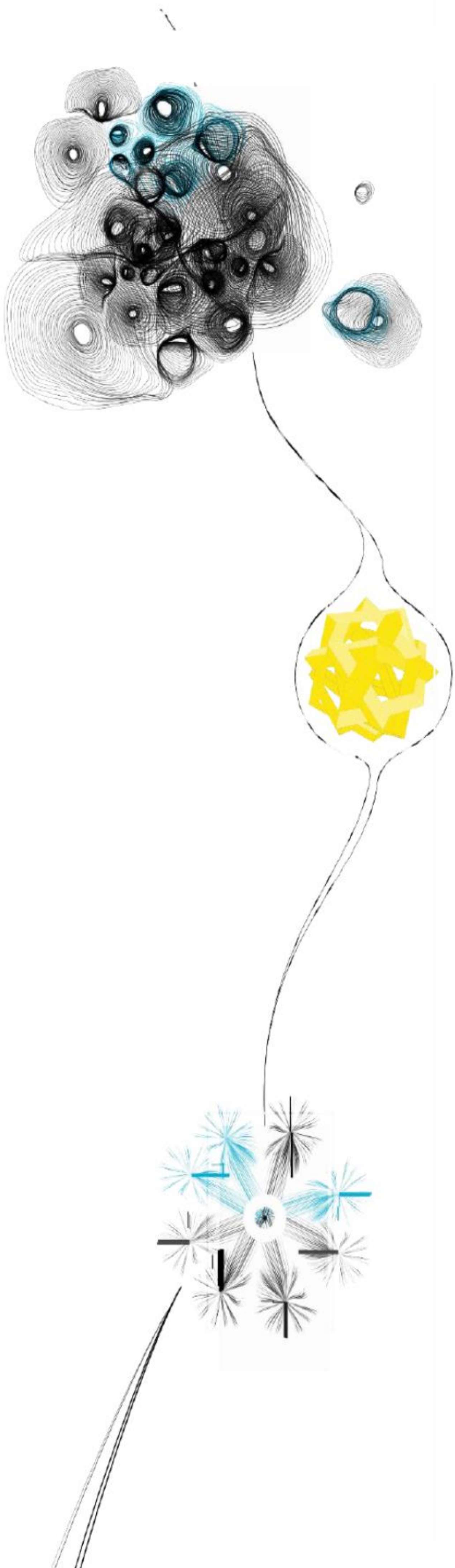

Master Thesis

CO-DESIGN APPROACH:
A COLLECTIVE DESIGN METHOD FOR IMPROVING WORKING EFFICIENCY AND SATISFACTION IN USER SUPPORT DESIGN PROCESSES

An empirical study based on three comparison groups simulating a real-world quick start guide design process

Leiying PU

Technology and Communication, Communication Studies
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Master graduation thesis of:
Leiying PU
Specialisation Technology and Communication, Communication Studies
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ABSTRACT

Purpose: To analyse the effect of the co-design approach on working efficiency and satisfaction; from empirical studies; in the context of user support design processes; from the views of design teams and individuals.

Method: A qualitative study based on empirical experiments was conducted. Under a simulated design environment, three comparison groups were set up for cross-comparison. Twenty-one university students were arranged in nine groups with assigned roles completing a real design task. The qualitative data from observation and interviews were analysed.

Results: The differences in time completing tasks and team satisfaction remained significantly different between general groups and co-design groups. Co-design groups designed products more efficiently with closer user involvement and more integrated intra-team cooperation; those groups perceived higher satisfaction with the design process, teamwork and team structure. On the individual level, participants from co-design groups were more satisfied with their product than general groups. The results for personal working efficiency and satisfaction vary for each role. The 'users' and 'experts' perceived higher individual working efficiency and satisfaction than 'technical writers' during the process.

Conclusion: Co-design improves the working efficiency of design teams. It provides a more pleasing and satisfying design process in the context of user support design. New insights from the study add to the benefits and risks of adopting the co-design approach in practice. As an exploratory starting point, this study provides new empirical support for co-design research. Needs for generalising the effects in other contexts of designing user support is suggested for future studies.

Keywords: co-design approach, design process, empirical study, qualitative method, user support

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1. INTRODUCTION

Over the years, uncountable user manuals, documentation, quick reference guides, instructional videos and embedded user assistance have been created. Generally, these are materials and means serve as safe backup support to ensure that everyone who uses products or services is using them efficiently. Thus, in the domain of technology and communication, sometimes they are grouped with a 'family name': user support.

