribution	Research method	Technique
1	Explorative study	• Semi-structured interviews (Kvale and Brinkmann, 2008) • Meaning condensation (Patton, 1990) • Yin's five-phased cycle (Yin, 2011)

The first research question was addressed by observations conducted at Radiometer and via interviews within the industry. I had the opportunity to work as a UX designer at Radiometer for five months prior to the start of the research project and thereby participate in the daily work, different meetings etc. The observations were part of the diagnosing phase to verify what management at Radiometer had experienced as obstacles.

Contribution 1: To investigate if these problems were Radiometer-specific/only problems when developing medical devices, I interviewed seven other companies. The findings are presented in Contribution 1. Interviews were performed both in 2013 and again in 2015. The interviews revealed that UX had advanced noticeable during these two years, and the UX field had the companies' attention.

4.2. RESEARCH QUESTION 2

Is it possible to tailor existing UX methods in order to plan, conduct and analyse findings during one agile development sprint?

Answered by:

Contribution	Research method	Technique
2, 3, 5	Action research	**Triangulation by:** • Observation • Semi-structured interviews • Documentation **Analysis by:** • Meaning condensation (Patton, 1990) • Yin's five-phased Cycle (Yin, 2011)

To answer the second research question, the selected methods presented in Section 2.2 were modified via the iterative process presented in Section 2.1. Contribution 2, 3 and 5 present this work.

Contribution 2 presents the initial steps of the modification of the Focused Workshop paradigm and reports on the "imitation"-teaching approach where two developers participated. The focused workshop method proved to fit well in the Scrum rhythm and it was possible to carry out the planning, conducting and analysing within one Scrum sprint. From this work, it was clear that it was possible to train developers to perform minor UX work within a Scrum environment.

Contribution 3 presents an action research study conducted at Radiometer investigating how the AB-test paradigm was modified and structured. The result of the study is positive; the AB-test fits well with the Scrum rhythm. It was found that by using the developers' feedback in the modification process of both method and materials, the method truly became applicable within an agile, industrial setting.

Contribution 5 presents the initial work with Contextual Inquiry at TC Electronic and an action research study conducted at Radiometer and SenDx investigating how the Contextual Interview paradigm was modified and structured. The overall result of the study is positive; the Contextual Interview fits well with the Scrum rhythm. However, some problems were identified due to the industrial organization at Radiometer.

4.1. RESEARCH QUESTION 3

How can software developers be supported when conducting UX work?

Answered by:

Contribution	Research method	Technique
2, 3, 4, 5	Action research	**Triangulation by:** • Observation • Semi-structured interviews • Documentation **Analysis by:** • Meaning condensation (Patton, 1990) • Yin's five-phased Cycle (Yin, 2011)

Contribution 2 and 3 present the work leading up to answer this question, see above.

Contribution 4 presents the work with the supporting materials. Across the studies it became clear that the training and the developed guidelines and templates were an answer to the presented questions. This contribution presents the templates and how they were refined throughout the training sessions based on observations and feedback from the developers. The templates provided a quick overview of the given method, guided the developers in the work and gave them security and confidence in conducting this type of work independently.

Contribution 5 presents the structured training approach across all studies. The in-situ, hands-on approach using real life tasks was found very beneficial and provided the participating developers with the competences and confidence to conduct UX independently. I found that an extra feedback session proved to be quite beneficial. It gave me the opportunity to address minor flaws and adjust the developers' skills within the different methods, which elevated the developers' confidence and security in this work.

4.2. THE OVERALL OBJECTIVE OF THE RESEARCH STUDY

The overall objective for the research study was to answer the question:

> *How can usability and UX work be conducted in an agile software development environment while following and supporting the sprint rhythm?*

The approach of modifying UX methods and train software developers in performing this work independently of UX specialists proved to be applicable within the software teams. The approach has proven to work within development for embedded software for medical devices. The modified methods are designed to be used for formative UX tasks and they proved that they indeed can be planned, performed and analysed within one development Sprint. The Contextual Interview might be used in the explorative phases of a development as well – however, this is not investigated within this research study. The approach enabled the developers to perform UX tasks independently from the UX specialists and thereby reduced the risk of UX becoming a bottleneck, and it facilitated a shared language in the development team as well. It has been interesting to observe how this approach has facilitated a shared language within the development team, and overall all developers have displayed an increasingly positive attitude toward UX work. The training has heightened their confidence in their ability towards conducting usability and UX work themselves.

4.3. RADIOMETER MANAGEMENT INTERVIEWS

To finalize the Action Research study presented in the thesis, I conducted three interviews with Radiometer Management. I interviewed Jakob Skriver [JS], Director of IT & Software Solutions, Sune Yndgaard Sørensen [SS], Head of ABL Software and Rasmus Villefrance [RV], Head of Offshore SW Dev. & Processes (incl. UX and usability). The interviews were concerning the anchoring and the further work with the UX toolbox within their organization.

They all agree that the toolbox facilitates a higher and even level of UX within the company. They also agreed on that the toolbox gives the developers a greater understanding in how to conduct UX work, how to execute tests and how to assist UX designers in their work, and it enables the developers to undertake minor UX work as well. However, when it came to how to anchor the toolbox within the development at Radiometer, they had some different opinions. JS opted to have the software developers manage the work with the toolbox themselves, the two others believed the UX team should manage the work especially in the initial phases.

The toolbox is already taken into use within the development team: *"On our agile board we have a number of tasks and some of these tasks are UX tasks. When I*

asked our UX designer who executes the UX tasks on the board, she has previously told me that she always was the one executing them. Now we are starting to see that individual UX tasks are being driven by someone other [developers] than her, and they use the toolbox" [RV]. He continued: *"But we believe that it occurs only on teams where there is a "real" UX designer to manage it*" [RV]. However, the interviews revealed that Radiometer aims at empowering the developers to make decisions and enable them to understand how they can influence the decisions within this field.

All agreed that the toolbox will be a part of the software process: *"When the toolbox has been successfully introduced in a couple of teams, the natural next step will be to formalize the use of it and have it described in our software processes"* [RV]. They see the toolbox be a part of the software process as every other work field: *"There is someone who is the code architect and I see it [the toolbox] the same way. It does not mean that only one person should write code and make changes, it means that this person must be consulted or at least informed"* [JS]. He continued: *"Just as we have different tools to make a code component in a feature, an analysis part or a requirement part, one of the tools we have to make UX decisions is the methods in the toolbox"* [JS]. However, the plan is not to have the toolbox be a part of the actual usability compliance in the company.

They all agree on the potential of applying the toolbox within teams without UX competences and the plan is to do so when they have more experience with the toolbox: *"It is our plan to try to drive the use of the toolbox in teams where we have a UX specialist and when we feel confidence in that, we will introduce the toolbox in teams that are too small to have a UX specialist employed"* [RV]. He continued: *"We have some products which do not require a high level of UX professionalism, the UX toolbox would be enough for the individual developer"* [RV]. SS saw the potential in using the toolbox in different ways in relation to the size of the project: *"We have UX designers handling large and difficult tasks. The toolbox is initially intended for small or easy tasks"* [SS]. He continued: *"On large projects the toolbox will be a relief – having the opportunity of having some minor UX tasks conducted by developers. On middle scale projects the developers might be doing most of the work and have the opportunity to have feedback and quality control from a UX designer, who are part-time on-board project. Small scale project might not have a UX designer on-board at all"* [SS].

They see the importance of being able to measure the use and contributions of the toolbox. The plan is simply first to count every time a UX task is perform by a non-UX specialist, including which method from the toolbox was used and which team performed this work. This information should give some inputs to illuminate the type of UX work being performed. Accumulating this information will enable the company to develop Key Performance Indicator (KPI) for the toolbox.

As a final note, one of the interviewees said: *"If the developers are doing UX work, then one might think that the next exciting idea would be UX specialists writing code"* [RV].

These interviews indicated an emerging anchoring of the toolbox within the company. I am confident that with management support and by the strategies presented above, the UX toolbox will gain its grounds within the development process and be an integral part of it.

CHAPTER 5. DISCUSSION

In this chapter I discuss the different aspects of the research study concerning settings, methodology and how the UX Toolbox can support the already existing frameworks of integrating UX and agile development. Discussions concerning the developed materials and the training approach can respectively be found in Contribution 4 and 5.

5.1. THE INDUSTRIAL SETTING

The industrial settings have been a great gain for the research. Being able to modify and applying the approach in different agile, industrial environments have supported and heightened the validity of the work. Especially the fact that the toolbox has proven usable within two companies developing medical devices with the strict regulatory demands this entails, secures high quality of the approach. Hence the transferability of the UX toolbox is judged to be highly feasible. However, conducting research within companies where resources are expensive and the struggles with daily management (Contribution 5) have been challenging. These real life settings have unfortunately also influenced the number of investigated methods and the number of developers being trained in the methods.

5.2. ACTION RESEARCH

The study was framed as an action research study. However, the action research has not yet been fully finalized since the development cycles at Radiometer and SenDx are approximately five years. Hence it has not yet been possible to track if the interventions have had the desired effect. However, this was known before the initiating of the study. I judged the action research approach to be the most suitable and beneficial for the research setting and the work reported in in the thesis is a part of the overall attempt to have UX permeating the development process.

Some difficulties have occurred in the research study, which is related to the change within the companies. Davison et al. (2012) list different principles and criteria when validating action research. This study has problems within two criteria:

- *"Were both the researcher and client motivated to improve the situation?"*
- *"Did the client approve the planned actions before they were implemented?"*

(Davison et al., 2012)

The research was driven by me and to some extent Radiometer management. This was initially identified as a potential problem, since the software developers might regard the UX work as an additional work task on top of their normal

responsibilities. However, this was not the case. The developers engaged in the UX work and were truly interested in gaining competences within this field. As seen in Contribution 5, the problems turned out to be related to the very strong goal oriented culture within the companies. As UX goals and KPIs had not been formally defined and integrated into the companies' resource allocation structures prior to the study, they faced serious problems finding and justifying the resources needed to carry out the training sessions. This was a huge struggle for the research, since it has not yet been possible to measure value or progress related to the toolbox. It became clear that the long term goal of performing UX work throughout the development process to secure good usability and UX clashed with the goal of finalizing e.g. a feature as fast as possible. This corresponds to problems concerning intervention and improvements discussed in Chapter 2.1.

The outcome of the action research study is judged to be valid. However, it is important to have the research setting in mind. The close collaboration with the developers can have influenced the results. I have tried to address this by a triangulation of information sources, by performing the modification and training in different companies and by having other researchers perform some of the training, however this can potential be an issue.

5.3. ITERATIVE DEVELOPMENT OF THE UX TOOLBOX

The fact that I have been employed in two of the companies doing the research has secured a great amount of synergy between me and the developers, entailing that a lot of implicit knowledge has been transferred to the modification of the methods and the development of the materials. By having the developers participate actively in the iterative work with the toolbox has secured that the methods now are truly agile.

5.4. THE UX TOOLBOX COMBINED WITH AGILE DEVELOPMENT

The modified methods in the UX Toolbox proved to fit well into the agile (Scrum) environment. All three methods can be planned, conducted and analyzed within a couple of days, which fits the sprint rhythm perfectly. It especially supports the aim of having a truly agile development team, where everyone can perform every task. At Radiometer, the UX designer on the software development team has been able to outsource some of the minor UX work to the developers and it has been possible to let the developers perform some supporting UX tasks as well.

The UX Toolbox approach is applicable within companies with and without in-house UX specialists, since the aim was to upgrade the software developers UX competences. When no UX specialists are employed the toolbox enables existing staff within the Development Team to conduct UX tasks. In case of more elaborate

UX tasks, the company may call upon external UX experts, typically from a consulting company. When UX specialists are employed, the toolbox can enable the Development Team to quickly perform simple UX related tasks. For more elaborate UX activities, the gained knowledge will allow developers to assist and participate in e.g. more complicated user trials, where the in-house UX team is then called upon.

5.5. THE UX TOOLBOX SUPPORTS THE THREE PREVALENT PROPOSALS FOR UX AND AGILE INTEGRATION

It has been a major strength for the research study to be performed in-situ, during real Scrum sprint and with real-life tasks. The successful outcome from this indicates that the toolbox is applicable within the development and not just working on a hypothetical level. The toolbox can furthermore be combined with the processes and approaches presented in 1.4.

The parallel approach: The problems with this approach was concerning the UX specialists not working agile and the lack of cross-functional synergy (Sy, 2007). These two issues can be addressed by applying the UX Toolbox. If the UX work is performed by the developers it will be performed agile. This will potentially leave time and resources for the UX specialists to perform more extensive UX work, which rarely fits the agile development rhythm. The lack of cross-functional benefits is already handled, since working with the toolbox facilitates a shared language and entailing better synergy, combined with making use of potential domain knowledge within the development team.

The satellite approach: The problems with this approach was related to the satellite UX specialist being disconnected from the UX team, combined with problems having results from research and user tests disconnected from the whole UX vision (Kollmann, 2008). Other problems might be a UX specialist working on more than one team at a time and perhaps not working agile at all. By applying the UX Toolbox and let developers conduct some of the UX tasks, a close connection is established between results and the development team. Additionally, by having the developers conduct some of this work the UX specialist can focus on the UX version and secure connection with the UX team (if such exists). By enabling the developers to perform this work, the UX specialist will potentially not be a UX bottleneck anymore.

USCrum: Here, a major problem was the overhead of having two product owners (Singh, 2008). By applying the UX Toolbox approach in the development team, the whole team is able to take the UX responsibility. Hence the idea of having two Product Owners would be eliminated.

CHAPTER 6. CONCLUSION

This thesis has investigated how UX work can be conducted in an agile, industrial environment following and supporting the sprint rhythm. Three research questions were put forward. These were answered by an interview study performed within the Danish industry, and by an initial explorative study and two action research studies. These studies were concerned the iterative processes of the development of the UX Toolbox. The toolbox contains selected modified UX methods, combined with supporting materials in the form of guidelines and templates. The toolbox furthermore contains training materials on how to perform one-day training of software developers in performing such work independently of UX specialists. By applying structure to the usability and UX methods, minimizing the load of in-depth analysis and by developing supporting materials the toolbox proved feasible to fit the sprint rhythm. This work has been described in five contributions, which are included in the present work.

6.1. LIMITATION AND FUTURE WORK

As stated above, the action research study has not yet been fully realized, thus it is not possible to say if the work has facilitated organizational process changes at Radiometer or SenDx. As it can be seen in the paper contributions, the developers were indeed cable of performing UX work independently of UX specialists and they were very interested in acquiring competences within this field. The work was supported by upper management, but the daily management faced problems when asked to provide resources for the research. This proved to be a challenge and can potentially be a hindrance in further work with the approach. However, via the Radiometer management interviews (see Chapter 4.3), it has been decided to initiate long-term work which will lay a foundation for the development of a KPI for the toolbox. This will increase the ability for daily management to support this type of work.

Turning to the UX toolbox a critical obstacle was found to be the developers' difficulties with analysing especially the collected qualitative data. This finding limits the scope of the UX methods suitable for the toolbox. A next step is to extend the toolbox by modifying and developing more methods, applying the experiences from the three methods investigated in this work. Another next step is to try out the toolbox in other companies and other contexts for further evaluation and validation.

As a final note, it should be kept in mind that this approach does not obviate UX specialists within the development processes, nor secure compliance with standards put forward by e.g. the FDA. This approach is to be seen as an enhancer to the overall UX level within the company and as an instrument to improve the quality of the products.

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Part II
Papers

Paper 1

THE PREVALENCE OF UX DESIGN IN AGILE DEVELOPMENT PROCESSES IN INDUSTRY

Tina Øvad and Lars Bo Larsen

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ABSTRACT

The gap between how the academic world develops usability and user experience (UX) methods, and how the industry employs these methods is perceived as both broad and deep. But is that the real picture – and has there been a change in how companies work within these fields over the past two years? By conducting interviews with eight companies, this paper tries to answer these two questions. The companies were initially interviewed in 2013 and by follow-up interviews in 2015 the paper draws a picture of how the companies work with UX and usability in an agile development environment. We identify the challenges they are facing and if, and how the work progresses. We found that the UX maturity during these two years had changed significantly. This was revealed by the fact that almost all of the companies in 2015 had implemented or were in the process of developing a UX strategy together with more formalized UX processes. They also allocated more resources to conduct UX and usability work than earlier. We found that all of the companies made use of low-fi prototyping, followed by usability testing, workshops, personas, expert evaluations, user or customer journeys, customer visits and user task analyses. Almost all the companies carried out development using the Scrum framework. All of the companies were interested in the idea of agile UX, and found the idea of using the developers as a UX resource interesting. This, together with an idea of modifying existing usability methods to be used in an agile, industrial setting could be a solution to bridge the gap between academia and the industry.

1. INTRODUCTION

For more than a decade discussions concerning the gap between how the academic world develops usability and user experience (UX) methods, and how the industry employs these methods, have floated back and forth. In 2003 Wixon stated that: *"The literature evaluating usability methods is fundamentally flawed by its lack of relevance to applied usability work"* [1]. Sadly that still seems to be the case, even though many companies - especially within software development, now have in-house usability and UX teams [2].

In 2013 Moreno and colleagues stated that *"…the integration of usability engineering methods into software development life cycles is seldom realized in industrial settings."* [3]. Methods addressing usability and UX are often mentioned in research papers, but rarely applied to the current practice of software development [4]. Even though different steps have been taken to both reduce the gap between academia and industry e.g. [5]–[12] and to facilitate an integration between UX design and agile development e.g. [4], [13]–[21], the industry still finds this type of work challenging.

In this paper we set out to investigate how companies work with usability and UX in an agile environment and if, and how this work has evolved over the past two years. We do this by interviewing nine people from eight different Danish

companies both in 2013 and again in 2015. In the remaining part of the paper we will: Summarize related work (Section II), provide an overview of our research method (Section III), present our findings (Section IV), discuss and conclude on our findings (Section V and VI) and present tips for practitioners (Section VII).

2. RELATED WORK

Several studies and surveys on how industry conducts usability and UX work can be found in the literature and many papers discuss the benefits and challenges of conducting usability and/or UX work in industry e.g. [22]–[27]. Fewer have studied specific industrial organizations in order to understand the different reasons of the limited role of usability and UX processes in practice. However, in the following some findings related to this hurdle are presented.

In [28] Ardito and colleagues conducted a comparison study between Denmark and Italy concerning how companies perform usability evaluations. The studies were conducted three years apart. They found no difference between the number of companies conducting usability work, regardless of whether the comparison was made between companies from different countries, or over time. However, the understanding of the concept of usability had changed during the three years. Furthermore, they found that developer mindset and resources were the two most common problems when introducing and working with usability evaluations within the companies.

Bruno and Dick [29] conducted 12 interviews with usability practitioners to learn about successful and less successful usability outcomes. They found that in order to both provide a successful usability outcome of a project and ensure stakeholder involvement, the usability process should be iterative, have clear usability goals and requirements, and it was critical that technological constraints could be avoided. They also stress that; to increase the likelihood of involvement, usability should be evangelized.

In the study reported in [30], Bygstad and colleagues conducted a survey in Norway investigating the integration between usability and software development. They found that usability testing was perceived less important than usability requirements, and the companies believe that software development frameworks and usability frameworks were already integrated.

A survey with 92 respondents is reported in [31]. Here, Hussain and colleagues found that the majority of the respondents experienced the integration of usability and the agile framework added value to the processes and teams, hence resulting in an improvement of both usability and quality of the product developed – entailing an increased satisfaction for the end-users (i.e. better UX). Furthermore, they found that companies primarily make use of low-fi prototyping, followed by conceptual designs, observational studies of users, usability expert evaluations, field studies, personas, rapid iterative testing, and laboratory usability testing. These findings are quite similar to the findings from a study conducted by Jia et al. [32], who found

that in a Scrum environment the most used usability methods were workshops, followed by lo-fi prototyping, interviews, meetings with users and scenarios.

Lárusdóttir and colleagues reported findings from interviews with 21 informants from four different professional roles within software development in [33]. They found that; usability and UX work being conducted were typically informal, unplanned, conducted with few users, and the focus were on gathering qualitative data. This is supported by Bornoe and Stage [7] who conducted interviews with 12 representatives from different Danish software development companies. They found that companies primarily focus on up-front usability and UX work to support the design and implementation process. The companies furthermore implemented usability via informal and ad hoc evaluations.

These studies indicate that industry indeed perform usability and UX work of various complexity and extent. They reveal that methods often diverge from those developed and used in academia, and are adapted towards more informal use.

In our study we are interested in extending this research and uncover whether any trends can be found over time regarding the consolidation of methods and/or increase in the usage of UX and usability work in industry in recent years. Furthermore, we wish to collect the experiences and recommendations from practitioners in industry.