User support not only benefits people who use it but also rewards all stakeholders. In the product training, a useful guide is a huge part of cultivating self-learnability and product accessibility (Scott Cooley, 2017). Beneficial to not only users but more stakeholders. For example, a writer may refine her thoughts in the process of explaining things to others (Selic, 2009), a software developer could follow system consistency and improve quality from design documentation (Prechelt et al., 2002), and a company can impress consumers by providing user-friendly support (De Jong, Yang, & Karreman, 2017). Regarding those advantages, technical communication professionals have been working on optimising written user instructions (Van der Meij, Karreman, & Steehouder, 2009). Scholars have built solid a foundation with the topics of structure (Farkas, 1999), content (Carroll, 1997), style (Kohl, 2008), and design (Selic, 2009).

In user support practice, however, challenges have been distracting people away from those good omens. On the one hand, users keep complaining about their experience with documentation that is regarded as less useful than 'just Google it'. It is because their relation with user support has been changed in the new era, from passive readers who are referring user support to active information producer. Large amounts of end-users have acquired an essential taste of design and technology with increased knowledge and skills. The greater focus on users is not a new idea, but the concept of encouraging users as a 'co-producer' is a step forward. On another hand, creators of those manuals have labelled the writing process as an unpleasant but necessary task (Selic, 2009).

Researchers have acknowledged the challenges. Human-centred design serves as a popular approach that involves users from an early stage (Gould & Lewis, 1985). Recent years, literature on co-design and co-creation methods has emerged (e.g., Ardito, Buono, Costabile, Lanzilotti, & Piccinno, 2012; Trischler, Pervan, Kelly, & Scott, 2018), and it is slowly nudging designers of products and services to focus again on user involvement and creativity (Kristensson, Magnusson, & Matthing, 2002). Moreover, the focus on user experience (e.g., Battarbee & Koskinen, 2005) calls for filling a missing perspective: collective experiences, which are created together with others.

Product and service providers have noticed the risks as well. Development teams try to solve the problem in a 'fast' way: agile documentation development. To align with the fast system development pace, companies that provide technical documentation and related user support services adopt agile development for shortening the delivery time (Selic, 2009). At the same time, collective design approaches like participatory design, co-design and co-creation have been adopted, especially in a context of marketing and branding to attract customers. Those collective approaches benefit technology users with higher satisfaction and a better fit in needs (Steen, Manschot, & Koning, 2011).

Among them, co-design attempts to actively involve all stakeholders in any design process activity (Dodero, Gennari, Melonio, & Torello, 2014), creating a shared language between users and designers so as to enhance understanding of the new product from the point of view of all participants (Ardito et al., 2012). To investigate the impact of co-design on participants and product, works of literature indicate a clear need for more empirical and experimental studies (Silva da Silva, Martin, Maurer, & Silveira, 2011). The existing research on co-design is hard to be found in the context of user support design. Furthermore, there emerges a need for research of some curious questions, e.g., what potential effects of co-design on working efficiency could be? Will the approach improve the satisfaction of other stakeholders besides the user group? Will different stakeholders perceive a process as satisfied differently by adopting this approach?

Therefore, in order to investigate those questions, the study conducted comparison experiments on three comparison groups simulating a real-world in the context of user support design. The study aims to explore the potential impact of the co-design approach on working efficiency and satisfaction, from individual and team perspectives in the design process.

The study first outlines existing research on co-design, user support and design process topics. It is followed by the method section, where an empirical study with a qualitative approach is introduced in a sequence of design, participants, procedure, measures, and data analysis. The results section first concludes two conceptual design patterns for the general technical writer group and the co-design group. Then it compares three comparison groups from perspectives of the team working efficiency, individual working efficiency; satisfaction with process, team, individual work, and product. Finally, it discusses the main findings from the empirical study. Theoretical and practical implications are concluded with the limitations and future research possibilities.

2. THEORETICAL FRAMEWORK

The research questions focus on the potential effect of the co-design approach on working efficiency and satisfaction in a context of user support development process. A literature overview in this chapter outlines three critical terms of the questions, namely, co-design approach, user support, and design process.

2.1 Co-design

Within the substantial research on co-design, scholars have defined ‘co-design’ as a team-based process in which stakeholders from different disciplines contribute to the design process and content with shared knowledge’ (Kleinsmann, 2006; Penuel, Roschelle, & Shechtman, 2007). Co-design creates a shared language between users and designers to enhance understanding of the new product from all participants (Ardito, Buono, Costabile, Lanzilotti, & Piccinno, 2012). It stresses on a ‘collective creativity’ in the design process by participants not explicitly trained in design (Sanders & Stappers, 2008). In this view, co-design attempts to actively involve all stakeholders in any design process activity (Dodero, Gennari, Melonio, & Torello, 2014).

2.1.1 Evolution of co-design

This innovative design approach is not emerged from nowhere. Early studies relevant to the concept of co-design can be traced in several design approaches human-centred design, participatory design, and co-creation. The following outlines definitions, essences, strengths and weaknesses of those design approaches in order to set a common ground for highlighting the unique features of the co-design approach.

First, co-design has a root in human-centred design (HCD). HCD emerged from the 1980s; it features in three fundamental principles, i.e., ‘early and continual focus on users’, ‘empirical measurement of usage’, and ‘iterative design’ (Gould & Lewis, 1985). User involvement is the core value of human-centred design. It has been reviewed systematically since the 1990s (e.g., Allen et al., 1993; Driessen & Hillebrand, 2013; Kaulio, 1998; Wind & Mahajan, 1997), underlining the importance of integrating multiple stakeholders to extend the range of collective creation opportunities (Gummesson and Mele, 2010). Kaulio (1998) presents an analytical framework and an interdisciplinary review of seven selected approaches dealing with customer, consumer and user involvement in product development. The principal activities in the HCD process are arranged with iterative loops (Figure 1).

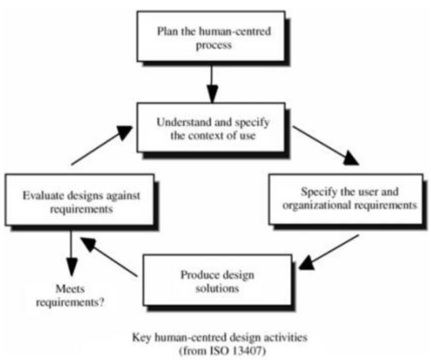

Figure 1. The human-centred design cycle (Maguire, 2001, p.589)

As one of the most popular design approaches that enthusiastically endorsed by practitioners, HCD appears to be making an impact across the industry (Mao, Vredenburg, Smith, & Carey, 2005), in a broad fields like health, technology, education and service (Farinango, Benavides, Cerón, López, & Álvarez, 2018; Galer, Harker, Ziegler, & Galer, 1992; Ructtinger, 2015). However, it can be time-consuming for design teams to specify user requirements, conduct testing and collecting feedbacks in every round (Norman, 2005). It has been criticized since the 2000s primarily for three reasons: 1) adding complexity and cost to a design process; 2) focusing only on specific end-users; and 3) leading to improvement, not innovation (Norman, 2005). Facing those challenges, the scope of the HCD research keeps growing and evolving in response to the needs of the market (Sanders & Stappers, 2008). Scholars have called for extending the focus of HCD to include a broader range of stakeholders from 'user involvement' to 'human focus' in the design process (e.g., Gasson, 2003). Moreover, recent research indicates involving users directly in the design process that make users become part of the design team as 'expert of their experiences' (Visser, Stappers, Van der Lugt, & Sanders, 2005) contributes to innovation value of the product (Frow, Nenonen, Payne, & Storbacka, 2015). Scholars further illustrate 'which participants should be involved' and 'how' (Vink, Imada, & Zink, 2008). However, the question about the effect of the co-design approach on participants who experienced the design process is still not apparent.

Second, as the definition stated, co-design highlights 'multidisciplinary contribution', the derivation of similar concepts, i.e., 'participation' and 'joint decision-making', is from the 1970s. Since then, those two concepts became essential factors concerning workplaces and the introduction of new technology (Kaulio, 1998). Started in Scandinavia through a partnership between academics and trade unions (Robertson, Simonsen, & Simonsen, 2012; Spinuzzi, 2005), participatory design can be defined as "a process of investigating, understanding, reflecting upon, establishing, developing, and supporting mutual learning between multiple participants in collective 'reflection-inaction'" (Robertson, Simonsen, & Simonsen, 2012). In human-computer interaction and related fields, it explores conditions for extensive user participation (both users and designers) in the design and the introduction of ICT systems at work (Bødker & Iversen, 2002). PD influences writing studies, mainly from technical communication as well as computer and composition (Johnson, 1998; Spinuzzi, 2005). Still, the application of co-design is merely seen in the context of technical communication.