3. RESEARCH METHOD

We find that it is fundamental to analyze current development practices within the industry and investigate how this type of work is evolving. This paper describes and discusses the results and differences of the findings from two interview studies conducted respectively in 2013 and 2015. In both studies the same Danish companies were interviewed about how they work with UX in an agile environment and if something has changed during this time span. The purpose of the interviews was to identify and map the changes to the following research questions:

- How is UX oriented work initiated and matured within the companies?
- Are the companies working agile – if so how?
- How do the companies work with UX in an agile development environment?
- How do the companies make decisions within the UX design field?
- Do the companies embrace agile UX[1]?

[1] The term *Agile UX* denotes the attempt of integrating UX design and agile development methodologies.

Furthermore, we investigate which skills and background UX practitioners have, what usability/UX methods are being employed and what the current view on UX is within the companies.

A. Interviews

The interviews were constructed as in-depth, semi-structured interviews. Empirical data was collected from interviews with nine interviewees from eight Danish companies - see Table I (in 2015 seven of the same companies and interviewees participated).

B. Selection criteria

The companies were selected so the following profiles were represented:

1. Companies that develop pure software products and companies developing physical products with embedded software.
2. Different size companies as defined by [34]:
    - Small companies: <50 employees
    - Medium-sized companies: <250 employees
    - Large-sized companies: over 250 employees
    - Companies already doing usability and UX work and companies who had expressed an interest in starting doing UX work.

From the selection criteria, eight Danish companies were selected, see Table I.

TABLE I: OVERVIEW OF THE COMPANIES, 2015 NUMBERS

Company	Type	Employees in Denmark
Atosho [35]	Software	15
BAE Systems Detica GCS [36]	Software	200
Brüel & Kjær [37] **(2013 numbers)**	Software and hardware	500
FOSS Analytical [38]	Software and hardware	550
GN Netcom [39]	Software and hardware	200
NN (anonymous)	Software	4,000
Radiometer Medical [40]	Software and hardware	1,000
TC Electronic [41]	Software and hardware	80

C. Interviewee profile

The interviewee profiles can be seen in Table II. The presentation of the profiles is randomized and does not correlate with Table I.

TABLE II: OVERVIEW OF INTERVIEWEE PROFILES, 2015 INFORMATION

Interviewee	Job title	Education	Industry Experience
I1	User Experience Designer	Engineering Psychologist	3.5 years
I2	Development Engineer	Acoustic Engineer	17 years
I3	Product Manager	Master in Philosophy and Media Science	15 years
I4	Team and Product Manager	Electronics Engineer	12 years
I5	UX Engineer	Engineering Psychologist	2.5 years
I6	R&D manager	Bachelor in Computer Science	15 years
I7	UX Specialist	Engineering Psychologist	4 years
I8	Senior Method Consultant	Master in Informatics, PhD	10 years
I9	Concept Developer	Optical Engineer, PhD	19 years

D. Procedure

All interviews were conducted in Danish. The duration of the initial interviews was between 45 and 75 minutes and all were conducted face-to-face. The interview guide included the following themes:

- Background and presentation of the company
- Initial work with UX and UX maturity
- The interviewee's definition of UX and the company's UX vision
- Organizational placement of the UX team
- UX responsibility and UX decisions
- The UX processes, tools and user involvement
- The dissemination of UX findings
- The development process
- Agile UX
- Final remarks

The duration of the follow up interviews was from 26 to 51 minutes. The follow-up interviews followed the interview guide, but were more focused on the change between 2013 and 2015. These interviews were carried out over the telephone.

E. Data analysis

All interviews were recorded and afterwards transcribed. To analyze the initial interviews we first performed a meaning condensation of the data as described by [42], followed by performing Yin's five phase cycles, consisting of: compiling,

disassembling, reassembling (and arraying), interpreting and concluding [43]. This iterative process resulted in eight overall themes. The follow-up interviews were analyzed in the same manner, using the themes from the initial interviews as codes. During this process one more theme emerged. All nine themes are described in the following, including quotes from the interviews related to the respective themes.

The quotes have been translated from Danish to English.

4. FINDINGS

In all of the following tables, percentages are used to make comparisons between the two studies, due to the different number of companies between the studies.

A. The interviewees description of UX

In both interview rounds we started by asking the interviewees to give their definition of UX, in order to have a baseline to discuss from.

When the interviewees in 2013 were asked to describe UX in their own words, their approaches were very pragmatic e.g.: "*It is something that permeates a product. From the specification phase, where you have to have it incorporated […] So actually it permeates all the way through the development, where there are continuously testing. So I see it as a major integral part of the product development, in which you have to be acute, because in the end it is what the users see - they do not see the machinery".* [I1]

The interviewees' descriptions verged on the edge of being a description of usability. Furthermore, two of the interviewees did not use the terms usability and UX design, and when asked, they revealed they did not perform any usability or UX work at all in the companies. However, further along in the interviews they started using terms as user interface expert, key product drivers, customer satisfaction etc., and it was clear that, although they might not use the terms usability and UX design, they did in fact perform both usability and UX work.

In 2015 all of the interviewees stated that their companies perform a variety of usability and UX work. Furthermore the interviewees were more aware of the concept of UX, especially the experience part of the concept, and that the experience stretches from before purchasing a product until the product has been discharged. I7 puts it very well: "*It (UX) is a umbrella for both classic usability and interaction design, where you look at the human limitations on how to understand and remember things, and it is a user journey from the beginning when you buy or hear about a product, to trying it, and to after you have used it, recommending it and maybe buying a new from the same brand. It is something both before during*

and after use. It is both at the physical level, but also the mental and socio-economy level - there are many levels."

B. UX initiative and how UX has matured

The 2013 interviews revealed that in all of the interviewed companies the interest for UX design had been initiated from grass-roots movements within the company. The grass-roots movements consisted of people with an interest for the end users and how the end users use the developed products. Within the interviewed companies the start of the UX movement had either been in the mechanics or the software department.

The 2015 interviews revealed that the companies have kept an interest in UX design and furthermore the UX design has matured. Five of the companies have employed more people to perform UX work, see Table III.

TABLE III: THE CHANGE IN THE NUMBER OF UX PRACTITIONERS IN THE COMPANIES

Company	No. of UX practitioners 2013	No. of UX practitioners 2015
Atosho	1	1
BAE Systems Detica GCS	1	2
Brüel & Kjær (2013 numbers)	0	-
FOSS Analytical	4	5
GN Netcom	8	12
NN (anonymous)	0	1
Radiometer Medical	3.5	7 + 5 student workers
TC Electronic	0	1

In 2015 almost all of the companies now have described UX processes integrated into the company's overall development processes. This is presented in more details in section *E*. I6 describe the nature of the maturity: *"It (UX) is a well-defined processes and it is matured organizational, as it is now a stronger organization that is not hung up on individuals as it was previously, but a professional UX group that is not quite so vulnerable."*

Four of the seven interviewed companies in 2015 have had a specific strategy for UX work the past two years. Especially in the past year UX strategies have emerged, as I8 put it: *"We have had a strategy to make it (UX design) more visible and we succeeded. In my position, I have the last year had a concrete goal of bringing UX forward in the company"*. This is supported by I1: *"We got a UX*

strategy about a year ago – when UX started to gain more focus and we were to develop a brand new product from scratch. It became clear to the managers that it was an important area because the UX designers, in principle, are the ones who work across users."

C. Agile development within the companies

In 2013 all of the companies used or had the opportunity to use Scrum as their primary development framework. In 2015 one of the companies did not use Scrum anymore, but the rest were still using Scrum as the primary development framework. This had been the case for a variety of years, see Table IV.

TABLE IV: YEARS OF EXPERIENCE WORKING WITH SCRUM WITHIN THE COMPANIES, 2015 NUMBERS

Number of years using Scrum	0	1	2	3	4	5	6	7	8+
Number of companies	1	0	1	0	1	0	1	1	2

Not all of the companies used pure Scrum in 2013. Some used a combination with other development frameworks, see Table V. Serval interviewees in 2013 pointed out that their company stated they worked agile and with Scrum, however the fact was that the companies were not that agile as they said they were, as I1 pointed out: *"Even though we (the company) say that we are agile and constantly are testing and changing, it still seems more like a Waterfall approach".* When asked how the companies had taken the idea of working with Scrum, I4 said: "*They (the company) said: Just do it – but by the way, we have a Waterfall model and you should of course still go through these phases."* I9 pointed out: *"We are developing in an agile environment and using Scrum on our software platforms. Our hardware process is gate ruled and thereby quite similar to the Waterfall approach".*

TABLE V: DEVELOPMENT FRAMEWORKS IN THE COMPANIES

Development framework	**% of companies 2013**	**% of companies 2015**
Scrum	63%	71%
Scrum + Waterfall approach	12%	15%
Scrum + Lean	25%	0%
Ad hoc	0%	15%

In 2015 almost all of the companies used pure Scrum, see Table V. However, this should be read with modifications, as I8 pointed out: *"We are running it (the agile development) by the book as closely as we can, but there are always changes",* and I6 pointed out that: *"Scrum development, in our company, is adapted to an overall stage gate model".* However, I8 also pointed out that: *"More projects are running agile. We have definitions of what it means to develop in an agile environment in our company and a lot of our employees are undergoing further training in the agile framework".*

In the company that no longer applies Scrum, the reason, when asked, was that: *"A lot of replacements in the management team"* and she continued: *"We never reach a stage where we are able to make second iterations. We launch and then we bug fix".* [I5]

D. Decision making within the UX field and resources

The interviews in 2013 revealed that UX design decisions within the companies were often based on the employee's experience, sometimes in combination with a small, internal user test, see Table VI. The interviews also revealed that there were no resources to make several user tests or time to consult theory within the given field. The companies were very result orientated and they had a lot of focus on resources and on the cost, as I3 pointed out: *"We choose which features to remain and which ones to cut out in the products. If a design should have e.g. one less button than the existing product, it would entail that we should invest in a new mould that maybe costs $20.000. So we, by all means, try to find a function for that extra button".*

In 2013 two of the interviewees pointed out that UX takes time and sometimes the companies do not show an understanding for that, as one of them pointed out: *"I find that UX decisions to others seem like something that can be made quickly, and then we do not get enough time devoted to the UX work"*. [I5] Furthermore, several of the interviewees were met with the attitude in the companies, that UX is just common knowledge, as I8 pointed out: *"Anyone can comment on something being easy to use […] this also means that everyone has an opinion about usability and user experience."*

TABLE VI: HOW UX DECISIONS ARE MADE IN THE COMPANIES

Strategy	% of companies 2013	% of companies 2015
Experience	38%	15%
Experience + test	50%	43%
Experience + test + theory	12%	29%
Experience + theory	0%	15%

In 2015 the companies still have a great deal of focus on resources, but also the understanding of the importance of UX, as described in section *B*.

The companies seem to have more resources for conducting UX work, as I7 pointed out*: "We have fewer projects, but higher quality and ideally more money for them. So now we have the option to choose solutions with a higher quality rather than solutions that are quickly on the market. Even though we have fewer projects, we have hired several extra UX designers. This means that we make solutions that are better and more thought through"*. I8 pointed out: *"We have different ways of making decisions. We try to get away from it being based on attitudes. So we try to argue from scientific concepts and talk about consistency, Gestalt Theory, etc. Something that is more tangible, which will gain more weight than "I like...""*

Furthermore, there now is an understanding of UX as a profession, I6 pointed out: *"Our UX employees have a theoretical background within the field of UX, so we rely on their background and experiences in our user tests."*

However, the companies still prioritize the usability and UX findings, I2 told: *"We use experience and user tests. We take in assessing how important it (findings) is to correct. Is it achievable to correct and how important is it for product success versus how much of a burden it is for developers to implement it."*

E. UX processes

In 2013, 63% of the companies pointed out that their UX processes are ad hoc, see Table VII. This can be problematic, as I9 told: *"We made a concept, where we forgot to integrate the software part".* This was supported by I2, who told: "*We had a product, and just a week before release, it was decided what a big button in the middle of the products' front plate should be used for".*

However the companies were aware of the lack of processes and some of them were trying to develop different processes regarding UX design, as I1 said: *"I am building a knowledge database, which contains user profiles and some small user stories. Then there will be a clear structure for what the developers should have in mind, which tools they should use and which steps they should take".*

TABLE VII: OVERVIEW OF UX PROCESSES IN THE COMPANIES

UX Process	Percent of companies 2013	Percent of companies 2015
Ad hoc	63%	42%
Are developing processes	25%	29%
Have processes	12%	29%

In 2015 only 42% of the companies stated that their UX processes were ad hoc and entire 58% of the companies stated that they now have a UX process or are developing one. The interviewee of one of the companies conducting ad hoc UX work said: *"Our tester judges when it makes sense to conduct a user test".* [I2]

One of the interviewees from a company currently developing a process said: *"We are in the in the middle of developing a UX process. We have defined the overall lines, but not yet the details of each step e.g. we do not always start with a clear specification of requirements - sometimes we make them ourselves, other times there will be requirements from the outside. Furthermore, personas are not yet properly integrated. The details are not in place, but the overall lines are laid."*[I1]

The interviewee from the company having a UX process in 2013, in 2015 pointed out that: *"Now it is more that we are trying to see if the process is right, more than if the design is. It is about getting the right process, change and update the processes, IT support them or make them more efficient, skip some steps, make use of other entrants etc.".* [I8] He continued: *"We have introduced some new principles - let's say the business analysis falls behind. We do not want our developers to work on something without it having been tested and analyzed. So instead of having them work on something that has not been tested, the developers start to gold plate and reduce technical debt."* [I8]

Again the supply of more resources has had an effect: *"The area (UX) has been strengthened by several people - hence more money and the second thing is that things have become much more formalized in our overall development process.*

Now it is a formal, integral part, but it still leaves little room for interpretation of how to do it on the different projects. But you cannot get around it (UX)". [I6]

F. Usability and UX methods used within the companies

In 2013 most of the companies used a combination of usability tools and methods. The most popular methods can be seen in Table VIII.

TABLE VIII: OVERVIEW OVER THE USED USABILITY METHODS WITHIN THE COMPANIES

Method	% of companies 2013	% of companies 2013
Low-fi prototyping (incl. sketching and mock ups)	100%	100%
Usability test (incl. think aloud and IDA[2])	75%	71%
Workshop	25%	43%
Personas	37%	29%
Expert evaluation	25%	29%
User or customer journey	25%	29%
Customer visits	25%	14%
User task analysis	12%	29%

In 2015 the overall picture was fairly the same. However, there seemed to be a more systematic approach to how the methods were applied. Furthermore, two of the companies experimented with a couple of other methods – AB-testing and Contextual Inquiry. These two companies were collaborating with universities and it was through this work, they were introduced to the methods. Furthermore, one of them experimented with modifying existing usability methods by making them more lightweight and suitable to be used in the company's development sprints.

G. Developers as a UX ressource

In 2013 the software developers within the companies were very interested in observing how the company's products were handled by the users. Three of the companies had developers observe user tests. Five of the companies were keen on the idea of either having the developers make small, internal UX tests themselves,

[2] Instant Data Analysis - a description can be found in [44]

testing some of the features on e.g. test subjects from HR, marketing etc. or have the developers participate in/observe the user test.

In 2015, six out of seven companies were keen on having the developers performing minor usability and UX work on their own and two of the companies were already experimenting with this approach. In five out of seven of the companies the developers participate as observers in UX work. As I8 said: *"Moving the developer from his desk and out into the world gives a lot… Often it is our technical profiles that are those who have insight into what is new within a framework. The business analyst can have a tendency to think that we just do things like we always have done. The developer might have kept an eye on what is emerging within the field."*

In the company where I6 works, they are experimenting with having the developers conduct minor UX work on their own, I6 told: *"As something new, we are trying to have them (the software developers) execute minor tests or observing the users on their own. So they can perform minor UX tasks."* In I2's company it is the same tendency emerging, as he told: *Five of us (developers) have participated in mini-project concerning usability and UX. So half of the team has been taught and gained insights in the different (usability and UX) methods."* [I2]

H. UX work conducted within an agile framework

As pointed out earlier all of the companies in 2013 use or had the opportunity to use Scrum as the development framework. However only three of the companies used Scrum in their UX development, see Table IX. Two of the companies using Scrum for their UX activities, did not have employees working explicitly with UX design in 2013. Only in one company do the UX designers participate in the Scrum rhythm and it is only when the UX designers are working on a specific project, using Scrum. Here, the UX designers participate in the Scrum development almost on equal terms as the software and hardware developers, but they do not have their own story points.

TABLE IX: OVERVIEW OVER UX WORK CONDUCTED IN AN AGILE FRAMEWORK

Type of team	Percent of companies 2013	Percent of companies 2015
UX work without UX employees	25%	0%
UX work with UX employees	12%	43%
UX work performed in a non-agile framework	63%	57%

In 2015 all of the companies have employees working with UX design and all of the interviewees pointed out that the UX designers now work much more iteratively. This is illustrated by what I1 told: *"In the past, we were e.g. told that a feature should be implemented somewhere in this this big behemoth, and then we did that. Now we have more ideas on the drawing board and run these iterative loops."*

In 43% of the interviewed companies the UX person or team works profoundly agile. I6 told: *"We have a process for how we are doing UX backlog grooming in Scrum, how we get from a high level user story to have it described and ready for the developers to use. There it is written that we have to have a UI concept before the developers can start – so UX is integrated. If the UI concept requires that we go out and make a small user test to find out whether this or that works best, then we do that. It is integrated in the process. When they are finished with the code, there is a review of if the UX is as intended and finally more features are picked up in a release and then a usability/UX test is made."*

The support for agile UX within the companies can be seen in Table X. In 2013 one of these companies would like to have the UX department as customers to the software development department, so that the software developers feed the UX department. Only one company was not supporting the idea of agile UX, see Table X. All of the interviewees could see a potential in increasing the work with UX design.

TABLE X: SUPPORT OF THE IDEA OF AGILE UX

Agile UX	Percent of companies 2013	Percent of companies 2015
Support the idea	50%	71%
UX in separate teams	38%	29%
Do not support the idea	12%	0%

In 2015 all of the interviewees support the idea of agile UX. Four would like to have the UX designers fully integrated in the agile development team and two would like that the UX designers have their own UX team. I7 likes the idea of agile UX, however: *"Agile UX makes very good sense. […] But typically we are working on maybe two or three projects at the same time."*

The organizational placement of the UX designers in 2013 gave an indication on which approach the companies have taken in order to integrate UX design and agile

development, see Table XI. The two companies without any UX employees are placed under *Other* in Table XI.

TABLE XI: OVERVIEW OVER UX APPROACHES

UX approach	Percent of companies 2013	Percent of companies 2015
Parallel [45]	38%	57%
Satellite [46]	38%	43%
Other	25%	0%

In 2015 the approaches are almost the same as in 2013, however one of the companies is working with a mix between the satellite and parallel approach, this was described as: "*I am sitting on a project and act as a consultant on three others. The reason I must be the consultant on three projects is that we need to develop something to the same portal, so I have to work for consistency. I make sure to talk design manual on the other projects, so they preferably can be self-running in the end. They have to show me the designs they make, then I make sure that they are within the limits of the overall framework."* [I8]

I. The companies' view on UX

In the 2015 interviews the interviewees were asked about their company's view on UX. For all of the companies the view was described as being very good.

I8 told that his company's overall development had been changed for the benefit of UX: *"Previously we built the architecture first and then we built the user experience on top. Now we start by designing the user experience and then we find the architecture that can support that. So we have swapped the architecture and user experience around."* [I8]

I1 told about how they in her company have seen the profit in focusing more on UX design: *"The last few years it has gone from that; yes, we have someone making it (UX) and we do it because it is a buzzword to it is very important and the UX designers have a great power and much to say, cause they understand what it is about and they can talk across users and they can write user requirements. It has been a cornerstone of the company."* [I1] and I6 stated that: *"It (UX) is indeed recognized as a key competitive factor in our organization.* [I6]

5. DISCUSSION

Take note that the company sample is quite small – eight companies in 2013 and seven companies in 2015. Even so, some tendencies emerged and are discussed here.

A. The interviewees description of UX

The interviews from 2013 showed there was a lack of understanding of the concept of UX, which was voiced when the interviewees were asked to describe UX in their own words. On the other hand this lack of understanding also entails that the companies made more usability and UX work than they believed they did. This is something to have in mind, when discussing UX design and agile UX.

The interviews from 2015 clearly demonstrated the concept of UX had matured within the companies. The interviewees were better at distinguishing between usability and UX and had a more in-depth understanding of the concept of UX. This corresponds to the findings found in [28].

B. UX initiative and how UX has matured

The forming of UX grass-roots movements in either the mechanics- or software departments can be seen as a natural starting point, since there within these two fields are a lot to win by having developed the right product or feature to the users early on, both with regard to time and money.

However, according to the usability maturity model put forward in [47] and [48], the movement can only grow to a certain extent without having the management encouraging the UX work and allocating resources. However, if UX is not seen as a core element to the product development, it is inevitably in the risk of being one of the first fields to be cut away, which one of the interviewed companies had experienced almost a decade ago.

The 2015 interviews revealed that there has been an increase of focus on UX in the past two years and the companies have taken usability and UX seriously. Almost all of them have developed a strategy for UX activities during the resent years and employed several more UX practitioners. Two of the companies now consider UX as a key competitive factor within their companies. This should be seen in the light of some very competitive markets, where it is not enough the products work (have a good usability), but also focus on aesthetics, pleasure, etc. – all in all create a good *user experience*.

C. Agile development within the companies

Scrum was widely adopted in the companies in 2013 and they perform it very seriously and had applied many of the Scrum artifacts. Some of the companies had an overall stage gate model for their development process. This model is similar to the waterfall approach, however it is feasible for the companies to use Scrum within the development phases of this model. Within the resent two years all of the companies except one have become more secure in the way they apply Scrum and their Scrum framework is now perceived purer. This is something to consider in relation to conducting usability and UX work and an idea could therefore be to develop usability and UX methods, which could be suitable to be applied in an industrial, Scrum setting, making it possible to complete the method within one development sprint. This idea is supported by the findings in [28] where seven respondents pointed out a lack of agile methodologies for evaluation.

D. Decision making within the UX field and resources

In 2013 there was a tendency within the companies of not allocating enough resources to conduct proper UX work.

This was reflected in many UX decisions within the companies were made on the employees' experiences and not by e.g. a proper user test. The tendency has shifted during the past two years and especially within the past year, the companies now have a deeper understanding of the importance of usability and UX and there therefore now exists more respect and understanding of UX as a profession. The result of the companies having more resources can be seen in the change of time allocated to conduct better and broader user tests and actually have time to consult theory both when developing, but also when analyzing the UX work.

E. UX processes

The interviews from 2013 revealed a lack in described UX processes and this seemed to be one of the most extensive challenges when working with UX in an agile development environment. This corresponds to the findings in [7] and [33], who both found that usability and UX work was conducted informal and unplanned. Furthermore, a couple of the companies pointed out, that the lack of UX processes were a problem, since no one was appointed the responsibility for the UX area and a lot of the UX work were only done, when someone remembered it. However, it was something the companies were aware of and they were working on having the UX work formalized.

The interviews from 2015 revealed that the companies have been successful in developing more formalized UX processes and three of the companies now has UX as a part of their overall development process. By having a process it is possible to

record the work with UX and four of the companies have or are planning to have UX matrices, in order to be able to keep track of the UX work and the impact as well.

F. Usability and UX methods used within the organisations

In both 2013 and 2015 all of the companies used low-fi prototyping, which corresponds to the findings in [32]. The other methods correspond to the methods mentioned in both [30] and [31]. However, none of the two references mentioned the use of user task analysis and user or customer journeys, which two of the interviewed companies were using in 2015. In 2015 two of the companies were experimenting with introducing new methods. However, it is striking that the methods is introduced by academia, this is something to take note of, since this could be an indicator on that the methods developed within academia are not readily accessible and maybe too detailed or time consuming to be employed by the industry.

G. Developers as a UX resource

The companies are very interested in having software developers take part in UX work. This is very promising in relation to a both a potential integration between UX and agile development, since the developers could be relied on as a UX work resource, and to the development of usability methods that is applicable within one development sprint.

An idea put forward by one of the interviewees is to use Rapid Iterative Testing and Evaluation (RITE). In this case, this method is described in [49].

H. UX work conducted within an agile framework

There is no tradition for UX practitioners to work within an agile development framework. In 2013 only one company had their UX practitioners working agile and it was only when they worked on a specific project using Scrum in the first place. The resent two years the companies have been very iterative in their development process and in three of seven companies the UX professionals now work agile. However, the companies do not perceive usability/UX and agile development as integrate as described in [30].

In 2013, 88% of the companies supported the idea of agile UX. 50% would like to have the UX designers fully integrated in the agile development team and 38% would like that the UX designers have their own UX team. All of the interviewees could see a potential in increasing the work with UX design.

As one of the interviewees pointed out in 2013: *"When we started using Scrum, a much greater transparency emerged and it was easier to trace which tasks took the longest in the software development"* [I3]. This could be an indication that if UX design is integrated in the Scrum framework, the UX work can be more transparent as well. The UX work will then be broken down into tasks, fitting into one iteration (sprint). This could help make clearer goals for the UX practitioners and make value deliveries to the development more transparent. All in all, by using Scrum as a lifter for more in-depth UX processes, it would be possible to address the points stated in [29] for a successful usability outcome and to secure stakeholder involvement.

In 2015 all of the interviewees support the idea of agile UX. 71% would like to have the UX designers fully integrated in the agile development team and 29% prefer their own separate UX team. When working with UX design, the companies seem to be using either a parallel approach as described in [45] or a satellite approach as described in [46]. In 2015 the approaches were almost the same as in 2013, however one of the companies was working with a mix between the satellite and parallel approach, where the practitioner was working parallel with one team and as satellite on three other teams.

6. CONCLUSION

In the past two years the investigated companies have obtained a better understanding of the concept of UX and UX has matured within the companies. This was revealed by the fact that almost all of the companies have had or are developing a UX strategy together with more formalized UX processes. It is also significant, that they allocate more resources to UX work in 2015. This combined with a deeper understanding of the importance of good usability and UX has induced more resources to conduct UX and usability work. In three companies UX is now a part of the overall development process and four have or are developing UX matrices in order to measure and keep track of the UX work and impact. All of the companies make use of low-fi prototyping, followed by usability testing, workshops, personas, expert evaluations, user or customer journeys, customer visits and user task analyses. Two companies are experimenting with new usability methods in collaboration with academia. This indicates that a closer collaboration between industry and academia can help introducing new usability and UX methods within the industry. Almost all of the companies are employing Scrum. UX work is carried out in a very iterative manner and 43% of the companies are conducting UX work within an agile development environment. All of the companies are interested in the idea of agile UX, and find the idea of using the developers as a UX resource interesting. This together with the idea of modifying existing usability methods to be used in an agile, industrial setting could be a solution to bridge the gap between academia and the industry.

As a final note, it should be kept in mind that the study was limited to eight Danish companies in 2013 and seven in 2015. We can therefore not draw definite conclusions about the generalizability of the findings to other sectors or countries.

7. TIPS FOR PRACTITIONERS

The following are suggestions that companies can have in mind when working with usability and UX design in an agile development context:

- Consider to use the Scrum framework as a lever for the us ability and UX work
- Consider to modify usability and UX methods so they suit within the agile development framework used within the company
- Consider to use the software developers as a UX work resource by enhance their qualifications within the field of usability and UX

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Paper 2

EXPERIENCES FROM TRAINING AGILE SOFTWARE DEVELOPERS IN FOCUSED WORKSHOPS

Tina Øvad and Lars Bo Larsen

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ABSTRACT

Due to increasing focus on usability and user experience (UX) design, with a focus towards medical devices, this paper reports on the experiences of teaching developers to do UX work in an agile software development environment. The taught method is a focused workshop. The case study is not yet finalised, but the current results indicates that the developers support the idea of making some of the UX work themselves, they feel more secure and confident in the method after having been note takers in such a session and that both planning, conducting and analysing the workshop can be done during one development sprint.

1. INTRODUCTION

There is an increasing focus on usability and user experience (UX) design when designing and developing software. Due to strict regulations put forward by FDA[3] and ISO[4], this is especially the case in the development of medical devices. As a result of this increasing focus, it is desirable to have UX design permeate the whole software development process. This combined with a preference for developing software in an agile environment, induces integration between UX design and agile software development. In the resent years a large number of studies have introduced and discussed potential solutions and issues with this merge (i.a. Ardito et al., 2013; Bruun and Stage, 2014; Meingast et al., 2013; Schwartz, 2013a, 2013b; Silva et al., 2013, 2012).
The present paper describes our first experiences from training agile software developers how to conduct a focused workshop. The paper first presents the background, followed by the case study, then the results will be discussed and finally a conclusion is made together with ideas for future work.

2. BACKGROUND

In Øvad et al. (2014b) a qualitative study was carried out in eight Danish companies. The goal of the study was to investigate how Danish companies work with UX design, agile development and if an integration of the two was being made in the Danish industry. This study showed that there is a major lack of processes for working with UX design (Øvad et al., 2014b). The findings indicate that a successful integration cannot be achieved until UX processes are well-defined and documented. In addition the study also revealed the companies have adopted agile software development, in particularly Scrum (with sprints of a duration of two to

[3] U.S. Food and Drug Administration

[4] International Organization for Standardization

four weeks), and the companies seem to continue with Scrum after they have introduced it. This finding provides a strong motivation for integration between UX design and Scrum and thereby uses the well-established Scrum framework as an entry-point for the development of a UX design process. Thereby, UX design can reap some of the benefits the software development has gained from the Scrum framework. These are: more transparent work processes; a more systematical and clear prioritisation of the different development tasks; and always having something to show to the customers (Øvad et al., 2014b).

2.1 Related Work and Method Selection

Different approaches have been taken to integrate UX design and agile development. One solution is the UScrum approach described by Singh (2008), here the role of product owner is assigned to two peers – a traditional product owner and a usability/UX product owner. Another approach is to have a UX specialist working directly in the development team as a satellite (Kollmann, 2008). Other approaches introduce the use of a phase or sprint zero (Beyer et al., 2004; Kollmann, 2008; Miller, 2005; Sy, 2007), where the UX practitioners work sprints ahead of the developers when designing, and sprints behind regarding user tests. Pros and cons exists regarding the different approaches; however a common problem seems to be a lack of cross functional synergy between the two fields; that the developers is not used as UX work resources; and guidance is missing on how to actually integrate the two work fields on a day-to-day basis. A recommended solution to these issues is to have the developers do some of the UX work, raising the synergy between the two fields, entailing a shared language. To develop guidance on how to do it on a day-to-day basis, different user research methods, applicable in a sprint by the developers, are investigated. As suitable methods should be applicable during ongoing development, those suited for explorative research in the initial phases (e.g. user studies and surveys); and e.g. usability evaluations and expert reviews, which are often applied in the end of the development process are discarded. The preferred methods should furthermore be fairly easy to learn, plan, conduct and analyse, since non experts are to perform them. Different methods were investigated and found suitable for a closer examination, e.g. observations; AB testing; different light weight methods such as Instant Data Analysis (IDA) (Kjeldskov et al., 2004) and Rapid Iterative Testing and Evaluation (RITE) (Medlock et al., 2002); Heuristic Evaluation (Nielsen and Molich, 1990); cognitive walkthrough (Polson et al., 1992); think aloud test (Lewis, 1982), focus groups (Krueger and Casey, 2001) to mention a few.

2.2.1 Focused Workshop

Based on these criteria, we chose a focused workshop for the study. This method obeys the selection criteria.

A focused workshop is derived from focus groups as described by Krueger and Casey (2001) and adapted to the industrial context. A focused workshop is described by Øvad et al. (2014a) as: *"A focused workshop aims at assessing the users' needs and feelings both before designing e.g. a feature and long after implementation. Like focus groups, a focused workshop is done with a small group of participants – minimum three participants, but preferable between five to ten participants. The participants are led through an open discussion by a moderator, which is assisted by a note taker. Focused workshops require several representative users, because you need a flowing discussion and various perspectives. The session can last from 90 minutes to a couple of hours."*

3. CASE STUDY

The case study is conducted at Radiometer Medical ApS. Radiometer is a global provider of solutions to acute care testing and develops medical devices. The company employ 2400 people worldwide and approximately 250 work with R&D. For the last nine years the company has been working with Scrum as the primary software development framework and have a sprint duration of three weeks. Radiometer has been focusing on UX design for a number of years and as a consequence employs a dedicated UX team. However, the company has a strategy to involve the software developers more directly into the UX processes.

3.1 Initial Interviews

To gain an initial insight into the developers' expectations and prior knowledge about UX tasks, ten semi-structured interviews were conducted. The interviewees where; eight software developers, one UI designer and one software and system analyst.

In general the interviewees were positive towards doing some of the UX work tasks themselves. Statements like *"It seems natural that we manage it – we are in the process from start to finish", "Yes of course and I think it is something we can learn a lot from concerning the use of the devices"* and *"Yes, if it was a part of a prepared process I would do it"* supports this. However three of the interviewees pointed out that they may not be the best to the job. One said *"I would feel more comfortable if there were other people, who are a bit more experienced with this sort of process".* One said that *"I could make user tests, however it is not my main*

interest" and another stated *"I could make some of the work, but I do not believe that I would be the best for the job – I would not be objective enough".*

All expected to gain knowledge about the users and have inputs and ideas to the further development, as one pointed out: *"The thing which is most important for me is not the concrete findings from the focused workshop, it is more the definition of how things relate that is important".*

3.2 The Training Session

Based on these findings and to investigate the suitability of the approach, two of the developers were trained in the focused workshop method by participating as note takers in a focused workshop session. The workshop was planned and led by an experienced facilitator. As a final part of the training the developers were to analyse the workshop notes, write a small report and present the results. None of the participating developers had any prior experience or knowledge about how to conduct a focused workshop.

3.2.1 Time Consumption

It is of interest to examine the time it has taken to plan, conduct and analyse the session, since it is desirable to investigate if the method is suitable to be used in a Scrum environment, see table 1.

Table 3. Time consumption for planning, conducting and analysing the workshop

Task	**Time spent**
Planning the workshop (experienced facilitator)	8 hours
Workshop	1,5 hour
Analysing the notes	5 hours
Presentation (incl. preparing)	2 hours
Total	**16,5 hour**

3.3 Post-interviews

To capture the effect of training the developers and if the expectations verbalised in the pre-interviews were met, a semi-structured interview was conducted separately afterwards with each of the participating developers.

They both expressed satisfaction about the workshop regarding information and insights in the work life of the participants. One of the interviewees stated that *"I*

think it was a fantastic way to get an insight in how other professions are involved in our products – an insight that is very hard to gain otherwise".

They both expressed that, having tried the role of note takers during the session, they had acquired higher degree of confidence and would be able to conduct such a session on their own, as one said *"I have a sense of security now because I have experienced it myself – if I only had bullet points to guide me, 80-90% would rely on my own former experiences".*

In addition they both had concerns with the flow and the time management of such a session, one of the interviewee observed *"The thing with both having to control the session and simultaneously let people talk as they please is a big challenge"* and the other remarked: *"I have problems just letting go and letting things drift in different directions where something pops up, things which only emerge when things drift. I would like to take charge and structure the session".*

4. RESULTS AND DISCUSSION

The pre-interviews showed that all of the developers have a positive attitude towards the idea of integration between UX design and agile development, and they had confidence in their ability to employ the methods themselves. However, they also pointed out that others may have better competences to do the job and that they maybe not always would be objective enough to do the job.

The developers still need to fully apply the method on their own before final conclusions can be drawn. However, it seems indeed possible to train developers to perform simple UX work within a Scrum environment. The time consumption for planning, conducting and analysing a focused workshop fits well to the Scrum rhythm. The study showed that it is possible to carry out the method within a single sprint, since it is possible to plan the session in one day and conduct, analyse and present the result in another day. This is clearly an advantage for integration into a Scrum development environment. Carefully measurements of the time consumption for the session were made, but especially the preparation phase can vary considerably and more sessions are to be studied before firm conclusions can be drawn.

5. CONCLUSION AND FURTHER WORK

The aim in this study was to investigate how integration between UX design and agile development could be done and how this integration could be facilitated in the day-to-day work. Having this goal in mind, it was chosen to investigate whether

software developers can be utilised as a UX work resource in a day-to-day working practice by training them in a focused workshop. This proved to be successful in the reported case, but it should be followed up with a more extensive study with more methods and participants before firm conclusions can be drawn. Having the developers do some of the UX work themselves, may induce that UX comes more into the mindset of the developers, thus entailing that UX design will permeate the whole development process.

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Paper 3

TEACHING SOFTWARE DEVELOPERS TO PERFORM UX TASKS

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ABSTRACT

Good UX design is becoming important within the industry when developing new products. This entails that UX skills have to be available in the development processes. This paper investigates the opportunities of using software developers as a UX work resource in the day-to-day working practice. This is done via an action research study where the developers were provided with material concerning a modified AB usability test, by training them in performing this type of work, and by using their feedback to improve the method and the material. The overall result of the study is positive and it is found that by using the developers' feedback in the modification process, the method has truly become applicable within an agile, industrial setting. In combination with a guideline and template this has induced the developers to feel confident in independently performing this type of work.

1. INTRODUCTION

A company's requirement for UX design introduces demands for UX skills to be available for the development processes. Within the industry an emerging tendency to employ a dedicated UX team in the company can be observed (Øvad and Larsen, 2015a). This corresponds well with stage 4: "Dedicated UX Budget" in the corporate UX maturity model (Nielsen, 2006). In accomplishing this some obstacles have been reported. Not all organizations have the resources needed to hire usability specialists or external consultants (Bruun, 2010). In organizations with both designers and developers cross-disciplinary collaboration can strengthen development, but the act of collaborating has been found challenging (Latzina and Rummel, 2003; Sy, 2007). Some see a UX team as a bottleneck or an organizational block in the development process (Ferreira et al., 2012). Several obstacles has been found when working with usability and UX design in an agile development context such as Scrum (Bornoe and Stage, 2014; da Silva et al., 2011; Ferreira et al., 2012; Lárusdóttir et al., 2013; Salah et al., 2014; Sy, 2007). The contrast between the workload of usability and UX activities, and the simplicity, speed, (Larusdottir et al., 2010), the iterative nature (Ferreira et al., 2012; Sy, 2007), and focus on sprint completion (Bornoe and Stage, 2014; Sy, 2007) in Scrum is challenging. One recommendation is to integrate usability work into day-to-day tasks (Lee and McCrickard, 2007). A specific suggestion is to investigate how usability work can be conducted on a small scale so the activities can be integrated into sprints (Larusdottir et al., 2010). Informal and lightweight approaches are already commonly followed in industry (Bornoe and Stage, 2014; Lárusdóttir et al., 2013). Bruun and Stage (2014) show how basic usability evaluation training is a fast and cheap approach to provide developers with minimum skills. For example, basic training can provide developers with a better understanding of user perspectives, while not replacing usability practitioners (Eriksson et al., 2009). Instead basic training can strengthen the collaboration between non-technical and technical roles (Latzina and Rummel, 2003).

The software industry has adopted the agile development approach and especially the Scrum framework is widely used (Larusdottir et al., 2010; Øvad and Larsen, 2015a). The agile framework states that to be truly agile, every team member should be able to perform every given work task. It therefore seems rational to train software developers in conducting certain usability and UX tasks (Latzina and Rummel, 2003) – and thus make use of the software developers' already present domain knowledge (Bruun et al., 2014; Høegh et al., 2006), and potentially facilitate a shared language within the development team (Ferreira et al., 2012). Especially since an emerging tendency to employ a dedicated UX team in the company can be observed (Øvad and Larsen, 2015a). For companies on level 3 of Nielsen's (2006) corporate UX maturity model ("Skunkworks UX"), this might be the only feasible solution. For level 4 ("Dedicated UX Budget") organisations, this approach facilitates that a dedicated UX team will have more time and resources to focus on e.g. the overall company UX strategy, collecting user requirements, evaluating, etc.

To address these obstacles, we set out to investigate in detail if and how software developers can obtain usability and UX skills and their motivations for doing so. Our aim was to identify potential problem areas and success factors and make recommendations accordingly. In concrete terms, we have selected to modify the comparative usability testing paradigm (here denoted AB-testing). We did this by adopting an action research approach, which makes it possible to address organizational processes by means of having developers take action and improve the process (Baskerville and Wood-Harper, 1996, 1998; Davison et al., 2004; McKay and Marshall, 2001). This study is defined as part of a larger collaborative practice research (Mathiassen, 2002) project, carried out in a company developing medical devices. In the remaining part of the paper we will: Summarize related work; provide an overview of our research method; present our findings; discuss and conclude on our findings.

2. RELATED WORK

Several approaches about involving software developers in usability work have been proposed.

2.1 Frameworks, guidelines, and tools

Different approaches about involving software developers in usability work have been proposed to overcome the described obstacles. Several frameworks, guidelines, and tools have been presented to support different stages of usability and UX work when no or limited expertise is available. For example, it has been proposed to provide guidelines to support the elicitation and specification of usability requirements (Juristo et al., 2007), or to provide a set of HCI methods with information about when and how to apply them in the development process (Ferre

et al., 2005). Another example is to provide tools, such as a conceptual tool to support problem identification in a usability evaluation (Skov and Stage, 2005).

2.1 Training

We have found that not much research has been conducted in the area of training software developers in usability and UX methods. It has been emphasized that most of existing studies about training developers have been conducted with students as participants (Bruun, 2010). Students may have the same competences as developers in industry, but do not face the same organizational circumstances (Ferreira et al., 2011), obstacles, and settings in which user-centered design (UCD) is performed in industry (Svanæs and Gulliksen, 2008). In this paper we only focus on research about development in a practical context.