Third, dating back to the 1990s, the core value of 'user creativity' co-design can be found in another similar design approach, namely customer idealized design. As a primogenitor, it is defined as 'a process for involving consumers in the actual design of new manufactured goods or services' (Cincianntelli & Magdison, 1993). The idea has been further adopted in value co-creation research, especially in the marketing domain (Nambisan & Baron, 2009; Payne, Storbacka & Frow, 2008; Sanders & Stappers, 2008). For example, it is being endorsed as a powerful new tool for product naming, packaging, promoting and advertising (Sanders & Stappers, 2008). Co-creation emphases a change from traditional customer-supplier relation to the new opportunity: customers can engage in phases of product design and delivery with suppliers, creating value through customized, co-produced offerings (Payne, Storbacka, & Frow, 2008). This form of engagement should be seen as an interactive process of learning together (Ballantyne, 2004). The role of customer highlights the value of co-creation. Therefore, the goal of co-creation is to improve or innovate the front-end process of identifying customers' needs and wants from the consumer's point of view (Lusch & Vargo, 2014).

Those similarities above between co-design and other collective design approaches, i.e., participatory design (PD) and co-creation, sometimes blurs the boundaries. Although all of these approaches characterized by user involvement (Johnson, 1998) in a service and product design context (Bødker & Iversen, 2002; Kristensson, Magnusson, & Matthing, 2002; Nambisan and Baron, 2009), they have different focuses and design processes.

The dissimilarity between co-design and PD is also in the purpose of applying the design approaches. PD is often used for improvement in the workplace (Kaulio, 1998), which means it is more suitable for controlled changes. First, the types of participants involved in the process differ from co-design, participatory design and co-creation. Typically, PD undertakes the two significant roles of users and designers (Robertson, Simonsen, & Simonsen, 2012); co-creation values customers and suppliers (Payne, Storbacka, & Frow, 2008); co-design focusing on design something that involves users and other specialized stakeholders. Second, PD assumes that some participants (mostly designers) are more critical than others. Designers play a role of guiding participants towards their ideal and away from what they perceive as obstacles (Kaulio, 1998); co-design and co-creation trust all participants for the quality, and thrives original ideas and innovation (Kristensson, Magnusson, & Matthing, 2002). Besides the comparison between collective design approaches and co-design, the human-centred design is also dissimilar with co-design. Fundamentally, UCD does not directly involve stakeholders in the design process. Moreover, UCD firmly steers designers to develop suitable design solutions for end-users, while co-design is more like a set of creative techniques to inspire the design process.

2.1.2 Benefits and risks of co-design

Co-design has been appreciated for empowering a design team with a combination of two sets of knowledge. It brings customer insights into latent user needs, and in-house professionals' conversion of promising new ideas into viable concepts (Trischler, Pervan, Kelly, & Scott, 2018). Trischler and colleagues made a real-world comparison of design concepts generated by co-design teams with those generated by an in-house professional team and a team solely made up of users in the course of a library service ideation contest. The empirical results indicate that co-collective teams generate concepts that score significantly higher in user benefit and novelty. In the field of corporate product manufacturing, the positive results highlight co-design as an "overlapping approach" in "the earlier delivery of a higher quality product to the consumer than the serial approach" (Bruce & Bessant, 2002, p119). Second, by being engaged in the process of change, people can actively contribute to the solution of their problems (Kaulio, 1998). This feature benefits two sides. On the one hand, it allows design teams early resolve disputes before the development process has gone too far (Bruce & Bessant, 2002). On the other hand, technology or designs can be made more suitable for users (DiSalvo, Lodato, Fries, Schechter, & Barnwell, 2011). Third, the benefits of adopting a collective design method, for the technology users, include higher satisfaction and a better fit between the technology and the users' needs (Steen, Manschot, & Koning, 2011).

However, the co-design approach has its limitations. Design teams applying the approach always face some challenges and risks. First, this kind of simultaneous engineering in companies raises two challenges. One is that design disciplines and philosophy can be lost once the team dissolute or individuals transferred. Another is that teams have to confront trade-off decisions on cost, features and delivery with careful consideration of pressures and constraints (Bruce & Bessant, 2002). Scholars have acknowledged that 'shared understanding' influences the quality of the final product

(Dong, 2005). Earlier studies have investigated the reasons why creating ‘shared understanding’ between stakeholders who are from different disciplines and have different backgrounds, interests and perspectives on the new design can be challenging (Bond & Ricci, 1992; Dougherty, 1992). To investigate into the reasons, the study of Kleinsmann and Valkenburg (2008) provides insight into how ‘actors', a.k.a. participants, in a multidisciplinary design team, dealt with their mutual differences.