Studies have shown positive results, but also report several limitations when training developers. Several studies report increased awareness and understand of usability engineering (Eriksson et al., 2009; Häkli, 2005; Karat and Dayton, 1995; Latzina and Rummel, 2003). Training has been used to establish a corps of usability advocates among developers (Karat and Dayton, 1995) and to increase interest in usability engineering and communicating with usability specialists (Latzina and Rummel, 2003). In one study the developers gained increased knowledge and awareness of the context of use resulting in a more clearly holistic view of the use of the software (Eriksson et al., 2009). Bruun and Stage (2014) trained developers in formative usability evaluation and data analysis, and included the developers in a redesign process (Bruun et al., 2014). As a result the developers were able to identify a significant amount of usability problems compared to usability specialists. Regarding impact, the evaluations resulted in increased downstream utility (Bruun and Stage, 2014). Training has been used to improve the developers' skills in designing and evaluating graphical user interfaces (GUI) (Bornoe et al., 2014; Bruun and Stage, 2014; Häkli, 2005; Latzina and Rummel, 2003; Nielsen et al., 1992). Usability training workshops have been used to make developers more self-supporting when designing a GUI. It is reported that by making abstract usability principles concrete through training, developers were able to apply the principles and design a cohesive GUI (Nielsen et al., 1992), generating potential GUI solutions (Latzina and Rummel, 2003), and correcting usability problems and proposing redesigns (Bornoe et al., 2014). Inclusion of developers has also been beneficial regarding utilization of domain knowledge when correcting usability problems (Bornoe et al., 2014; Bruun et al., 2014; Eriksson et al., 2009).

The studies also report several limitations in the gained skills. Developers find it difficult to conduct evaluations as structured as usability specialists (Häkli, 2005), interpret observations (Eriksson et al., 2009), they lacked clear descriptions of the impact, cause, user actions, and to support the observations with data. Problem descriptions were of a lower quality when compared to usability specialists (Bruun

and Stage, 2014), see how findings can be used for radical design changes (Bruun et al., 2014), and keep focus in a design process (Bornoe et al., 2014).

2.3 Expertise

An argument about involving developers in usability and UX work is that the developers will be the ones implementing the changes and they often accommodate domain knowledge (Bruun et al., 2014; Høegh et al., 2006). Especially for complex systems, domain knowledge has been empathized as being essential to meet usability goals (Chilana et al., 2010). One study reports that having developers observe usability evaluations provided a richer understanding of usability problems including the severity and use situations they occurred in, and their empathy towards the users. This understanding about the users and work processes was found to inspire future system development (Høegh et al., 2006). Studies have looked into collaboration and active involvement of developers when redesigning user interfaces. It is reported that the developers gained a deeper insight of the identified usability problems and could include domain knowledge not known to usability specialists (Bornoe et al., 2014; Bruun et al., 2014; Høegh et al., 2006). E.g. because of their understanding of the system they can spot minor details that easily can be fixed (Eriksson et al., 2009).

As demonstrated here, a large body of research supports the idea of training developers to perform UX and usability tasks. However, the experiences of doing so also points towards obstacles and still unsolved problems. Our aim is to further investigate the notion and address some of the reported difficulties.

3. Research method and initial steps

In the present study we are following an action research approach. Action research calls for an iterative process involving both the developers and the researchers acting together to define a diagnosis, plan and conduct an action intervention, followed by evaluation and reflection (Davison et al., 2004). The gain of this approach is the opportunity for addressing complex real life problems together with addressing organizational processes by means of having the developers take action and improve their work situation (Baskerville and Wood-Harper, 1996, 1998; Davison et al., 2004; McKay and Marshall, 2001).

The present work is a part of a larger research effort to improve the usability and UX design processes in agile software development. The research is conducted in collaboration with Radiometer Medical and Aalborg University. Radiometer develops medical devices and is therefore under strict regulatory demands of being in compliance with e.g. the usability standard put forward by U.S. Food and Drug Administration (FDA) (ANSI/AAMI HE75:2009, 2009) and ISO (2010).

The project as a whole follows the Collaborative Practice Research approach as put forward by Mathiassen (2002). This approach is an action research methodology, in which it is possible to connect the need to understand the current practices of working with UX, usability and agile software development with the need to integrate these two frameworks to improve the final product. The methodology furthermore offers a structure for the company, allowing the researchers and software developers to collaborate by combining *"action research, experiments, and conventional practice studies to strike a useful balance between relevance and rigour."* (Mathiassen, 2002). For the overall research project an action research protocol was developed, which documented initial thoughts, roles, controls framework, usefulness, documentation, transferability, decisions for each of the action research criteria (Nielsen, 2007). Relevant parts of the protocol are documented in the following section. The encounters important for the present study are included, as well as the roles of the participants and the interview guides. However, we do not have the space here to make a full account.

3.1 Initial observations

To initiate the overall research project, R1 (see Table 2 below) was hired to work as a UX designer in the software department. For five months she participated in the daily work and alongside made observations on how Radiometer worked with usability, UX design and Scrum on a day-to-day basis and an in-depth diagnosis was made, which is described in (Øvad, 2014). This diagnosis corresponded with the initial assumptions by Radiometer prior to R1's employment.

Based on the diagnosis of the problem situation, a literature study concerning the work with usability and UX in an agile development environment was performed by R1. Three main findings emerged and are described in (Øvad, 2014). Based on these findings it was suggested to have the software developers do some of the usability and UX work themselves. This solution mitigates the identified problems by achieving two goals:

- The software developers can perform certain, minor usability and UX tasks themselves, thus reducing the UX bottleneck
- A shared language and understanding within the development team

To address the suggested solution, it was agreed between Radiometer and the researchers that suitable usability and UX methods should be selected and adapted to fit into a Scrum process. The modification should also take into account that the performing actors would be software developers, not UX experts. Hence, the overall purpose of the overall research project was agreed upon to be the investigation to what extent a UX toolbox, developed to be used by software

developers in an agile software environment can facilitate synchronous work with agile development, usability and UX design.

A prioritised list of usability and UX methods was identified through a literature study (Øvad and Larsen, 2014). The present paper presents the work with AB-testing. A classic AB test is a simple way to test the effect of changing one variable in a design, e.g. the colour of a button, against the current design and determine which design is perceived as the best solution. AB testing is a way to validate that any new change to a variable is improving the product before making the final change.

3.2 Participants

Seven software developers participated in the present study. See Table 1 for their profiles. All of them are employed in the software department at Radiometer, but working on two different projects.

ID	*Years of work experience*	*Interested in UX Tasks (expressed before the training session)*
D1	*16*	*Yes*
D2	*9*	*Yes and would conduct this type of work to a certain extent*
D3	*11*	*Yes*
D4	*14*	*Yes, to a certain degree*
D5	*6*	*Yes, to a certain degree*
D6	*3*	*Yes, but would not conduct this type of work himself*
D7	*25*	*Limited interest*

Table 1. Developer profiles.

None of the developers had formal training in usability or UX work. However, all had observed user tests during their employment at Radiometer, but never participated or facilitated one themselves.

Four researchers conducted this study. Their roles are shown in Table 2. All researchers have extensive training and experience in usability and UX work and all participated in the data analysis.

ID	*Roles*
R1	*Insider action researcher, performing all observations and interviews, performing the modification of the method and the material together with R3*
R2	*Outside action researcher, performing the training*
R3	*Outside action researcher, performing the modification of the method and the material together with R1*
R4	*Outside researcher participating in the interpretation of findings and conclusions*

Table 2. Researcher profiles.

3.3 Key encounters

The present study had six key encounters, summarized in Table 3. All encounters took place on-site at Radiometer. The AB-test method was modified in two iterations based on the analysis from encounter 1 and 3. Due to the real-life conditions, not all of D1-7 were available for all encounters, which is reflected in Table 3.

Date	**Enc.**	**Activity**	**Participants**
Dec. 2014	1	Initial Interviews concerning the developers' expectations and reservations	R1, D1-7
Dec. 2014	2	Training session	R2, D1-5
Dec. 2014	3	Interviews collecting training experiences	R1, D1-5
Feb. 2015	4	The developers applied the method on their own.	R1, D1, D2, D4 and D7
Feb. 2015	5	Final interviews	R1, D2, D4 and D7

Feb. 2015	6	Evaluation of the results from encounter 4	In-house UX designer at Radiometer

Table 3. The action research encounters.

We have elected to place the detailed schedule for the training (Encounter 2), as well as examples of the used materials in the subsequent Findings section instead of here.

All interviews were conducted as semi-structured, face-to-face interviews. The duration of the initial interviews (Encounter 1) was between 14 and 34 minutes. The interview guide included the following themes: Background of the participant and years of relevant work experience; work field; knowledge about UX and usability and attitude towards these work fields; the possibility that they will use the method on their own; any prior knowledge concerning the method; final remarks.

The duration of the second interviews (Encounter 3) was between 18 and 31 minutes. The interview guide included the following themes: The participant's output from the training; their overview of the method; things they would like to change concerning the method; things they would like to change concerning the material; remarks for the method and the material; final remarks

The duration of the final interviews (Encounter 5) was between 15 and 47 minutes. The interview guide included the following themes: How the planning, test and analysis were carried out and the logistic concerning this; the results and what they could be used for in the future; remarks for the method and the material; final remarks.

All interview encounters were documented through audio recordings and observation notes. The training session and the session where the developers applied the method on their own were documented via video recordings and notes. Following each encounter, the participating researchers (R1-3) conducted a debriefing.

After having transcribed the interviews, R1 analysed them and the notes by performing a meaning condensation of the data (Patton, 2015), followed by performing five steps in a cyclic manner: compiling, disassembling, reassembling, interpreting and concluding, as described by Yin (2010). This iterative process resulted in the identification of some overall themes. All themes are described in the following, including quotes from the interviewees related to the respective themes. By integrating the analysis into the action research process, we allowed feedback after each iteration. This formed the basis for the iterations and modifications of the method and the material.

Following the evaluation performed by an in-house UX designer at Radiometer on the results from encounter 4, we closed the action research process for this method, since she assessed the method and material's usefulness and found it highly applicable. The materials are described in details in (Øvad and Larsen, 2015b).

4. FINDINGS

This section presents the findings related to the different encounters.

4.1. Encounter 1: Initial Interview

The developers (D1-D7) were interviewed individually prior to the training session. The subsequent analysis revealed three major themes; *expectations towards the particular method and UX activities in general*; *confidence in their capabilities,* and the *usefulness of the work.*

4.1.1 Expectations

The expectations to the method ranged from; "*I expect a lot of work in order to clarify a little thing*" [D6] to "*A way to quickly find a solution*" [D2]. Furthermore, all developers expected to be very clear about the parameters they are to test and that the outcome would be clear, quantitative results presented in some sort of report.

4.1.2 Confidence

All found the idea of doing certain UX tasks interesting. However, the responses clearly indicated they lacked confidence in their abilities. Some would prefer the dedicated UX team did the work. D4 pointed out: "*I would feel more comfortable if there were other people, who are a bit more experienced with this sort of work*" and D5 said: *"I would prefer that our UX team perform these tasks"*. When asked if he could conduct such work if he had some guidelines, D6 responded: *"I do not think I would be any good at facilitating such a test"* [D6]

4.1.3 Usefulness

All of the developers would use the results from an AB-test, but only three of them expressed willingness to conduct an AB-test on their own. D1 said: *"I would definitely use the data from an AB-test. Organise… I would like to participate, but I'm not sure of organizing"*.

D3 pointed out that: "*I sense that by an AB-test, you can try different options and I think it will benefit the product in the end*".

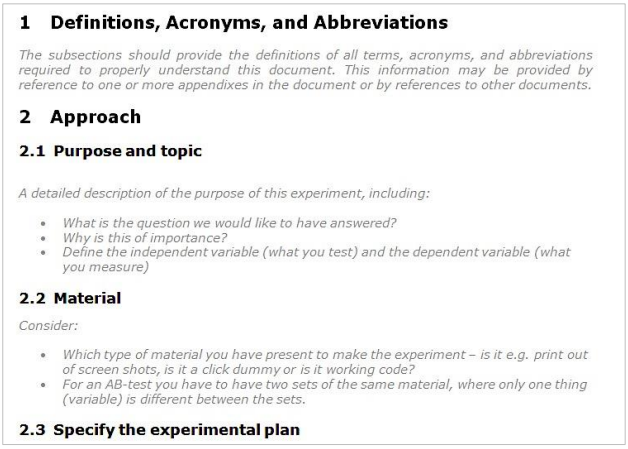
All expected the results would be used in the product development. However, D2 pointed out: *"I can see a problem in that we do not have that much to say (design-wise)"*. D3 expects that: "*... process-wise it will move faster. Right now it seems like a user test is conducted and then months go by before we actually have the experiences and results to use in the development. I hope this method can speed up the process"*.

4.1.4 First iteration of the training process and materials

Based on these findings, a modification of the comparative usability test paradigm (Rubin and Chisnell, 2008) was instituted. We denote the method AB testing. It was in particular the concerns about framing this type of work; difficulties of estimating the time frame; and the company's general needs and policies, which led to this choice. It was clear the generic approach must be tailored to be applicable within one single sprint and the material should be lightweight, but still detailed enough to guide developers without a specialised background in conducting this type of work themselves. Furthermore, since the products of interest are characterised by embedded software running on physical devices, the method must accommodate the physical aspects as well. These considerations led to a modification towards a more qualitative based approach, relying on data from a small sample size.

Guidelines and templates for planning and reporting were developed from these requirements. This is supported by the observation by (Nielsen et al., 1992) that novice practitioners need structure, especially if conducting tests are not their main task.

During the diagnosis phase at Radiometer it was observed that the company made use of different artefacts in the development process. Especially the use of different templates was widely used to document the work, and correctly filled out documents is a requirement, when validating the different products. This template-based approach was adapted to our work, where greyed out text in the template is to guide the developers in performing an AB-test, see Figure 1 (only intended to give a broad impression), for more details see Øvad and Larsen (2015b). In order to further support the developers, a more in-depth guideline concerning AB-testing was developed as well.



1 Definitions, Acronyms, and Abbreviations

The subsections should provide the definitions of all terms, acronyms, and abbreviations required to properly understand this document. This information may be provided by reference to one or more appendixes in the document or by references to other documents.

2 Approach

2.1 Purpose and topic

A detailed description of the purpose of this experiment, including:

- *What is the question we would like to have answered?*
- *Why is this of importance?*
- *Define the independent variable (what you test) and the dependent variable (what you measure)*

2.2 Material

Consider:

- *Which type of material you have present to make the experiment – is it e.g. print out of screen shots, is it a click dummy or is it working code?*
- *For an AB-test you have to have two sets of the same material, where only one thing (variable) is different between the sets.*

2.3 Specify the experimental plan

Figure 1. The first steps of the first iteration of the planning template. The full version of the final template is available from: http://UXToolbox.es.aau.dk

The training session layout was based on principles and designs used by earlier studies, following a "presentations and exercises" approach (Bornoe et al., 2014; Bruun and Stage, 2014; Eriksson et al., 2009; Latzina and Rummel, 2003). By combining short lectures with hands-on exercises we wanted to engage the participants (Nielsen et al., 1992) and have an opportunity to ask questions and getting clarifications. The duration of the training session was set to one day and the agenda is shown in Table 4.

4.2. Encounter 2 Training Session

R2 conducted a one-day training (7 hours) session in conducting AB-testing, where five of the developers (D1- D5) participated. The participants were divided into two teams, corresponding to the expected resources available for real-life tests. Each group applied the learned theory on two real life cases taken within the company. One test objective was to determine the placement of a button and the other was to determine the wording of a button. The training activities are shown in Table 4.

Activity	***Details***
Introduction *(20 min.)*	Essentials of AB-testing.

Planning and preparing *(60 min.)*	Clarification of objectives Experimental design (Setting independent and dependent variable) Decide on tasks or actions Practical concerns
Conducting a test *(25 min.)*	Advice and expectation about carrying out an in-the-wild study.
Small break *(15 min.)*	
Hands-on exercise #1: Plan and prepare an AB-test *(60 min.)*	Set up evaluation goals and objectives. Prepare the analyzer.
Lunch *(30 min.)*	
Hands-on exercise #1: Plan and prepare an AB-test continued *(20 min.)*	Set up evaluation goals and objectives. Prepare the analyzer.
Hands-on exercise #2: Conduct a test *(120 min.)*	Find participants and run the AB-test
Small break *(10 min.)*	
Analyze test results and report outcome *(30 min.)*	Qualitative and quantitative data analysis How to report results

Hands-on exercise #3: analyze and report the collected data *(60 min.)*	Decide on which methods to use for analysis and interpret the results
Plenary session *(30 min.)*	Present the analyzed test results.

Table 4. Plan for the training session.

4.3 Encounter 3: Collecting Training Experiences (second interview)

The five developers (D1-D5) who participated in the AB-test training were interviewed after the training session. The interviews were performed to capture how the training had affected the developers. The analysis revealed four themes; experiences and issues; confidence and usefulness and training materials.

4.3.1.Experiences and Issues

Overall the developers were satisfied with the training; especially the hands-on exercises were very successful. All experienced some issues and made mistakes. D2 pointed out: ”*It was first after the first three participants that we remembered to ask the follow up questions, it was obvious that we became better over time”* and D3 felt that: *“In the beginning we were very awkward and we felt a bit stupid*”.

The most important issue was the problem of finding test participants. When asked what they would find the hardest part to do, D1 stated: “…*looking for the test participants, that is a problem… getting the participants – that was really challenging*”. Furthermore, all of the developers found the qualitative analysis hard, and it was fairly obvious the developers did not fully grasp the concept of qualitative data analysis.

An important insight was noted by e.g. D1: *“Even if you want to test something very, very small – there is actually a lot of preparation and a lot of after-work after the test*”

4.3.2 Usefulness

All now expressed they would both use data obtained by a test and also conduct an AB-test on their own. D1 expressed this: “*I feel comfortable in any of the steps*”

4.3.3 Training materials

The developers were very positive towards the materials. D3 stated: "*I think they (guideline and templates) were very professional and thorough – and I liked the greyed out guiding texts*". However, some issues with the templates for scoping and reporting the findings were pointed out, e.g. by D4 *"It is just that the test script looks quite intimidating cause there are so many entries, but you just need to understand that some of them are not applicable*".

4.3.4 Confidence

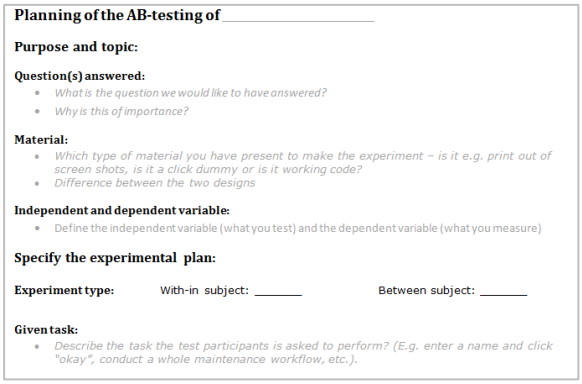
After the training, all felt secure in conducting an AB-test. The most important reason given was they could rely on a structured and established process in combination with the provided materials. D2 pointed out: "*Just to know what making such a test involves and what challenges there are – I think that is healthy*".

From observations during the training and the interviews, the importance of the guidelines and especially the templates was evident, as also noted above. D5 said: *"I think the report should just be a one-pager, where you have five lines to describe the purpose and some check boxes to check concerning if it is a within – or between subject design, etc. – it has to be as easy as possible"*.

Materials should be as lightweight and accessible as possible. Even though it had caused problems; it became clear the main analysis focus should be qualitative, as the scope would be small-sample testing.

4.3.5 Second iteration of the materials

Based on these findings, the templates were modified and made even more accessible and lightweight, and all materials were merged into one single template, thus including both a planning and a report part, Figure 2 shows the first steps of the template (although only broadly illustrated here, due to space limitations). For more details see Øvad and Larsen (2015b). Emphasis was devoted to support the data analysis part. This iteration of the materials was then used in encounter 4.


Planning of the AB-testing of _____

Purpose and topic:

Question(s) answered:
- *What is the question we would like to have answered?*
- *Why is this of importance?*

Material:
- *Which type of material you have present to make the experiment – is it e.g. print out of screen shots, is it a click dummy or is it working code?*
- *Difference between the two designs*

Independent and dependent variable:
- Define the independent variable (what you test) and the dependent variable (what you measure)

Specify the experimental plan:

Experiment type: With-in subject: _____ Between subject: _____

Given task:
- *Describe the task the test participants is asked to perform? (E.g. enter a name and click "okay", conduct a whole maintenance workflow, etc.).*

Figure 2. The first steps of the second iteration of the planning and report template.

4.4 Encounter 4: The developers applied the method on their own

Four software developers (D1, D2, D4 and D7) planned, conducted and analysed an AB-test on their own, two months after the training. This work was handled as any other development task in the software team. The task had been defined and assigned story points before being placed in the product backlog. In this sprint the task was moved to the sprint backlog and performed by three of the developers who had participated in the AB-test training and one (D7) only participated in the initial interview. R1 observed the developers when they planned, conducted and analysed the AB-test. The test objective was to determine which of two keyboard layouts should be included in the final product.

The developers decided to split into two teams and perform a test each. They had the responsibility for organising all activities. Details are showed in Table 5.

Activity	Time spent	
	Team 1	Team 2
Planning	145 min.	145 min.
Conducting test	75 min.	90 min
Data Analysis	75 min.	80 min

Table 5. Time used by the developers for planning, conducting and analysing an AB-test

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4.4.1 Observations

The developers used the templates extensively to assist the planning of the test and it facilitated some good discussions concerning the different choices to make regarding the test, such as selecting a within- or a between subject test design, how data would be obtained, etc. The extensive reliance on the materials meant the tests were designed almost exactly as the ones they performed during the training session. However, one team developed an extra template for the test.

During the test, the developers handled the test participants well. Both teams videotaped the tests, made notes and recorded the timing. Both teams attempted to conduct a t-test, even though they did not have enough test participants. Generally, the data analysis seemed to be the biggest obstacle and the teams had problems comprehending and applying the qualitative analysis. This observation is supported by Skov and Stage (2005).

4.4.2 Encounter 5: Final Interviews

Similar to the previous encounters, data was captured via interviews. The analysis produced three themes seen previously: Experiences and issues; confidence; and usefulness. A fourth theme emerged, related to the two last ones: Attitude to UX work.

4.4.3 Experiences and Issues

Overall all of the developers were satisfied with the execution of the test and the outcome. D2: "*I think it was excellent and it was obvious that we had tried it once before. ... I think it went much better than last time*".

The observation about strict adherence to guides and templates was verified in the interviews and the participants confirmed the level of detail as appropriate.

In relation to the planning and execution of the test, D4 pointed out that: *"I think it was a fairly simple test, and maybe some minor things got too much attention… I think the hard part is coming up with the A and B. After that it should be really straight forward.*" None of the developers experienced problems in finding test participants.

In relation to the observed difficulties with qualitative analysis D7 pointed out: "*There were some exciting comments – and some of them recurred*". However, none of the groups conducted deeper qualitative analysis besides writing down the test participants' comments. D1 noted: *"It would be nice to touch up the analysis part"*.

4.4.4 Usefulness

All developers are sure the results from the test can and will be used within the development process at Radiometer. D1 answered: "*Definitely, definitely! Not only the things we set out to test, but also the things we didn't plan to test (additional finding)*".

4.4.5 Confidence

All of the developers would perform an AB-test again. D7 pointed out: "*You are helped with this material*" and D2 said: "*Yes, but maybe not on my own initiative – it depends on the tasks lying on my desk*".

4.4.6 Attitude towards UX work

The participants expressed an increasingly positive attitude towards UX work during the process. D2 pointed out that: "*It was a nice experience. We are not used to conduct tests ourselves so being able to use our work … I think it is healthy to participate in such stuff.* "

4.5 Encounter 6: Evaluation

In a final step to evaluate the results, an in-house UX designer separate to both the teams and researchers was called in and asked to review the outcome of the tests. She confirmed the quality of the obtained information and the value produced for the company: "*The findings are definitely usable. We have obtained a clear indication of the direction to go. One test showed no clear preferences, which in itself is a good thing, as one solution would be much more expensive to implement compared to the other.*" Commenting on the data she observed that both the qualitative and quantitative data was useful, although she would have preferred more observation data. She stated that: "*We have been able to compare this AB-test to earlier tests we have made*".

5. DISCUSSION OF THE STUDY FINDINGS

The reported action research study demonstrated the feasibility of training developers to perform certain UX tasks in an agile environment. A series of interviews supported by observations was used to provide evidence of how the participants' expectations, confidence and perceived usefulness of the work evolved during the process.

During this research study it was noticeable that the involved developers all displayed an increasingly positive attitude both toward the presented method, as well as the confidence in their ability towards conducting usability and UX work

themselves. The training and application of the method provided new knowledge and skills to the participants as well as an accommodating attitude towards usability and UX work. Concerning the applied training method, it has been successful as indicated by the participants; much of the success is ascribed to the practical approach and the possibility to use real life tasks in the training.

5.1 Limitations of developers' skills

Other studies have found that developers find it difficult to interpret observations (Eriksson et al., 2009); to support the observations with data (Bruun and Stage, 2014); and to understand how findings can be used for radical design changes (Bruun et al., 2014). This study confirms and provides further evidence towards this. We saw problems with qualitative data analysis and although the external evaluator found the results useful, she would have preferred more observation data.

5.2 Impact of developers performing UX tasks

In line with Larusdottir et al. (2010)'s suggestions, our findings indicate that small-scale developer-driven usability and UX activities can support the understanding between UX designers and developers and indeed provoke an organisational change. Our findings indicate that the developers will be able to enter a dialogue and provide useful input to the UX designers. Furthermore, agile development requires quick and informal evaluation and by this study we have shown that the developers can be trained to perform such tasks.

For companies on level 3 of Nielsen's (2006) corporate UX maturity model involvement of developers can support that UX work is done consistent and systematic. For companies on level 4 the utilisation of developers as a UX workforce can reduce UX as a bottleneck and promote a shared language and understanding between the UX and the software teams, and facilitate that the UX team can focus on tasks requiring expert knowledge.

6. CONCLUSION

Our aim is to provide software developers with capabilities to perform usability and UX work on their own and thus facilitate a merge of UX work and agile software development. With this in mind we chose to focus on using the developers as a UX work resource in a day-to-day working practice by providing them with material concerning modified AB usability test, by training them in performing this type of work, and by using their feedback to improve the method and the material.

With this action research study we have contributed with empirical knowledge on how to train software developers to conduct minor AB usability tests. Furthermore,

we have contributed to the limited research on how software developers can be a part of the on-going work with usability and UX design within companies.

We conclude that the study has successfully demonstrated the feasibility of training software developers to carry out certain usability and UX tasks. A key element of the approach has been to first adapt the method to fit into an agile environment and to provide a set of detailed templates and forms to guide the participants, both elements have been performed via an iterative process in collaboration with the software developers, see Øvad and Larsen (2015b). This proved to be effective and allowed the participating software developers to plan, facilitate and implement a test session on their own within a sprint. In the present study the quality of this work has been evaluated and found usable by an in-house UX designer.

However, it is important to note that we do not see the results of our study as general step towards removing UX specialists from the development process. Rather we regard it as an approach for supporting developers during ongoing day-to-day product development, by performing certain limited usability and UX tasks themselves.

7. LIMITATIONS AND FUTURE WORK

It is still too early to say if the training of the developers has facilitated an organizational process change at Radiometer. However, as presented in this paper, the developers are indeed capable and motivated for this type of work and this is supported by management. Future work will therefore be to keep track of how often the developers perform an AB usability test on their own. Radiometer management is currently developing Key Performance Indicators (KPI) and different metrics in order to measure the usability and UX work performed by the UX team. It is under consideration to develop KPI's for the usability and UX work performed by the software team as well to fully integrate this type of work in the development process.

The AB usability test method applied in the present study was carefully screened and evaluated as feasible for integrating into an agile environment and teaching non-UX professionals (Øvad and Larsen, 2014). Only a limited number of methods can be expected to fit these criteria. One important obstacle was observed, as the developers showed difficulties with analysing the collected data. This finding will potentially limit the scope of the usability and UX methods suitable for this approach. Next steps are to extend the overall action research study to include other usability and UX methods and a broader base of companies for further evaluation and validation. It should be kept in mind that this type of test cannot secure compliance with the standards put forward by e.g. the FDA, but be an instrument to enhance the quality of the product and ease the compliance work in the long run.

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Paper 4

TEMPLATES – A KEY TO SUCCESS WHEN TRAINING DEVELOPERS TO PERFORM UX TASKS

Tina Øvad and Lars Bo Larsen

The paper is to appear as a chapter in the book:
Integrating User Centred Design in Agile Development.

2016

The layout has been revised

ABSTRACT.

Working with usability and UX design in an agile development con-text such as Scrum has been found challenging. Not all companies have the need or resources for a team of dedicated UX specialists. In other cases the UX team is perceived as a bottleneck. We therefore set out to investigate; how companies can perform UX tasks, when no or little UX expertise exists in the organization; if it is possible to perform this work in line with the Scrum sprints and how such work should be facilitated. To do this and since the Scrum framework states that every team member should be able to perform every work task, we trained software developers in three different companies to perform certain selected UX methods. The training was done as one-day training sessions. The developers were provided with materials describing UX methods modified to be used in an agile, industrial environment. These consisted of guidelines, templates and cheat sheets. These materials were refined throughout the training sessions based on observations and feedback from the developers. We found that especially the templates were highly valued by the developers. The templates provided a quick overview of the method, guided them in the work and gave them security and confidence in conducting this type of work independently of the researchers. The templates described in the paper have been made publicly available and may be used freely.

1. INTRODUCTION

Even though a company realizes a need to increase the usability and user friendliness of their products, it might be unable to invest in the resources needed to achieve this [1]. This could be to set up a specialized UX team or assign UX specialists to their product development teams. Furthermore, studies have shown that companies with UX specialists often experience the UX work as a bottleneck [2].

In this paper, we address these problems by investigating how a company can perform UX tasks, when no or little UX expertise exists in the organization. We investi-gate if it is possible to perform this work in line with the Scrum sprints and how such work should be facilitated.

Our approach to alleviate these problems is to leverage already existing resources in the organization – by enabling software developers to perform certain UX tasks. We do not make any claims towards this approach being the best or indeed the only solution – in fact; we believe it should be combined with other initiatives. However, we do make the claim it is a viable solution and in the following sections we will demonstrate how this can be achieved through a number of empirical studies.

Industry has largely adopted agile approaches. In particular, Scrum has become popular [2], [3]. This paradigm states that every team member should be able to perform every work task. Therefore, it seems quite rational to train developers to conduct certain usability and UX tasks. This will utilise the developers' already present domain knowledge [4], [5] and could potentially facilitate a better downstream utility and a shared language within the development team. Thus, to enable developers to conduct UX tasks seems to be a potential solution to the challenge of increasing the presence of UX activities in the development process. This is elaborated and argued further in Section 2 on related work.

Working with usability and UX design in an agile development context such as Scrum has been found challenging [6]–[8]. The contrast between the workload of usability work and the simplicity, speed [3], the iterative nature, and focus on sprint completion [9] in Scrum is a challenge. One recommendation is to integrate usability work into day-to-day development tasks [10]. A specific suggestion is to investigate how usability work can be conducted on a small scale so the activities can be integrated into each sprint [3]. Informal and lightweight approaches are already commonly followed in industry [11]. Bruun and Stage [12] shows how basic usability evaluation training is a fast and cheap approach to provide developers with minimum skills. For example, basic training can provide developers with a better understanding of user perspectives, while not replacing usability practitioners [13]. Instead basic training can strengthen the collaboration between non-technical and technical roles [14].

As stated above, we suggest addressing this problem by using software developers as a UX work resource. To facilitate this, we have selected and modified three widely used UX methods to be tailored to an agile, industrial environment [15]–[18]. This is described in Section 3. We will make the case that this approach will facilitate a shared language in the development team while at the same time reduce a potential bottleneck in the organization.

Our approach is empirical: We do in-situ training sessions with software developers from three different companies. We record their attitudes towards UX tasks before and after the training sessions, and monitor their performance, when they apply the acquired knowledge and carry out the tasks independently. During the process, we provide written materials, such as guidelines, templates and "cheat-sheets". We developed and refined these supporting materials in an iterative manner throughout the process, reinforced by observations and developer feedback. This is described in de-tail in Section 5, where focus is on the templates, which proved to be the most popular and usable tool. Furthermore, we show examples of the evolvement of the templates. The materials developed in this work and described in the following sections have been made available as a freely accessible resource via the Open Publication Licence and can be downloaded from [19].

2. RELATED WORK

This section reviews a number of empirical studies concerning developers receiving training to conduct certain UX tasks.

Bruun and Stage [12] introduced eight software developers from a small company (20+ employees) to a two-day basic training course in a traditional user based usability test with video analysis. As a part of the training, the developers were to analyse five video clips from a previous conducted usability test. After this, five of the developers were asked to conduct a user test on one of their own products and analyse this for usability issues. Two HCI specialists likewise analysed the data. In comparison of the results, the developers were able to identify 48% of all usability problems compared to a team of HCI specialists, who identified 62%. A second study focusing on the IDA usability testing method and showed comparable results between developers and specialists. A follow up study later revealed that developers had fixed approximately 60% of the found issues, thereby accepting the usability corrections as a task in their development project. [12]

Karat and Dayton [20] reported on two different training programs for education developers in user research and usability methods. The first training program was conducted at an IBM software development lab as a six-day on-site training session. The training session's purpose was to establish a corps of usability advocates among the developers, by introducing them to contextual inquiry, customer interviews, and design constraints and standards, which they could use in their daily work. The training resulted in the practitioners conducting numerous of user inquiries and establishing effective communication between different parts of the organization. Both the practitioners and the management expressed satisfaction with the training and its outcome, which had increased the general awareness of usability among the employees. The consulting company Bellcore provided the second training program as a service to their customers. The training consisted of a three-day workshop where the developers were seated in small groups of six-seven people, with minimum one real end-user among these. The workshop introduced a participatory design framework and focused on task analysis and paper mock-ups. The workshop was split into 10% formal lecture and the remaining 90% of the time was focused on the developers applying the methods on their own products. Because the learning environment of the workshop were very similar to a real software development environment, we argue that the participants would have an easy job explaining their methods to others co-workers, and likewise easily be able to apply the methods from the workshop in their real project. However, we have not presented any evidence for these positive benefits of the workshop's outcome [20].

Nielsen et al. [21] presents a series of five workshops training all-in-all 27 developers in designing GUIs. Each workshop was designed as a one-day event and focused on design principles and guidelines for GUIs, and paper mock-ups. The participating developers worked together as a team and used the learned methods for their own GUI designs. Afterwards usability specialists using a heuristic inspection method evaluated each GUI design. Afterwards the results of the inspections were discussed with the participants in order to provide constructive feedback to the developers' design and learning. Seven month after the training, we made a follow-up evaluation on one of the participating teams. They had made a complete GUI prototype for one of their products. The prototype was inspected using heuristic evaluation. The inspection revealed several usability problems but also showed that the developers had been able to apply the leaned methods and design a cohesive GUI [21].

Based on these experiences, as well as requirements made by the participating companies, we decided to apply a number of constraints to the approach:

- The training should be conducted in-situ, both for convenience and for easy access to resources, such as test participants, prototypes and other equipment.
- The cases provided in the training sessions should be real-life and taken from the company's on-going product development process.
- A training session should have a duration of one day and include a large proportion of hands-on exercises.
- Training materials such as templates and other documents should be prepared prior to the training and provided at the training session.
- After the training session, the participants should carry out the tasks independently of the researchers, preferably within a three-month window.

3. METHOD SELECTION

The restrains mentioned above narrowed down the number of suitable methods, together with the demand that the methods should be suitable to be used in an agile, industrial setting and applied by software developers.
We will not include more explorative user research methods (e.g. ethnographical studies) primarily applied prior to the product development process. Nor include the very formal quantitative usability evaluations sometimes performed by the end of the development process. However, Contextual Inquiry is listed, since this approach can be used throughout the development process in order to gain information regarding the use situation and the end-user.

These decisions are based on the fact that software developers are typically not involved at these phases of the product development process. Furthermore, the

methods typically require trained specialists. In addition to this, the methods must be applicable within a single sprint. These constraints have been applied to a range of widely used UX methods.

Not surprisingly, we only identified a limited number of suitable candidates. Furthermore, during the initial steps we observed that developers showed difficulties with analysing the collected data. This finding limited the list even further [18]:

- A modified focus group technique [22]. This is denoted Focused Workshop [17], [23].
- Comparative usability testing, modified by [16]. This is denoted AB-testing [16], [23].
- Contextual Inquiry as described by [24], [25] and modified and referred to as Contextual Interview [23].
- Cognitive Walkthrough as first described by [26] and modified by [27], [28].
- Instant Data Analysis (IDA) as described by [29].

The present short list contains five methods, which cover the desired development phases. Furthermore, these methods are judge to be ideal as a starting point for the present work, due to their level of complexity and time restrains. Since the time frame for the present project is restricted, only three of the methods are included in the present work (Focused Workshop, AB-test and Contextual Interview). A more thorough description of the modified methods can be found in section 5 and in [19], [23].

4. METHOD

The software developers at three companies (presented below) were trained in using the methods over a period of two years. The training approach and corresponding materials were updated and refined based on the experiences gathered in each iteration. In the present paper, we will focus on the templates provided to the developers to design and plan the studies and report the results.

To introduce each of the methods, the developers participated in a one-day hands-on teaching course for each method, for more details concerning the training see [16], [23]. The training session was based on principles and designs used by earlier studies, following a “presentations and exercises” approach [9], [12]–[14].

The notion of using guidelines and templates together with one-day hands-on training sessions is the result of the experiences of previous studies reported in the literature coupled with the requests from the participating companies. Together these enable a quick, simple and efficient solution, which suits to the pace of agile development.

During our initial observations at Radiometer (see description below), we found that the use of different artefacts in the development process was widely adapted.

Particularly, the use of templates for documentation is widely used to efficiently track the progress and the validation process of the different products. It was therefore decided to develop guidelines and templates to guide the developers in how to plan, conduct and analyse and apply the different methods. In order to document the process and the findings, templates were developed as well. This approach is supported by Nielsen et al. [21], who point out that novice practitioners need structure, especially if conducting this type of work is not a main task.
During our work, it became apparent that templates acted as the pivotal instrument. Initially we hypothesized it would be the guidelines, but this was proved wrong. The templates were found to be the most useful instrument to steer the execution and documentation of the UX tasks. Therefore, the issue addressed in the remainder of the paper is how such templates should be designed to achieve the optimal acceptance and usefulness for the developers.

4.1. Study Sites

The empirical studies were carried out within the software development teams at three distinct companies: Radiometer Medical and TC Electronics in Denmark, and SenDx Medical in the US. All applying the agile framework Scrum.

Radiometer Medical ApS is a global provider of solutions for acute care testing and develops medical devices. The company is headquartered in Denmark and has about 2400 employees worldwide with 250 in R&D. The company has used Scrum for five years as the primary development framework with three-week sprints. Radiometer has focused on UX design for a number of years and due to increasingly strict regulatory demands from the U.S. Food and Drug Administration (FDA), to be in compliance with e.g. the usability standards e.g. [31]. Consequently, Radiometer has a dedicated UX team in place, but intends the software developers to perform minor UX tasks on their own, thus minimizing potential UX bottlenecks and developing a shared language between the UX and development teams. [30]

TC Electronic is a global company with headquarter and main R&D facility in Denmark. TC Electronic produces audio equipment primarily for the music industry, e.g. guitar and bass amplifiers, guitar pedals, sound and picture production systems, and broadcast systems. Worldwide TC Electronic has about 300 employees, where 30 are in the R&D department.

The company has four years of Scrum experience as the primary development framework with three weeks sprints. Each of three development teams is a mix of software, hardware, and mechanical engineers with a joined focus. TC Electronic has no dedicated UX team or employees and has no current plans in this direction, but intends the R&D teams to carry out UX tasks. [32]

SenDx Medical is an American based company located in California. SenDx is a subsidiary to Radiometer and develops medical devices. SenDx is under the same regulatory demands as Radiometer concerning the usability standards put forward by FDA. SenDx is using Scrum as the development framework and work with three-week sprints. The company has people working with usability, but relies on Radiometer's UX team concerning major UX tasks. By upgrading the developers' skills at SenDx they can perform minor usability and UX task on site instead of having to rely on the Radiometer UX team. [33]

4.2 Research Method

To record the effects of the training and the developers' attitudes towards the tasks, we decided to carry out semi-interviews with the developers at three points: Before and after the training, and a final interview after they had applied the methods on their own. For every interview, an interview guide was developed. Furthermore, observations and video recordings were performed throughout the sessions and transcribed and analysed together with the interviews.
The interviews and notes were transcribed and analysed by performing a meaning condensation of the data as described by Patton [34], followed by performing five steps in a cyclic manner: compiling, disassembling, reassembling, interpreting and concluding, as described by Yin [35]. This iterative process resulted in the identification of some overall themes, which led to further modification of the different usability and UX methods and corresponding materials. The themes related to the templates are described in section 5.

4.3 Study Organization

In the final selection, three of the methods mentioned in Section 3, "Focused Workshop", "Contextual Inquiry" (later adapted to Contextual Interview) and "AB-testing" were chosen. These were applied at the three companies according to the overview shown below in Table 1. In the following, a study refers to training and evaluation of one usability/UX method within a company. This paper consists of six studies – three carried out at Radiometer, two carried out at SenDx and one carried out at TC Electronic.