Second, design teams need to select stakeholders involved in the design process carefully. Recent research focuses on ‘lead users’ in co-creative activities. Those users are consumers who are into initiate things and sharing their approaches to others (Sanders & Stappers, 2008) so that they can provide "new product concept and design data" (Von Hippel, 1986, p791). Lead users are an essential source of innovative, contributing to profitable new product and service opportunities (Carbonell, Rodriguez ‐ Escudero, & Pujari, 2012). Von Hippel (2005) and Seybold (2006), however, questioned the representativeness of an elite group of the majority, and its effect on the design process. The function and impact of the ‘lead role’ inside co-design teams are still unclear.

Last, co-design may “lengthen the product development and planning stages” (Bruce & Bessant, 2002, p119). Besides lower in feasibility, the challenges indicate a need for constructing an active design working pattern that can shorten planning time with some universal-shared disciplines.

2.2 User support

User support as a kind of user services plays a vital role in product design. Users’ evaluations of user support can affect their evaluations of that product and even of the company behind it (De Jong, Yang, & Karreman, 2017). In this study, the definition of ‘user support’ is more close to technical communication domain, referring to user documentation, instructional materials, system support.

For decades, technical communication professionals have been working on optimizing user instructions (Van der Meij, Karreman, & Steehouder, 2009). Scholars highlighted research topics of documentation structure (e.g., streamlined procedure; Farkas, 1999), content (e.g., minimalism reconstructing; Carroll, 1997), style (e.g., the English style guide for translatable documentation; Kohl, 2008), and design (e.g. agile design documentation; Selic, 2009).

With flourishing innovative IT products in the new era, the focus of product design recently has shifted from usability research (e.g., Guillemette, 1989) to user experience research (e.g., Caddick & Cable, 2011), aiming for minimizing user’s cognitive overload and enhancing the experience. Battarbee and Koskinen (2005) reviewed three approaches to user experience that focus on individuals having the experience, and noted a missing perspective of ‘experiences that are created together with others’. Few existing research explores designers experience in the process.

The trend inspires some scholars in user support domain to focus on practical evaluation of different types of user supports, e.g., using instructional video to deliver information of software tasks (Van der Meij & Van der Meij, 2013). However, research on the influence of different design processes in developing user support is not sufficient.

2.2.1 User support and design process

Darke (1979) reviewed previous literature of design process. Darke concluded that a failing of the unified approach was the neglected diversity and complexity of actual design process occurred in real situations; other unfruitful attempts were made to observe designers at work by analyzing sketches but not a “knowledge of mental process the designer goes through” (p.37). Thus, asking designers to recall their processes may get closer to what happened. However, this method bears the risks of some ‘over-simplified’ descriptions and missing non-verbal process. Scholars rarely conduct studies focusing on real-time interaction in design processes.

Previous researchers in software design have examined the usefulness of design pattern documentation in program maintenance through controlled experiments (Prechelt, Unger-Lamprecht, Philippsen, & Tichy, 2002, p595). Using design patterns ("a proven solution to a software design problem to make the solution reusable”) is claimed to improve programmer productivity and software quality. However, questions related to how a design process influence working efficiency, and how the design team perceive satisfaction internally, are still unknown.

In technical communication domain, the design process of developing user support has been rarely researched as a topic, except some unsystematic web posts and blogs. In practice, producing documentation is considered necessary but sometimes unpleasant chore (Selic, 2009), especially in software and other engineering disciplines. In order to fit in with the fast development pace, companies that provide technical documentation and related user support services nowadays adopt agile development for shortening the delivery time (Selic, 2009). Technical writers construct manual information mainly by themselves with original technical contents provided by technicians or experts. This task is difficult even when experts are available to guide and instruct the novice. Considering pressures and constrains, staffs from the marketing department, sometimes play a role of target users for technical writers to profiling user personas and testing usability.

2.2.2 User support design process and co-design

In today's information and communication society, the role of users is becoming more active. They do not only use software but also get involved in creating or modifying it (Ardito, Buono, Costabile, Lanzilotti, & Piccinno, 2012). They are no longer passive readers who are referring user support but are a more active role of producing information. Thus, while producing documentation comes at a cost, a proper investment may pay off substantially in the future. The collective approach of co-design seems feasible in the context of user support. With this approach, it is a curious topic to involve multiple stakeholders in a design process and investigate its impact on design teams and individual participant.