Table 4. Overview of the training and evaluation iterations

–	TC Electronics	Radiometer	SenDx
Focused Workshop	–	Summer 2014 Summer 2014	–
AB-Testing	–	Fall 2014 Winter 2015	Spring 2015 Summer 2015
Contextual Interview	Fall 2013 Winter 2014	Spring 2015 Fall 2015	Summer 2015 Summer 2015

As indicated in Table 1, not all methods were applied at all sites due to practical and logistical constraints. However, a substantial empirical material was collected from the studies. This is presented in Section 5, where the iterative development of the templates is also described.

The methods are presented in a strictly chronological order instead of method-wise.

5. RESULTS OF THE STUDIES

This section presents the studies described in table 1 above. The focus is on the development of the templates and materials, but the training approach is also discussed, however a more in-depth description of the training can be found in [17], [23]. The studies are described in a chronological order, and each study may contain up to four iterations of the materials. The results quite broadly described the initial studies and iterations to save space, but become more detailed as a detailed format emerges.

5.1. Contextual Inquiry at TC Electronics

We initiated the study cycles by training developers at TC Electronic. The method in this session was Rapid Contextual Inquiry (CI) including the tailored qualitative data analysis methods, as described in [24], [25] within the framework of Contextual Design (CD). The choice of introducing the CI method was based on a wish from TC Electronic to acquire a systematic and simple method for gathering insights of user behaviour. These insights would be used to support TC Electronic in determining the key features and the context of use of new product from an initial phase. It was further a request that the methods should fit into their agile

development process. The participants were introduced to the CI and the data analysis methods through a one-day workshop (7 hours) at the company facilities. At this point the training materials largely consisted of the materials described in [25] including samples of affinity diagrams, artefact models, etc., associated with CI. The training was well received and approximately two months later, the development team at TC Electronics planned and conducted out a Contextual Inquiry. This was also successful, but at this point, we observed problems during the analysis phase of the collected Contextual Inquiry results and were called upon to assist during the analysis phase. The interviews with developers confirmed that the teaching approach was well received, but revealed that the subsequent analysis part was felt to be too hard and required external expertise. Additionally, it was experienced as too time consuming. Overall, the method was considered useful and a representative from the company later stated that several months had been cut from the product development time, as the Contextual Inquiry demonstrated that many anticipated features would in fact be superfluous and was omitted early in the process.

This study clearly showed that the structured approach imposed by the Contextual Inquiry was a gain. However, we found that the analysis phase of Contextual Inquiry seemingly required a stronger background within UX than we aimed for and the method needed to be adapted further. This was taken into account in the next iteration of the Contextual Inquiry method (see section 5.8 and 5.9).

5.2 Focused Workshop at Radiometer

Radiometer requested a method that could facilitate a closer relationship between the developers and their end users. Therefore it was decided to go with a focus group approach, but customized to the agile, industrial setting. Pre-training interviews with Radiometer developers and the experiences from the training at TC Electronic including post-training interviews with TC Electronic developers formed the basis for the approach. The aim was to make the analysis part less prominent and we wanted to create some additional structure to this often less structured method. The resulting adaption is denoted Focused Workshop. We developed a structured and rigorous guideline to support the developers, together with two templates – one for planning the session and one for reporting the findings. [17]

Instead of assigning a whole day to training, we decided to have two developers observe one of the authors conducting a Focused Workshop as trainees and acting as note takers. From interviews with the developers it was clear that this approach resulted in a high confidence in the results the method could provide as well as their ability to conduct a Focused Workshop session on their own. One of the developers subsequently planned, facilitated and analysed a Focused Workshop. Interviews made it clear that the practical aspect of the training and the structure of the guideline were accepted. But when the developer facilitated a Focused Workshop independently, he did not use the templates at all and when going through his

report, a number of important items and findings were left out. Matters, which would had been emphasized in a more structured training session. [17], [23]

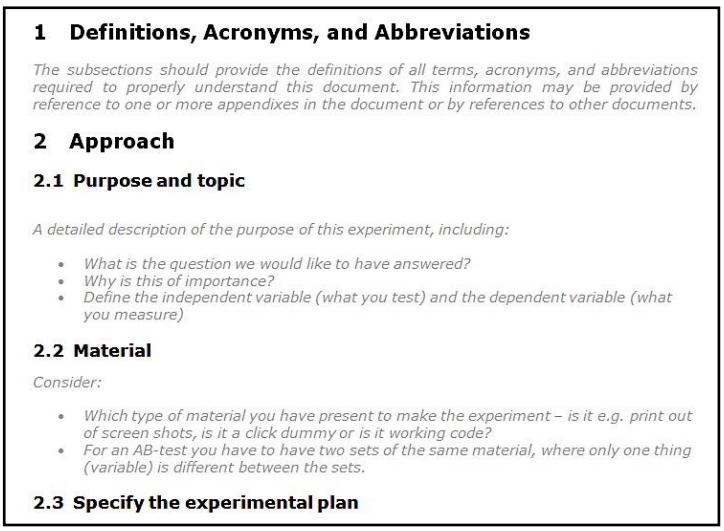
From this, it became clear that a strict *"observe and learn"* approach is not sufficient, even though it was well received and imparted the developers with a high level of confidence.

A more directed and organized training supporting the information in the guideline and the templates was needed, and the templates must be more accessible to be adopted.

5.3 AB-Testing at Radiometer

AB-testing is a usability test, where the goal is to compare user performance and preferences for different design proposals and help the decision process. In our approach, a variable can be everything from the colour of a button to whole GUI designs [16], [23].

We decided to use a structured training approach together with both a guideline and two sets of templates (planning and reporting). An excerpt from the templates is shown in fig. 1.



1 Definitions, Acronyms, and Abbreviations

The subsections should provide the definitions of all terms, acronyms, and abbreviations required to properly understand this document. This information may be provided by reference to one or more appendixes in the document or by references to other documents.

2 Approach

2.1 Purpose and topic

A detailed description of the purpose of this experiment, including:

- *What is the question we would like to have answered?*
- *Why is this of importance?*
- *Define the independent variable (what you test) and the dependent variable (what you measure)*

2.2 Material

Consider:

- *Which type of material you have present to make the experiment – is it e.g. print out of screen shots, is it a click dummy or is it working code?*
- *For an AB-test you have to have two sets of the same material, where only one thing (variable) is different between the sets.*

2.3 Specify the experimental plan

Fig. 8. Initial version of the first page of the planning template for AB-testing.

5.4 First Iteration of AB-Test at Radiometer

The training was conducted as a one-day (7 hours) training session including five developers. The training included the participants planning, performing and analysing an AB-test of a real-life test case, taken from a current project. For more details concerning the actual training session, see [16], [23].

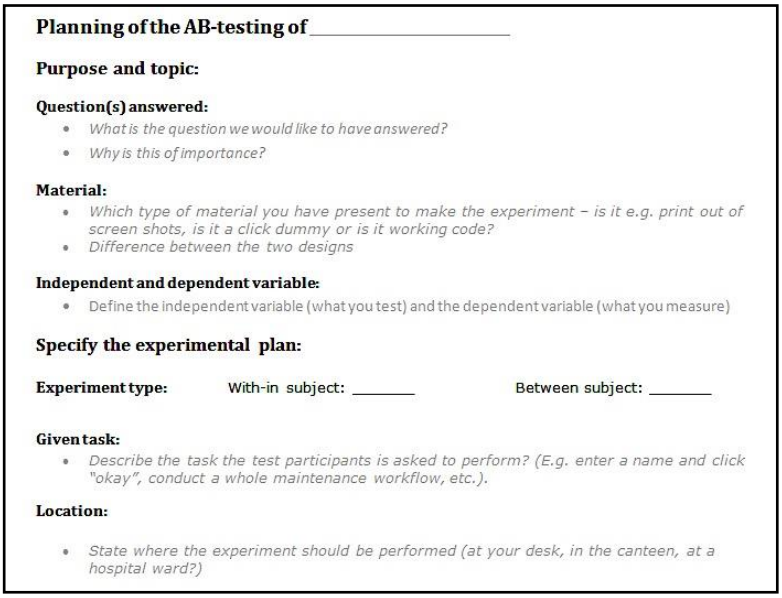
After the training, all felt secure in conducting an AB-test. The most important reason given was they could rely on a structured and established process in combination with the provided materials. One participant pointed out: "*Just to know what making such a test involve, and what challenges there are – I think that is healthy*". [16]

The developers were very positive towards the materials. One stated: *"I think they (guideline and templates) were very professional and thorough – and I liked the greyed out guiding texts".*

However, it was clear that the templates were the central item, as one of the developers pointed out: *"We are not like the university; we have these tools because we are going to solve a specific problem. Therefore, I would turn it upside down. In my world the tool is the template."* The templates were used very closely: *"We used it [the template] a lot - step-by-step, and almost answered it."* This was supported by: *"They were really good. They were really, really good. We used them a lot. I think it would have taken us more than the double amount of time than it took us to do the task without."*

From our observations during the training and the interviews, the importance of the guidelines and especially the templates were evident, as also noted above. However, some issues with the templates for scoping and reporting the findings were pointed out: *"It is just that the test script looks quite intimidating cause there are so many entries, but you just need to understand that some of them are not applicable*". And another participant had an idea of how he would like them to be: *"I think the report should just be a one-pager, where you have five lines to describe the purpose and some check boxes to check concerning if it is a within – or between subject design, etc. – it has to be as easy as possible"*.

Based on these findings, the templates were modified and made even more accessible and lightweight, and they were merged into one single template, thus including both a planning, and a report part, see fig. 2.



Planning of the AB-testing of _____

Purpose and topic:

Question(s) answered:

- *What is the question we would like to have answered?*
- *Why is this of importance?*

Material:

- *Which type of material you have present to make the experiment – is it e.g. print out of screen shots, is it a click dummy or is it working code?*
- *Difference between the two designs*

Independent and dependent variable:

- Define the independent variable (what you test) and the dependent variable (what you measure)

Specify the experimental plan:

Experiment type: With-in subject: _____ Between subject: _____

Given task:

- *Describe the task the test participants is asked to perform? (E.g. enter a name and click "okay", conduct a whole maintenance workflow, etc.).*

Location:

- *State where the experiment should be performed (at your desk, in the canteen, at a hospital ward?)*

Fig. 9. The first page of the planning and report template for AB-testing after first iteration

5.5 Second Iteration of AB-Test at Radiometer

In the second iteration four of the developers subsequently planned, implemented and analysed an AB-test on their own. We observed them during this work and interviewed them afterwards [16].

From the observations and the post-test interviews, it was clear that the participants were very appreciative of the templates. One said: *"We did not use the guideline when we organized the test - we only used the template"*, and he continued: *"When there is a template, we here at Radiometer are fostered to follow it... if there is a template we will follow it."* This is supported by: *"We followed it [the template] quite strictly – maybe we took out a little bit, because one part was not relevant"* and: *"We followed it [the template] very strictly, we tried to fill in as much as possible."* While these statements show a strong preference for the provided template they also show that any errors in these are likely to propagate directly into the studies. Thus, care must be taken when developing templates and a validation process must be in place.
An in-house UX specialist validated the developers' results from the AB-tests and found the obtained results valid.

5.6 Third Iteration of AB-Test at SenDx

To validate the results obtained at Radiometer a further training session was carried out at SenDx. Four developers participated. Like previously the template were well received and adopted. This was confirmed by statements like: *"We did not rely on the guideline, we followed the template", "Lovely. It was like – okay, and then I have to go here and do this. It guided us quite well. All you have to do is sit and do the work and then you're done."* and *"I liked it cause it kind of summarized everything pretty well. It gave an entire overview of the entire process, that's why I liked it."* However, some of the appeal is probably due to convenience.

One participant proposed to: *"Have a real world example we can go through and just replace the text"*. We considered this idea, but discarded it, as our previous studies indicated it would be too risky. Participants will be tempted to follow templates too literally. Including a real world example in place of the instruction texts (see figures 1 and 2), would lead developers to adopt it directly without considering necessary adaptions.

5.7 Fourth Iteration of AB-Test at SenDx

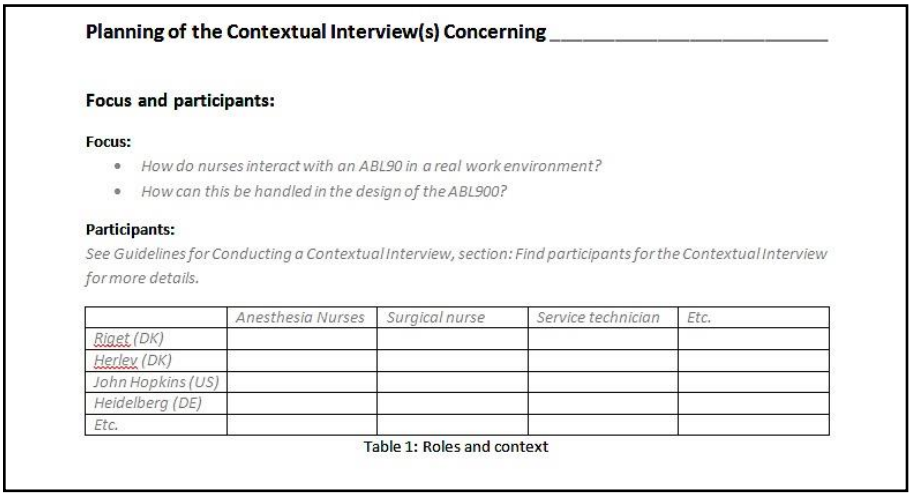
Four developers subsequently planned, executed and analysed an AB-test on their own. We observed them and interviewed them afterwards. The same trends as found at Radiometer were found at SenDx. This is supported by statements like: *"Yeah, it [the template] helped us prepare the whole test, it helped us organize material – it makes everything a lot easier."* and: *"We basically followed the template directly. We followed it similar to how we did last time. So basically we answered all the questions presented there and ended up with a document."* Further: "*The document [template] is flexible enough that you basically fill in the blanks with as much detail as you can provide. So I think it works out fine that way.*"

We conclude from this study that we have reached a stable version of the templates for the AB-testing case and consider the templates for AB-testing complete. The final version can be downloaded (and freely used) from [19].

5.8 First Iteration of Contextual Interview at Radiometer

The template-based approach has proved to work well for the AB-testing case, so we returned to Contextual Inquiry to investigate, if it was possible to adapt this method into a suitable form for our case. From the first trial with Contextual Inquiry at TC Electronic, it was clear that developers experienced some issues with the analysis phase. Furthermore, we make the claim that in an agile; industrial setting it is often not necessary to perform a full in-depth analysis as required by Contextual Inquiry.

We modified the method accordingly with a more shallow analysis phase and developed the materials for this. We denote the method Contextual Interview (CI), to indicate the strong inspiration from Beyer and Holtzblatt's Contextual Inquiry [25]. As previously, we developed a guideline for the method, together with a lightweight planning and report template, see fig. 3.



Planning of the Contextual Interview(s) Concerning _____

Focus and participants:

Focus:

- *How do nurses interact with an ABL90 in a real work environment?*
- *How can this be handled in the design of the ABL900?*

Participants:

See Guidelines for Conducting a Contextual Interview, section: Find participants for the Contextual Interview for more details.

	Anesthesia Nurses	*Surgical nurse*	*Service technician*	*Etc.*
Riget (DK)				
Herlev (DK)				
John Hopkins (US)				
Heidelberg (DE)				
Etc.				

Table 1: Roles and context

Fig. 10. The first step of the planning and report template for Contextual Interview

The training consisted of a one-day training session, where five participants had the opportunity to obtain hands-on experience and planned, executed and analysed a CI of a real-world task. For more information about the training, see [23]. When interviewed after the training session the reactions were similar to what we observed from the AB-testing case. The template was used throughout the CI and the developers where satisfied, as one pointed out: *"There was what there should be and nothing more"* and another stated that*: "I really like that if I start from the top and run through it, then I have probably captured what was intended."* The participants expressed a desire to have a cheat sheet to support the work, since they found the guideline too text-heavy, but still liked the possibility to look up details, as was pointed out: *"There has to be some sort of short guide – how to get started, do this and this."*

However, it was clear that the developers did not believe they would facilitate more than a single CI at a given time. This led to the removal of the data consolidation phase (derived from Contextual Inquiry, see [25]) from the template, see fig. 4.

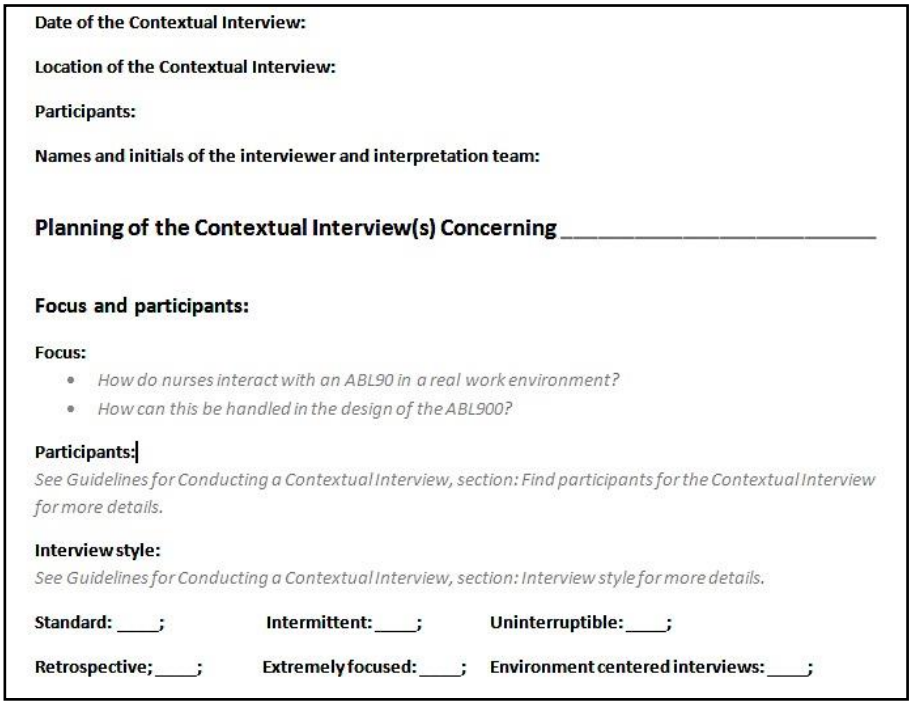
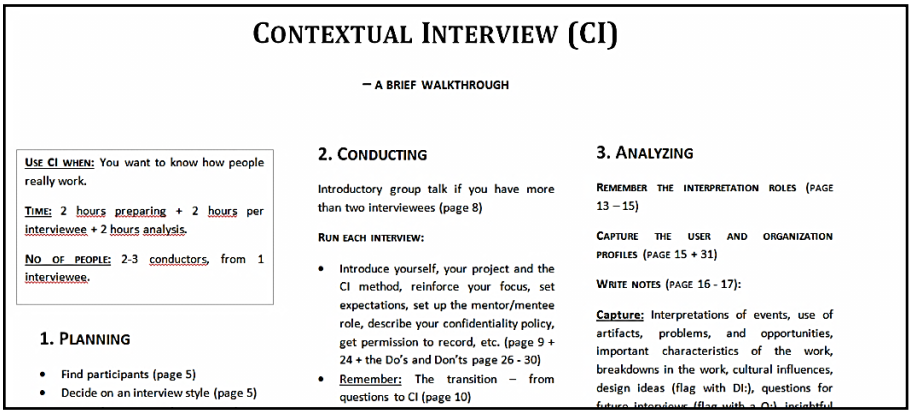


Fig. 11. The first step of the planning and report template for Contextual Interview after first iteration

5.9 Second Iteration of Contextual Interview at SenDx

The training was similar to that conducted at Radiometer. The four participating developers primarily used the template when planning, executing and analysing the CI. They did not have many new comments for the templates, but observed*: "It was pretty similar to the AB-test."*

As observed in the initial Contextual Inquiry case at TC Electronic, there were some problems with the analysis phase – especially how to analyses notes. We suggested to use the sequence model as reference to the notes [25]. This led to a proper analysis of the obtained data. Like the developers at Radiometer, several expressed a desire for some sort of cheat sheet, since the guideline is quite text-heavy and one developer actually made his own during the training session. See fig. 5 for an example of a cheat sheet for Contextual Interview.



CONTEXTUAL INTERVIEW (CI)

– A BRIEF WALKTHROUGH

USE CI WHEN: You want to know how people really work.

TIME: 2 hours preparing + 2 hours per interviewee + 2 hours analysis.

NO OF PEOPLE: 2-3 conductors, from 1 interviewee.

1. PLANNING

- Find participants (page 5)
- Decide on an interview style (page 5)

2. CONDUCTING

Introductory group talk if you have more than two interviewees (page 8)

RUN EACH INTERVIEW:

- Introduce yourself, your project and the CI method, reinforce your focus, set expectations, set up the mentor/mentee role, describe your confidentiality policy, get permission to record, etc. (page 9 + 24 + the Do's and Don'ts page 26 - 30)
- Remember: The transition – from questions to CI (page 10)

3. ANALYZING

REMEMBER THE INTERPRETATION ROLES (PAGE 13 – 15)

CAPTURE THE USER AND ORGANIZATION PROFILES (PAGE 15 + 31)

WRITE NOTES (PAGE 16 - 17):

Capture: Interpretations of events, use of artifacts, problems, and opportunities, important characteristics of the work, breakdowns in the work, cultural influences, design ideas (flag with DI:), questions for

Fig. 12. First example of a cheat sheet for Contextual Interview

5.10 Iteration of Contextual Interview at SenDx

Similarly to the AB-test case, two of the developers subsequently planned, executed and analysed a CI. We observed them during this work and interviewed them afterwards. Again is was clear that the template was the main focus in both planning and analysing. As one pointed out: *"We basically just filled out the sections to create the report. It is nice to have that kind overall structure already, it helps you to figure out – okay, I just have to put this in."*.

The cheat sheet was successful: *"I used the cheat sheet many times… I was able to quickly jump to the different areas."*

This concludes the results from the empirical studies carried out at the three sites. Stable versions of the training guides and templates for AB-test and Contextual Interview have been reached. These have been cross-validated by separately applying them at two participating companies, where feedback and observations are highly correlated.

6. DISCUSSION

6.1 Selection of Methods

The three methods applied in the present paper were carefully screened and evaluated as feasible for integrating into an agile environment and teaching non-UX professionals [17]. Only a limited number of methods can be expected to fit these criteria. An important obstacle was observed during the training, as the developers showed difficulties when analysing the collected data. This finding is supported by other studies; Eriksson et al. [13] found that developers find it difficult to interpret

observations; Bruun and Stage [12] found that developers had problems with supporting observations with data; and Bruun et al. [4] found that the developers have problems understanding how findings can be used for radical design changes. In our studies, we particularly observed problems with qualitative data analysis. This finding will limit the number of suitable methods, for our approach to those not requiring in-depth analysis of qualitative data.

6.2 Training Sessions

The training sessions and application of the methods provided new knowledge and skills to the developers as well as an accommodating attitude towards usability and UX work within the development teams. This shows that upgrading the developers' stills can facilitate a shared language in the development team.

Furthermore, our findings indicate that developers will be able to enter into a dialogue and provide useful input to UX specialists, when such are present in the organization. Furthermore, agile development requires quick and informal evaluation and by these studies, we have shown that developers can indeed acquire the skills and inclination to perform such tasks. We found it beneficial to conduct training sessions as hands-on and not just *"observe and learn"* and we found it highly successful to include real life tasks in the training sessions.

6.3 Training Materials

During the process, we asserted that a quite structured approach was required and guidelines, templates and cheat sheets were developed to support this. However, it was evident that the materials must be as lightweight, as possible, while retaining the necessary amount of guidance and information.
The developed training material can therefore be seen as addressing three different levels of guidance: The cheat sheets are the most lightweight, giving a quick overview over the method and the task sequence. The template is the next level, giving at bit more information and a bit more guidance. The templates ensure that, if followed from start to end, you have succeeded in applying the given method. The templates should therefore be easy accessible and self-explanatory. The final level is the guideline, where it is possible to look up more details concerning the method.

We do not claim the developed the materials can stand alone. In our work, we have always provided training in their use.

6.4 Evaluation of the Training

The main evaluation criterion has been the subjective impressions of the participating developers. We have measured their confidence and trust in their

abilities to carry out the tasks at three points: Before and after the training sessions and later, when they have applied the method on their own. These are illustrated in **Table 4**. In all the cases we could detect a clear rise in confidence and trust in own capabilities as reported throughout Section 5 above. In that sense the approach has clearly been successful.

In one study (AB-Testing at Radiometer) an external evaluator (a trained UX specialist with domain knowledge) was called upon to assess the usefulness and quality of the results produced by the developers. The assessment was positive and the results have indeed been included into the design process of the company's product. A more large-scale comparative evaluation scheme has not been possible, but could clearly be beneficial.

Concerning the training materials, we applied an iterative development strategy and used a saturation criterion to evaluate whether the materials needed more iteration. We judge that stable versions emerged through the iterations we performed and the quality and usefulness of the materials therefore are acceptable without further work.

7. CONCLUSION

Our goal with this work was to investigate how a company can perform UX tasks, when no or little prior UX expertise exists in the organization. Secondly; to see if it is possible to perform this work in line with the Scrum sprints and thirdly; how such work should be facilitated.

We chose to answer the questions by training software developers to perform certain selected UX tasks. We selected and modified three widely used UX methods and tailored them to be used in an agile, industrial development environment. We designed a training approach based on one-day sessions with a group of developers and kept a focus on hands-on experiences and real-life cases rather than watch-and-learn and textbooks. Finally, we provided the developers with three different levels of materials - guidelines, templates and "cheat-sheets".

The methods, training sessions and materials were then refined in four iterations in the organizations. Through our observations and interviews, we found that especially the templates were highly valued by the developers. These templates gave the developers a quick overview of the present method, guided them in the work and gave them security in conducting this type of work independently. Using the templates boosted the developers' confidence in their own abilities towards conducting UX tasks.

We have contributed with empirical knowledge on how to train software developers to perform minor UX tasks on their own. We conclude that the studies have

successfully demonstrated the feasibility of training software developers to carry out certain usability and UX tasks within a sprint, when they are supported by the templates.

We have also identified the limitations of the approach. It became obvious that the participating developers had trouble analysing qualitative data and the approach should thus be limited to UX methods not relying heavily on qualitative data. This excludes more comprehensive explorative methods, such as ethnographic studies. However, a method might be modified to fit, as demonstrated with the Contextual Inquiry, where some steps of the analysis were omitted.

However, we do not see this as a stand-alone solution and it is important to note that we do not intend the results of our study as an argument towards removing UX specialists from the development process. Rather we have contributed to the limited research issue on how software developers can be a part of the on-going work with usability and UX design within companies. Finally, we have described a hands-on approach on how to work with usability and UX on a day-to-day basis, which has been missing in the existing literature [7].

8. FURTHER WORK

The goal is to develop a UX toolbox with a variety of UX and usability methods targeted to be used by developers in an agile, industrial environment. The long-term plan is to collect the methods in a UX toolbox and develop an index making it possible for non-specialists quickly to identify the most applicable and cost efficient method for the given situation. The next steps are therefore to modify more usability and UX methods and work with a broader base of companies for further evaluation and validation. We therefore invite companies to make use of our material in order to refine the material even more. The materials are freely available and can be downloaded from: http://UXToolbox.es.aau.dk and we invite researchers and practitioners to use the methods and templates and contribute with their own.

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Paper 5

HOW TO REDUCE THE UX BOTTLENECK

– Train your Software Developers

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Abstract

Traditional usability and UX methods have originated from an academic environment, which have not taken industrial conditions of especially time and resources into account. Furthermore, usability and UX methods originate from a time when almost all software development followed a waterfall model. These two facts entails that the existing methods are too resource demanding and difficult to applied into today's agile, industrial environments. In this paper we make the statement that methods must be updated and tailored in order to be applicable within an agile, industrial development framework. We therefore pursue a solution, which is to simplify well-known methods and to train software developers to perform the UX work. To do this, three methods are modified via an iterative process together with the development of supporting materials. Software developers in three companies were trained in the methods to assess the approach. We found that it indeed is possible to update and tailor existing usability and UX methods to fit into an agile, industrial environment. We furthermore found that it is possible to train developers in performing usability and UX work via one-day, in-situ training using an "instructor"-teaching approach. This should be combined with hands-on exercises and real life tasks during the training. This further boosts the developers' confidence in performing UX work.

1. INTRODUCTION

User experience (UX) design has matured in recent years within industry and has started to become a competitive factor in product development (i.a. Øvad and Larsen, 2015).

However, two emerging problems occur when employing usability and UX methods in industry. The first problem is related to the fact that the methods originate from an academic environment, and thus have not taken the conditions in the industrial setting into account, especially constraints in time and resources. The second problem is that most usability and UX methods originate from a time when almost all software development followed a waterfall model. These two facts entails that the methods are too resource demanding and difficult to apply into today's agile, industrial environments.

In this paper we make the statement that methods must be updated and tailored in order to be applicable within an agile, industrial development framework. The ability to perform usability and UX work in an agile framework induces different benefits. The first are the classical agile benefits; transparency, inspection, and adaptation (Sutherland and Schwaber, 2011). Secondly, this induces the possibility to be truly user centred, due to the ability to apply user feedback to every development sprint.

In this paper we pursue a solution, where we simplify well-known methods and train software developers to perform UX work. By doing this we can facilitate a permeation of UX throughout the whole development process and induce more transparency within UX work, facilitate a shared language in the development team and minimize UX bottlenecks. By enabling the developers to perform certain UX tasks we can in some cases free resources for the UX specialists in the organisation. In cases, where no prior UX resources are present, it will now be possible to perform some tasks in house. The objective for the present work is therefore the investigation of how software developers successfully can be trained in applying UX methods.

We start by looking into related work concerning training of software developers. Next we present the research methodology. This is followed by a section concerning initial training, training in AB-test and Contextual Interview. Finally we present the discussion and conclusion of the paper.

2. RELATED WORK

The notion of training non-experts to perform UX work has been addressed in a number of studies. These have shown that developers can indeed gain an increased awareness and understanding of usability engineering (Eriksson et al., 2009; Häkli, 2005; Karat and Dayton, 1995a; Latzina and Rummel, 2003; Øvad et al., 2015; Øvad and Larsen, 2014).

However, it should be noticed that most of this research have used students as experimental participants (Bruun, 2010). We view this as a problem, since students do not face the same organizational circumstances as developers working in the industry. The organizational context is judged to be of great importance when evaluating the outcome of the training and we will therefore focus this work on developers in the industry. In the following we present four studies in which software developers from industry have been trained in usability and UX method.

The first study is by Nielsen et al. (1992). In a series of five workshops 27 developers were trained to design GUIs. Each workshop was designed as a one-day training session and focused on design principles and guidelines for GUIs and paper mock-ups. The developers worked as a team and used the methods for their own GUI designs.

A follow-op evaluation was made by the authors seven months after the training. Here they evaluated on one of the participating teams, which had made a complete GUI prototype for one of their products. Again heuristic evaluation was used to inspect the prototype and it revealed several usability problems, but also showed that the developers had been able to apply the methods and thereby design a coherent GUI (Nielsen et al., 1992).

The second study is by Karat and Dayton (1995). Karat and Dayton report two different training programs.

Firstly, they conducted a six-day on-site training session at an IBM software development lab. The aim was to establish a corps of usability advocates among the developers, as mentioned above. This was done by introducing them to contextual inquiry, customer interviews, design constraints and standards. The training led to the developers conducting numerous of inquiries and establishing effective communication between different parts of the organization. Both developers and management expressed satisfaction with the training and outcome - and the general rise in usability awareness in the organization.

Secondly, they conducted a three-day workshop, which consisted of 10% formal lectures and 90% hands on work on a product under development. During the three days the developers were seated in small groups of six-seven people, with minimum one real end-user among these. The developers were introduced to a participatory design framework and the focus was on task analysis and paper mock-ups. Due to the learning environment being very similar to a real software development environment, Karat and Dayton argue that the developers would have an easy job explaining the methods to other co-workers within the organization, and easily be able to apply the methods from the workshop in future projects. However, the authors do not present any evidence for these positive benefits of the workshop's outcome (Karat and Dayton, 1995b).

The third study is by Latzina and Rummel (2003). By a series of two-day training workshops, 18-36 developers from the SAP company were trained at a time. Even though SAP had their own usability experts, the company experienced a need to ease the communication between the developers and the usability experts and making the developers more self-supporting during the user interface implementation. The training sessions were focused on the introduction to Personas, together with a simulation game introducing user scenarios, paper prototyping, style guides, and user testing (usability evaluation).

After each workshop the participants filled out a questionnaire. A qualitative analysis of their answers revealed several aspects confirming the developers increased interest in user centred-design, they were able to develop own ideas for potential solutions and were motivated to engage in more usability training. Furthermore, the developers expressed some key observations on the organizational demands would be necessary to fit the learned methods into their development process. They had experienced a need for good communication both between team members and collaborating teams in order to succeed with their user driven approach and the use of usability standards and user/task information required time and solid project management (Latzina and Rummel, 2003

The forth study is by Bruun and Stage (2014). They trained eight software developers in traditional user based usability test including video analysis in a two-day training session. This enabled the developers to identify 48% of all usability problems in a test case - in comparison HCI specialists, who identified 62%. Next, focused on the IDA (Kjeldskov et al., 2004) usability test method and this study showed comparable results between developers and specialists. A later follow up study revealed that the developers had fixed approximately 60% of the found issues, hence accepting the usability corrections as a task in their development project. (Bruun and Stage, 2014).

These studies show that it is indeed possible to train software developers to perform UX tasks. However, none of the presented research has been conducted within an agile environment with the constraints this entails. In this work we therefore set out to investigate the opportunities of training developers in UX methods within an agile development environment.

3. RESEARCH METHODOLOGY

This section presents the research setting and methodology. Throughout the following, "a study" refers to training and evaluation of one usability/UX method within one company. A total of six studies are included.

3.1.The sites of the studies

The six studies are carried out in three different companies.

Radiometer Medical: "*is a global provider of solutions for acute care testing and develops medical devices. The company headquarter is in Denmark and it has about 2400 employees worldwide with 250 in R&D. The company has used Scrum for five years as the primary development framework and employs three-week sprints. Radiometer has focused on UX design for a number of years and due to increasingly strict regulatory demands from the U.S. Food and Drug Administration (FDA) to be in compliance with e.g. the usability standards such as* (ISO, 2010). *Consequently, Radiometer employs dedicated UX team, but intends the software developers to perform minor UX tasks on their own, thus minimizing potential UX bottlenecks and developing a shared language between the UX and development teams* (Radiometer Medical ApS, 2015)*."* (Øvad and Larsen, 2016b)

TC Electronic: *"is a global company with headquarter and main R&D facility in Denmark. TC Electronic produces audio equipment primarily for the music industry, e.g. guitar and bass amplifiers, guitar pedals, sound and picture production systems, and broadcast systems. Worldwide TC Electronic has about 300 employees, with 30 in the R&D department.*

The company has four years of Scrum experience as the primary development framework using three weeks sprints. Each of three development teams has a mix of software, hardware, and mechanical engineers with a joined focus. TC Electronic has no dedicated UX team or employees and has no current plans in this direction, but intends the R&D teams to carry out UX tasks (TC Electronic, 2015).” (Øvad and Larsen, 2016b)

SenDx Medical: *“is an American based company located in California. SenDx is a subsidiary to Radiometer and develops medical devices. SenDx is under the same regulatory demands as Radiometer concerning the usability standards put forward by FDA. SenDx is using Scrum as the development framework and work with three-week sprints. The company has people working with usability, but relies on Radiometer’s UX team concerning major UX tasks. By upgrading the developers’ skills at SenDx they can perform minor usability and UX task on site instead of having to rely on the Radiometer UX team (SenDx, 2015)”.* (Øvad and Larsen, 2016b)

3.2. Action Research

One of the authors had the opportunity of working at both Radiometer and SenDx, and she was therefore able to enter into longitudinal studies. This, together with the character of the research, made us choose to frame the study as an action research study. The overall research presented in this paper follows an action research approach. In more detail, it follows the Collaborative Practice Research approach as put forward by Mathiassen (2002). By using this approach it has been possible for us to connect the need to understand the current practices of working with UX, usability and agile software development in the companies, with the need to integrate these two frameworks to improve a final product. Furthermore, this approach offered structure for the company by allowing the authors and software developers to collaborate by combining action research, experiments and more traditional research approaches (Mathiassen, 2002). It should be noted that the research performed at TC Electronic should be looked upon as an initial explorative study and not an action research study.

3.3 UX Method Selection

The selection of suitable methods for the studies was partly based on their complexity and usefulness and partly the requirements from the collaborating companies.

The methods should:

- Enable the developers to perform limited formative testing (Radiometer and SenDx)

- Enable the developers to get to know the end-users (Radiometer)
- Feed directly into the development process (Radiometer and SenDx)
- Provide a simple way to gather insights of user behavior (Radiometer, SenDx and TC Electronic)
- Fit into the companies' agile development process (Radiometer, SenDx and TC Electronic)
- Furthermore, the methods should be fairly easy to lean, plan, conduct and analyze, since non experts were to perform them (Radiometer, SenDx and TC Electronic)
- Training should be conducted within one day (Radiomter and SeDx)

These selection criteria formed the criteria for a short list of methods:

- Situated observations and interviews e.g. Contextual Inquiry (Beyer and Holtzblatt, 1997; Holtzblatt et al., 2005)
- AB-testing (Rubin and Chisnell, 2008)
- Different lightweight methods such as:
    - Instans Data Analysis (IDA) (Kjeldskov et al., 2004)
    - Rapid Iterative Testing and Evaluation (RITE) (Medlock et al., 2002)
- Heuristic Evaluation (Nielsen and Molich, 1990)
- Cognitive walkthrough (Polson et al., 1992)
- Think aloud test (Lewis, 1982)
- Focus groups (Krueger and Casey, 2001)

Due to the limitations of the of the research study three methods were selected in consultation with the companies. The methods were the ones the companies regarded as the most beneficial for their current development phases. The methods were:

- Focus group technique, modified by (Øvad and Larsen, 2014). This is denoted Focused Workshop.
- Comparative usability testing, modified by (Øvad et al., 2015). This is denoted AB-testing.
- Contextual Inquiry as described by (Beyer and Holtzblatt, 1997; Holtzblatt et al., 2005) and modified by (Øvad and Larsen, 2016a). This is denoted Contextual Interview.

The following sections present the experiences with these three methods. The initial work with Contextual Inquiry is presented in Section **Error! Reference source not found.**, Focused Workshop is presented in Section 0, AB-testing in Section **Error! Reference source not found.**, and Contextual Interview in Section **Error! Reference source not found.**.

3.4 The iterative process

The three UX methods were modified to make them more applicable in an industrial, agile development environment. This was done in an iterative process, where supporting materials were also developed.

The basic process:

- Initial interviews with the developers concerning their expectations and wishes
- Modification of the UX method and development of supporting materials
- Training the developers in the UX method
- Interviews concerning training, experiences and wishes
- Modification of supporting materials
- Developers using the UX method
- Validation of data gathered by the developers performed by in-house specialist
- Final interviews with the developers concerning the UX method applicability

Every method ran through this process at least once, where the training materials were updated once between the training session and the evaluation. When a method is introduced at another company, this process is repeated at each company. Table 1 shows that Focused Workshop has been iterated once, AB-testing twice and Contextual Interview three times. For more details concerning the modified methods and the developed materials, see (Øvad et al., 2015; Øvad and Larsen, 2016b, 2014).

To further ensure the validity of the studies, three external researchers performed parts of the training, and the data collection was triangulated by making use of observations, semi-structured interviews (the ones performed in the iterative process) and analysis of the documentation created by the developers during both training sessions and when they used the methods.

Table 5, shows an overview of the training and evaluation iterations.

Table 5: Overview of the training and evaluation iterations

	TC Electronics	**Radiometer**	**SenDx**
Focused Workshop		Summer 2014 Summer 2014	
AB Testing		Fall 2014 Winter 2015	Spring 2015 Summer 2015
Contextual Interview	Fall 2013 Winter 2014	Spring 2015 Fall 2015	Summer 2015 Summer 2015

Our focus in this paper will primarily be on the training part and the outcome from this. However, we will also focus on how to fit the planning, execution and analysis work from the different methods fit into a development sprint (three weeks sprints) without the development team losing too much velocity. For details about the materials see (Øvad and Larsen, 2016b).

3.5 Participants

28 developers have participated in this Action Research work. All have a background as software developers. Only one developer had any formal training in usability or UX work. However, some have observed user tests during their employment, but never participated or facilitated this type of work themselves.

Two researchers conducted this study: One as an insider action researcher, performing all observations and interviews, performing the training in focused workshop and the statistical part of the training in AB-test at Radiometer, together with all training at SenDx. The second was an outsider action researcher performing training in Contextual Interview at Radiometer and Contextual Inquiry at TC Electronic. Both have extensive training and experience in usability and UX work and both participated in the data analysis and the modification of the methods and the materials. Furthermore two other researchers conducted the training in Contextual Inquiry at TC Electronic and AB-testing at Radiometer.

3.6 Research approach

All interviews were conducted as semi-structured, face-to-face interviews and they followed different interview guides. All interview encounters were documented through audio recordings and notes. The training sessions and the session where the developers applied the methods were documented via video recordings and/or notes. Following each encounter, the participating researchers conducted a debriefing and transcribed the interviews. The interviews and notes were analysed by performing a meaning condensation of the data (Patton, 1990), followed by performing five steps in a cyclic manner: compiling, disassembling, reassembling, interpreting and concluding, as described by Yin (2010). By integrating the analysis into the action research process, we allowed feedback in relation to each iteration and thereby formed the basis for the modifications of the methods and the materials.