Therefore, a study has been carried out to explore the potential effect of the co-design approach on working efficiency and satisfaction, in the domain of user support development process. In the research, a quick start guide has been chosen as the type of user support, and *co-design stakeholders* refer to the cooperation among users, technical writers, and field experts. The research questions are addressed as follows: In the design process of creating a quick start guide:

Research Question 1: Will the co-design approach improve working efficiency?

RQ 1.1: Will the co-design approach improve team working efficiency?

RQ 1.2: Will co-design approach improve individual contribution?

Research Question 2: Will the co-design approach improve satisfaction?

RQ 2.1: Will the co-design approach improve overall team satisfaction?

RQ 2.2: Will the co-design approach improve individual satisfaction?

RQ 2.3: Will the co-design approach improve designers satisfaction with the product?

3. METHOD

This chapter describes the methodology. A qualitative research method has been applied with direct observations and interviews in three comparison groups.

3.1 Design of study

A comparison study was designed for simulating design processes in real-world user support development. Three sets of comparison groups, regarding the general approach and co-design approach, were arranged in a university laboratory for creating a quick start guide.

With three design teams in each type of group, one design team consisted three participants: a user, a writer, and an expert, who were arranged carefully with a balance of gender, major, technical experience and education background.

Three groups were requested to use two different design approach. The study named one group with a general design approach as *S1 writer group* and named two groups using co-design approach as *co-design groups*. Inside co-design groups, two comparison groups were called *S2 implied co-design group* and *S3 explicit co-design group*. The comparison variables are demonstrated in Figure 2.

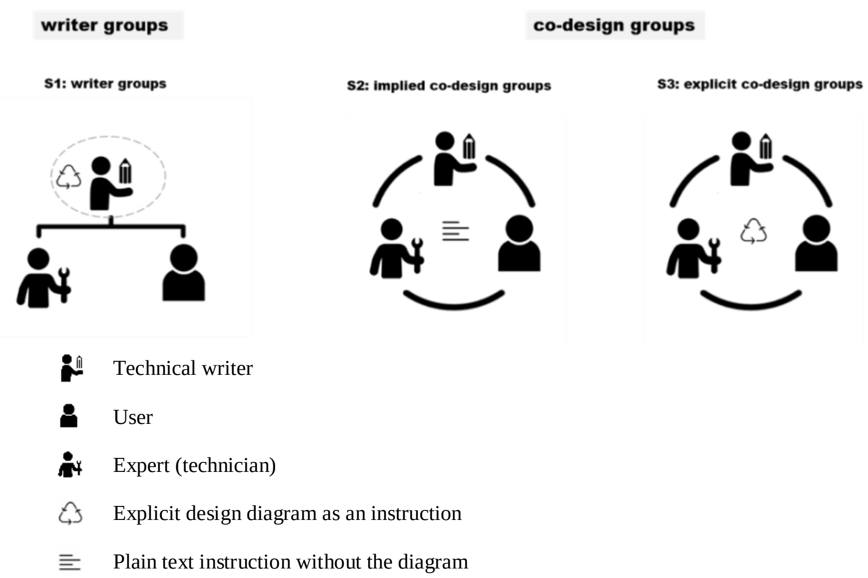

Figure 2. Comparison groups and working method

Firstly, working modes are different in *S1 writer group* and *S2, S3 co-design groups*. In the co-design teams, experts (E), users (U) and technical writers (W) worked in an equally prominent manner. Comparatively, the structure of writer teams was not parallel. Technical writers were requested to bridge the needs of users and experts.

Secondly, in order to explore the impact of different design sequences of co-design approach on the results, within co-design groups, two types of *co-design groups* were given different instructions: an explicit design diagram for one group, and a plain text describing tasks of each role for the other group. Teams in the former group were called *S3 explicit co-design teams*, and in the latter one were called *S2 implied co-design teams.*

The purpose of showing the diagram was to inspire the group to work in their unique ways with a more relaxed start. The design cycle in the diagram indicated three working phases, which was adopted by the researcher based on HCD and co-design approaches (see Appendix B instructions for the design cycle). As for the *S2 implied co-design group*, they were informed with the same amount of information of the design approach, but without visualized design phases as the other one did. All groups were asked to describe their design methods in the post interviews.

Besides, to avoid potential misleading of the name 'technical writer', the name of the writer role was changed in *S1 writer group* and *S2, S3 co-design groups*. In the S1 groups, the name of the writer was called "technical writer". In co-design groups, the role was called *technical communicators*. 'Communicator' was a role that was expected to be more cooperative, breaking a hidden stereotype of the writers who should take in charge with the writing part in the design process. Each expert was trained by staff from the BMS LAB (a laboratory focus on bringing technology into social science research) in the university before the study carried out. They were arranged to join three teams of each comparison group with a fixed sequence: from S1 writer group to S2 implied group, and finally to S3 explicit co-design group (see Figure 3). The interval days in participating in a different study was relatively the same.

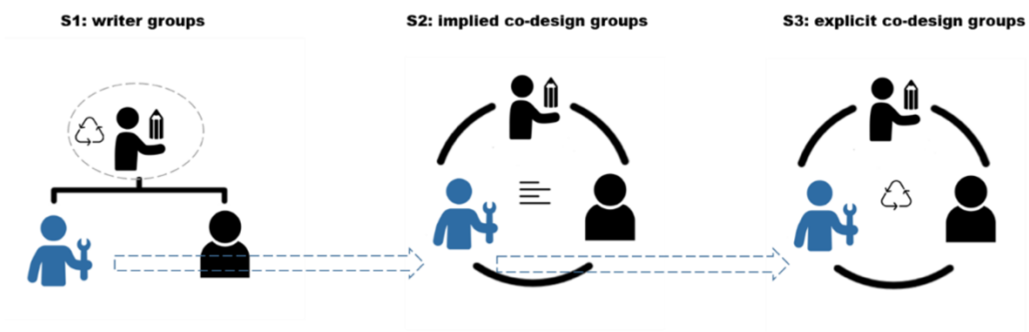

Figure 3. Experts experienced a fixed sequence of comparison groups

In the study, design processes were recorded and observed by the researcher without interrupting the participants. A semi-structured interview was constructed by themes and sub-questions and was conducted to each participant after the design process finished. Data collected from observations and interviews were analysed from the team and individual views on working efficiency and satisfaction.

3.2 Participants

Twenty-one participants were recruited voluntarily from the University of Twente. Table 1 provides general geographic information of the participants, see Appendix A for detailed geographic information, groupings and background.

Table 1

General Participants Geographic Information

Assigned role	*Education background*	*Gender*	*Experience with Myo*	*Experience with QSG*
Experts	Master (67%), Bachelor (33%); Mechanical Engineering (33%), Computer Science (33%), Biomedical Engineering (33%)	Male (100%)	Trained (100%)	No (100%)
Technical writers	Bachelor (55%) , Master (23%), PhD (22%); Communication Science (55%), Communication Studies (45%)	Male (33%), Female (67%)	Trained (100%)	Course-based (77%), Experience-based (23%)
Users	Bachelor (23%), Master (55%); Communication Studies (23%), Communication Science (11%), Sustainable Energy Technology (11%), Business & IT (11%), Interdisciplinary Systems Design (11%), Computer Science (11%), Technology & Liberal Arts & Sciences (11%), Industrial Design Engineering (11%)	Male (67%), Female (33%)	No (89%), Yes (11%)	No (77%), Yes (23%)

In order to build a team based on the co-design approach, the participants were recruited in three roles: users, experts, and technical writers. Nine users had a different demographic and educational background. For them, experience with the device or design approaches were not required. Nine participants as technical writers were recruited from the Communication Studies programs of the Behavioural, Management and Social Science faculty. They understood the human-centred design method and had particular experience in creating user support. They received official technical documentation of the device and got familiar with the armband Myo one week before the experiment. Considering difficulties (e.g., the device and training constraints) to find each design team a different expert, who has possessed enough knowledge and skills to guide a team from technician's perspective, the number of experts were compromised from nine to three. Three experts were recruited from the technical faculties. They acquired sufficient knowledge and skills about gesture control and the device after three-hour training one week before the study started.

3.3 Procedure

The comparison study was conducted in individual sessions in separate, quiet rooms at the university campus. Each study lasts for around two hours, including briefings, designing task, followed-up individual interviewing and debriefing.

Two briefings were organised, targeting at different participants before the design starts. For technical writers, a 10-minute recap-testing was organised to make sure the writers were on the same page about the device. The second briefing was for all participants in that experiment. Instructions (see Appendix B) were given on design approaches and procedures differently for the groups. A brief introduction of the Quick Start Guide and three samples (see Appendix C) were provided to the participants. All participants completed the informed consent procedure for permission of recording during design processes and interview sections before started.