3.7 Training objectives

Four training objectives were developed together with Radiometer management to help evaluate the training and how well the developers mastered the tasks defined in the objectives. We made use of Bloom's revised Taxonomy Table presented by Krathwohl (2002). The four training objectives were:

1. The developer should be able to remember and understand the terminology used when performing the given method.
2. The developer should be able to judge in which cases the method can be applied. Furthermore, the developer should be able to create a plan for the execution of the method.
3. The developer should be able to apply the method to solve a real life task, together with the ability to analyse the results obtained from this application.
4. The developer should be able to evaluate the results and the usability of the obtained data and have the ability to use the results to suggest solutions for the further development within the given project.

3.8 Training approaches

Dreyfus and Dreyfus (1980) state that two options exist when acquiring a new skill: You can either pick it up by imitation and floundering trial-and-error or you can seek the help from an instructor or a manual (Dreyfus and Dreyfus, 1980).

To investigate the best solution, we tried them both. This is presented in the section below in the initial work with Contextual Inquiry and Focused Workshop, together with a discussion concerning the two approaches in relation to the training objectives.

4. INITIAL TRAINING – CONTEXTUAL INQUIRY AND FOCUSED WORKSHOP

To identify the most suitable training approach for our purpose, we sat out to try both the "instructor"- and "observe-and-learn"-approach. This was done by two studies.

4.1 Contextual Inquiry training at TC Electronic ("instructor"-approach)

At TC Electronic we trained seven developers in Rapid Contextual Inquiry in a one-day workshop (7 hours). The training included the tailored qualitative data analysis methods, as described by (Beyer and Holtzblatt, 1997) and (Holtzblatt et al., 2005). Training materials consisted of (Holtzblatt et al., 2005), including samples of affinity diagrams, artifact models, etc., associated with Contextual Inquiry. The developers applied the techniques on example cases, such as analyzing a video recording of a person making coffee and assembling and testing a HiFi set.

4.1.1.Results from the Contextual Inquiry training at TC Electronic

Interviews with three of the developers revealed that the training had been well received. In particular they highlighted the practical approach, having small exercises and concrete examples, as very beneficial for their learning outcome. A few weeks after the training session TC Electronic was able to scale the extent of the Contextual Inquiry to fit their sprint rhythm (three weeks) and carry out a Contextual Inquiry as part of the definition phase for a new product. The Contextual Inquiry fitted well with their development process and the gathered user insights provided the developers with ideas for future product features.

Even though the interviewees were positive toward the method and regarded it a good match for their development process, some problems were verbalized. They found the data analysis too difficult - especially the creation of the affinity diagram and required the researchers to assist with this. Furthermore, they found it too time consuming using. The total time consumption and team members employed by TC Electronic during the Contextual Inquiry training and the following user research sprint are listed in **Error! Reference source not found.**2.

Table 2: Time consumption for the Contextual Inquiry performed by the TC Electronic participants

Activity	Time spent
Preparations	3 hours
Conducting	4 hours
Data analysis of CI	14 hours
Presentation of result to team	2 hours
Total	**23 hours**

The Contextual Inquiry as performed here can fit into a single sprint without problems.

The CI was successful in the sense that TC Electronic later reported that a number of anticipated features had been dropped due the CI and the total development time for the product had been reduced by three Months.

4.2 Focused Workshop training at Radiometer ("observe and learn")

At Radiometer two developers observed and acted as note takers while one of the authors conducting a Focused Workshop (1.5 hours). The training included a structured and rigorous guideline to support the developers, together with two templates – one for planning the session and one for reporting the findings, for details, see (Øvad and Larsen, 2016). The topic of the workshop was the serviceability of a new product to be launched primo 2016. The workshop participants were service technicians and engineers and an employee from marketing. The final part of the training consisted of analysing the workshop notes, write a small report and present the results, with support from the guideline and templates.

4.2.1 Results from the Focused Workshop training at Radiometer

Interviews with the participating developers after the session revealed that both had a higher degree of confidence in conducting such a session on their own. Furthermore, they expressed satisfaction regarding the information and insights in the work life of the participants they had gained. They both felt supported by the guideline as a reference when in doubt and used the report template when writing the report.

One of the developers subsequently planned, conducted and analyzed a Focused Workshop independently. The time consumption is shown in **Error! Reference source not found.**3.

Table 3: Time consumption for the Focused Workshop performed by the Radiometer participant

Activity	Time spent
Planning the workshop	6 hours
Workshop	1.5 hours
Analyze notes	5 hours
Presentation (incl. preparation)	2 hours
Total	**14.5 hours**

The sessions showed that it is possible to plan and facilitate, make the analysis of the data and present the data from the Focused Workshop in less than two days. However, it should be noted that the planning time of the workshop can vary considerably due to topic, experience etc.

4.3 Discussion and conclusion on the training in Contextual Inquiry and Focused Workshop

Both training approaches were well received, especially due to the practical aspect of using hands-on exercises and real life tasks. The interviews conducted at TC Electronic revealed a problem concerning the analysis and it was noted it was too time-consuming and difficult. The Radiometer interviews revealed that the structure of the guideline and templates was beneficial. However, when the developer later conducted a Focused Workshop some important issues where left out of the report, issues which would have been emphasized in a more structured training session.

Looking at the training objectives it was clear that both training approaches fulfilled the first two objectives. The "instructor"-approach was furthermore successful in fulfilling objective three and four as well. The "observe and learn"-approach was not successful in either objective three or four concerning the ability to analyze the results obtained from the applications, evaluate these results and suggest solutions for the further development within the given project. This experience indicated that the "observe and learn" approach was too much a "trial-and-error" approach. Even

though this approach was well received and had infused the developers with a high level of confidence, it introduced too much randomness in the learning process and was therefore discarded. Hence, we continued with the explicitly organized training paradigm.

As a result of these initial studies, it was decided to continue with training sessions as one day hands-on training courses, with real life tasks, combined with the "manual"-approach – in the present work; guidelines and templates.

5. AB-TESTING TRAINING

The training in Contextual Inquiry and Focused Workshop revealed that the training should be based on an instructor-approach and it was considered advantageous to employ the manual-approach as well. We outlined AB-testing in a structured way, see (Øvad et al., 2015) and developed supporting materials, see (Øvad and Larsen, 2016b).

The training in AB-testing was performed both at Radiometer and SenDx. In the following sections we first describe the training and findings from Radiometer, secondly the training and findings from SenDx.

5.1 AB-test at Radiometer

Five participants were introduced to AB-testing through a one-day training session (7 hours) at the company facilities. The participants were divided into two teams. Each team applied the method on real life cases extracted from the sprint backlog. One test objective was to determine the placement of a button and the other was to determine the wording of a button. Both tasks related to the design of the graphical user interface (GUI) for Radiometer's next generation blood gas analyzer, see (Øvad and Larsen, 2016). For a detailed training plan see (Øvad et al., 2015).

All participating developers were interviewed after the training session. Overall all developers were satisfied with the training – especially the hands-on exercises were popular, since these dry-runs were able to expose mistakes, combined with actually collecting useful data. After the training session, the developers expressed a strong preference for the structured approach and the support materials. However, all participating developers expressed having troubles with the qualitative analysis. (Øvad et al., 2015)

Two months after the training session four software developers planned, conducted and analysed two AB-tests. The objectives of the AB-tests were to determine which of two keyboard layouts should be included in the final GUI on Radiometer's next generation blood gas analyzer. The work was performed in two teams, who each

conducted an AB-test (Øvad et al., 2015). The timing of the test can be seen in Table 4.

Table 6: Time used by the developers for planning, conducting and analyzing an AB-test.

Activity	**Time spent**	
	Team 1	**Team 2**
Planning	2.4 hours	2.4 hours
Conducting test	1.3 hours	1.5 hours
Data Analysis	1.3 hours	1.3 hours
Total	**5 hours**	**5,2 hours**

It was observed that the developers made extensive use of the templates when planning the tests, which facilitated good discussions concerning the experimental design and the proper use of terminology within the used method was used. (Øvad et al., 2015; Øvad and Larsen, 2016b). In general the developers successfully performed the tests. Some problems were again observed concerning the data analysis, especially concerning comprehending and applying the qualitative analysis. Interviews afterwards supported this and one stated: *"It would be nice to touch up the analysis part"*. (Øvad et al., 2015) The potential of gathering qualitative data was something all developers were aware of. However, they did not perform a more extensive analysis, but wrote down the different comments from the test participants. The interviews furthermore revealed that all developers were surprised by the amount of useful data they obtained and they made extensive use of the template. For at more in depth description and analysis, see (Øvad et al., 2015).

An in-house UX designer was asked to review the outcome of the tests. From her analysis of the findings, she judged the results from both the qualitative and quantitative data to be of value, comparable to similar tests carried out by the UX team and usable for the development process.

5.2 Training in AB-testing at SenDx

To confirm the results obtained at Radiometer, an AB-test training session was carried out at SenDx. Four developers participated in the training.

Pre-training interviews revealed that the developers at SenDx use a great amount of time coordinating with Radiometer concerning alignment of the user interface (UI) design. Two of the developers pointed out that the ability to perform a quick AB-test at SenDx potential would enable them to decide on smaller UX issues independently of Radiometer. They also saw an opportunity to bring thoroughly tested arguments into the discussions with developers and UX designers at Radiometer. Furthermore, one believed that results from an AB-test would give him more confidence, since he would be more secure of developing the right thing.

The training followed the same structure as previously. The participants were divided into two teams. Each team applied the method on one of two real life cases. Both cases concerned an internal web tool (called SC admin). One test objective was to determine the wording of a tab and the other were the placement of a search box.

The training materials consisted of a guideline and a template concerning planning and reporting. For more details see (Øvad et al., 2015; Øvad and Larsen, 2016b). Interviews conducted with the developers confirmed the findings from Radiometer. The training was well received and all developers were surprised by the results: "I was surprised by the findings – it reopened my eyes on how little I was able to put myself in the end-users shoes and really see things". They were sure, that being able to conduct this type of work would entail independence from Radiometer, at least concerning minor UI decisions or initial investigations. SenDX developers had less prior experience in addressing end users and would benefit from more training in this.

Two weeks later the developers planned, conducted and analysed an AB-test. They were split into two teams. Each team applied the method on a real life case from within the company. One test case was an ABC-test of the Quality Control test setup on SenDx's soon-to-be-launched blood gas analyser - in this case three different interaction flows were tested. The other test case was an AB-test of the placement of an error notification in the SC Admin tool. Test materials were prepared beforehand Time spent on the tasks can be seen in Table 5.

Table 7: Time used by the developers for planning, conducting and analysing AB-tests at SenDx.

Activity	**Time spent**	
	Team 1	**Team 2**
Planning	1.5 hours	1.7 hours

Pilot test	0.2 hours	0.2 hours
Conducting test	1.6 hours	1.1 hours
Data Analysis	0.5 hour Plotted data throughout the test	2.2 hours Incl. typing in data
Total	**3.8 hours**	**5.2 hours**

We observed that developers made extensive use of the template. Some minor mistakes were observed. When they were made aware of the problem they changed their approach accordingly. As previously observed, both teams experienced problems comprehending and applying the qualitative analysis.

Interviews revealed that they were surprised by the amount of additional data they obtained. When asked if they would perform an AB-test again, all developers responded positively. Furthermore they could see the potential in conducting AB-tests: *"When we have these discussions anyway – some requirement discussions or UX discussions – I mean – it takes like an hour anyway to argue about an idea being good or bad… If you are going to do that anyway, then you might as well spend a little bit of extra time and gather some feedback and see where that leads to".*

The developers were very much aware of their own performance and were able to criticize it. One of the teams screened their test participants in order to have as much dispersal as possible and the team was able to support their findings with background information of the test participants.

Since SenDx does not have an in-house UX designer or team, the findings from these tests were evaluated in two different ways. For the internal web tool the software manager evaluated the results and found them good enough to implement immediately. For the QC test setup, one of the persons working with usability was contacted and presented with the results. These were judged to be valuable and were used as a foundation in further discussions on the design of this work flow.

6. CONTEXTUAL INTERVIEW

The one-day hands-on in-situ training approach proved to work well for the AB-test training. Next we returned to the Contextual Inquiry method to make the method more available to developers than the original method as described by (Holtzblatt et al., 2005). In the previous training session at TC Electronic, the developers

experienced problems during the analysis phase. Pre-training interviews conducted at Radiometer regarding the method revealed a conflict concerning the method. The developers were very interested in the method and could see it support Radiometer's "Go to Gemba"-visits at different hospitals. However, they did not believe time would be allocated to conduct the full extent of the method. Hence, the method was restructured and a more streamlined process requiring less subsequent analysis was defined. Detailed guideline and planning and reporting template were developed. Additionally, a "cheat sheet" was developed as well, see (Øvad and Larsen, 2016b). The method is denoted Contextual Interview, to indicate the strong inspiration from Contextual Inquiry (Beyer and Holtzblatt, 1997; Holtzblatt et al., 2005).

The training in Contextual Interview has been performed at both Radiometer and SenDx. In the following sections we describe the training and findings at Radiometer, followed by a short account from SenDx.

6.1 Training Contextual Interview at Radiometer

The training consisted of a one-day (7 hour) training session. Five developers participated and they planned, executed and analyzed a Contextual Interview on two real-world tasks from Radiometer's production site. The first team followed the assembly process of a blood gas analyzer and the second team followed the testing of an assembled blood gas analyzer.

The training materials consisted of a guideline and a template concerning planning and reporting. For more details see (Øvad and Larsen, 2016).

The responses toward the training in Contextual Interview were quite similar to what we heard from the AB-test training. The developers were satisfied with the training - especially the hands-on approach was highly valued. Three of them introduced the idea of receiving feedback after having preformed the contextual interview.

The developers still had problems with the more thorough qualitative analysis, but they were good at creating the different models known from Contextual Inquiry (physical, sequence and artefact) and they succeeded in creating an affinity diagram with one level headlines. They all felt well equipped for conducting a Contextual Interview again.

Six months after the training, four of the trained developers planned, conducted and analysed Contextual Interviews on their own.

The Contextual Interviews were conducted as a pre-study for a re-design workshop. They performed four interviews with in-house staff concerning how they handle

manual Quality Control installation on one of Radiometer's analysers. The findings were to support the design phase of the same feature in Radiometer's next generation blood gas analysers.

The developers split up in two teams, but performed the planning and data analysis together. Furthermore, one of the developers spent some time the day before for planning and inviting participants and another developer used 30 minutes the day after to finalize the report, see Table 6.

Table 8: Time used by the developers for planning, conducting and analyzing a Contextual Interview at Radiometer

Activity	**Time spent (Radiometer)**		**Time spent (SenDx)**
	Team 1	**Team 2**	
Planning	1 hour 0.5 hour on the day		1 hour
Conducting Contextual Interview	1 hour	1 hour	1.5 hours
Data analysis	1 hour 1.5 hour the following day		4.3 hours
Total	**5 hours**		**6.8 hours**

Observations revealed a lack of understanding of the terminology used within the method paradigm. Furthermore, none of the developers made a proper transition from Q&A to Contextual Interview.

During the analysis phase it was observed that their domain knowledge was a great asset and it enabled them to perform quite a good analysis and consolidate their notes in a proper manner. The analysis furthermore facilitated some good discussions.

Interviews afterwards revealed the same benefits as with AB-testing. However, the developers did not judge the chosen case for the Contextual Interview suitable for the method. *"It felt like we bent this [the method] enormously… it had not been the first choice if we were to choose ourselves".*

The interviews furthermore revealed inconstancy in the terminology used.

The Contextual Interview training and developers conducting Contextual Interviews were performed at SenDx as well. The results corresponded to the results obtained at Radiometer. However, in this case the tasks for the Contextual Interviews were well-chosen for the method paradigm and results improved accordingly.

7. DISCUSSION ACROSS STUDIES

The one-day, hands-on training, in-situ approach proved applicable. In particular, the real life tasks were advantageous to apply and quickly showed the developers how and where the method could be used in their own work. The structured processes and supporting materials were found helpful as well, together with the opportunity for the developers to ask questions throughout the training sessions.

The time consumption of the methods fit into the Sprint rhythm, see Table 7.

Table 7: The average time consumption when performing the different methods.

Tasks	**Hours spent**			
	Contextual Inquiry	Focused Workshop	AB-testing	Contextual Interview
Planning	3 hours	6 hours	2 hours	1.3 hours
Conducting	4 hours	1.5 hours	1.9 hours	1.3 hours
Analyzing	14 hours	5 hours	1.3 hours	3.4 hours
Communicate results	2 hours	2 hours	0	0
Total	**23 hours**	**14.5 hours**	**5.2 hours**	**6 hours**

To evaluate the training objectives, we made a triangulation by comparing interview findings with observations and the written materials written by the developers. In the following the training in AB-testing and Contextual Interview at Radiometer and SenDx are compared to the four training objectives.

Objective 1

The developer should be able to remember and understand the terminology used when performing the given method.

For AB-testing this objective was successfully fulfilled. The developers at both Radiometer and SenDx were able to actively use the terminology from the method. This was shown both verbally during interviews, observations and the filled-in templates.

For Contextual Interview this objective was fulfilled. At SenDx the developers were able to actively use the terminology from the method. This was shown both verbally during interviews and observations, and in the filled-in templates. At Radiometer problems were found concerning the description of the mentor/mentee role, the transition from Q&A to contextual interview and the understanding of the different interview styles. Some of this can be ascribed to the setting and the time between training and application.

Objective 2

The developer should be able to judge in which cases the method can be applied. Furthermore, the developer should be able to create a plan for the execution of the method.

For AB-testing this objective was successfully fulfilled. The developers had independently selected two different cases for the AB-tests they performed independently. Both cases fitted the AB-test paradigm.

For Contextual Interview this objective was fulfilled. The developers at SenDx had selected a case for the Contextual Interview they performed independently. The case fitted the Contextual Interview paradigm. At Radiometer all developers showed knowledge in the method and judged the settings concerning the Contextual Interviews not to fit the Contextual Interview paradigm, hence Objective 2 was fulfilled at Radiometer as well.

Objective 3

The developer should be able to apply the method to solve a real life task, together with the ability to analyse the results obtained from this application.

For AB-testing this objective was successfully fulfilled. The developers applied the AB-test paradigm different real life cases and analysed the results obtained from these tests. However, it could be argued that there existed a lack within their understanding of qualitative data analysis. Yet, the evaluation of the results was approved by external experts.

For Contextual Interview this objective was fulfilled. The developers applied the Contextual Interview paradigm to different real life cases independently and analysed the results obtained from the tests. However, it could be argued that there existed a lack within their understanding of qualitative data analysis. However, they sufficiently designed the proper models and were able to conduct affinity diagrams with one level headlines.

Objective 4

The developer should be able to evaluate the results and the usability of the obtained data and have the ability to use the results to suggest solutions for the further development within the given project.

For AB-testing this objective was been fulfilled. The developers were able to evaluate the results and the usability of the obtained data. However, they did not have the ability to use the results to suggest solutions for the further development within the given project. This might be due to the organizational structure, where the developers are not assigned to make such decisions.

For Contextual Interview this objective was not completely fulfilled. The developers were able to evaluate the results and the usability of the obtained data. However, do to the nature of the tasks, the developers were not to use the results further on.

Issues to consider

From the training in AB-testing:

The developers at SenDx expressed uncertainty in handling of the participants. This can be ascribed to them not being familiar with this type of work. Two asked for the opportunity to watch either a video of an AB-test being performed or to be present when an expert performs an AB-test. Furthermore, the developers at SenDx asked for the trainer to observe them performing an AB-test once more, which was doable since the trainer observed their second AB-test. However, this would not a possibility during normal circumstances, thus it could be an idea to split the training over two days in order to provide feedback twice and thereby make the developers even more secure in performing the task.

From the training in Contextual Interview:

The training and application of Contextual Interview at SenDx proved successful. The training at Radiometer proved successful, however the individual application of the Contextual Interview proved quite problematic.

From this work we may conclude that the Contextual Interview paradigm together with training proved usable and it utilises the developers' domain knowledge making securing the usefulness of the results. However, the method was a bit of regarding the current development phase in the companies.

8. CONCLUSION

In this work we have investigated how software developers successfully can be trained to apply UX methods. Furthermore, we have applied the constraints of the agile paradigm for software projects, which is predominant in industry. We achieved this by modifying existing usability and UX method in an iterative process and by developing supporting materials as well.

We found that it is indeed possible to tailor existing usability and UX methods to fit into an agile, industrial environment.

From initial training sessions in the methods Contextual Inquiry and Focused Workshop, the "instructor"- and "observe and learn"-approach were well received and infused the developers with a high level of confidence. However, our experiences when applying the "observe-and-learn"-approach indicated that this approach proved too random. Hence the "instructor"-approach was chosen and used to perform the AB-test- and Contextual Interview training. We found that by using hands-on exercises and real life tasks during the training provided the developers with knowledge and confidence in performing UX work. This approach set the present study apart from most previous ones and we believe it to be a deciding factor for the positive outcome of the study.

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