Each group was required to design a Quick Start Guide (digital version) for Myo. Myo is an innovative gadget that let users control technology with hand gestures wirelessly by reading the electrical activity of their muscles and the motion of the arms. It is an excellent sensor for presentations by controlling the presentation software with gestures and motion.

The design task was using this gesture control armband to control presentation slides in university settings. The design process of the Quick Start Guide was set as 80 minutes in total. Each team handed in their products for further evaluation. During their design process, the Go-Pro camera recorded their performance, and observation sheets were made simultaneously by the researcher. Semi-structured individual interviews took approximately 10 minutes each, counting to 30 minutes for a team. Finally, a short de-briefing was held for teams needed.

3.4 Measures

Table 2 outlines the main relevant factors used for comparing efficiency and satisfaction.

Table 2

Factors Related to Working Efficiency and Satisfaction

Research questions	***Sub-questions***	***Categories***	***Sub-categories***
1. Working efficiency	1) Team working efficiency	User involvement *(e.g. Visser et al., 2005)*	Requirement
			Device
			QSG drafting
			Feedback
		Design process	Diagram instruction *(e.g. Prechelt et al., 2002)*
			Iteration (e.g. *Gould & Lewis, 1985)*
		Leadership *(e.g. Carbonell et al., 2012)*	Personality
			Accessibility
		Cooperation	Shared experience *(e.g. Sanders & Stappers, 2008)*
			Communication *(e.g. Bruce & Bessant, 2002)*
			Role convergence
			Valued voice
	2) Individual working efficiency	Interaction levels	Producing
			Advising
			Assisting
		Completed tasks	Device-related
			Content
			Structure
			Visuals
2. Satisfaction	3) Team-related satisfaction	Design process	
		Teamwork	
		Team structure	
		Individual involvement	

	4) Individual-related satisfaction	Individual contribution
	5) Product-related satisfaction *(e.g. Bruce & Bessant, 2002)*	User-friendliness
		Content
		Structure
		Visuals

For team efficiency, time of completing each phase and the final design was counted in the observation. Furthermore, the factors in four categories, i.e., user involvement, design process, leadership and cooperation, were compared among the three comparison groups. For individuals, their working efficiency was noted by interaction levels and tasks, according to observations and their recalls in interviews. Some of the categories and sub-categories referred to relevant literature.

For satisfaction, it was compared from perspectives of team, individual and product with sub-categories. For example, team-related satisfaction was compared from the design process, teamwork, and team structure.

Besides those comparable factors related to research questions, the design pattern for the comparison groups, *S1 writer group* and *S3 explicit co-design group*, were sketched based on observations and recalled of the video records of the design process

3.5 Data analysis

The study applied a qualitative method for analysing data collected from interviews. The recorded audios were transcribed first. After a check of the transcripts, the coding process started in the software ATLAS.ti. Codes were developed from theory and emerged from raw-data. The draft of structural codes was generated from the first-round coding of five transcripts chosen randomly. With necessitate repeated examinations in the iterative process, finally, 94 codes developed and constructed the codebook (see Appendix F). A second coder was invited to code three transcripts (accounting for 11 per cent of the total number) chosen randomly from the transcripts. The codebook was assessed by Cohen's kappa which resulted in a substantial agreement between the two coders' judgements, $\kappa = .76$.

4. RESULTS

This chapter presents the results collected from observation and interviews in the empirical studies. Analysis was made regarding team working efficiency, team satisfaction, personal efficiency, personal satisfaction.

4.1 Observation results

Nine observation sheets (sample refers to Appendix 5) were made during the empirical study. The sheets measured the time-to-complete of each team, which contributed to RQ1 team working efficiency; documented the significant interactions among participants. Two conceptual diagrams of design processes were patterned for writer groups and co-design groups.

4.1.1 Time-to-complete

In Table 3, the rank of nine design teams based on an overall time they spent before submitting products. The time of completing each phase is also tracked, which does not apply to S2 implied co-design group. Besides, information about iteration and types of product is noted.

Timewise, generally, the co-design groups completed the quick start guide faster than the writer groups. Moreover, *S2 implied co-design teams*, which did not receive the instruction of the design diagram, finished their design quicker than *S3 explicit groups* did. Two *S1 writer teams* requested for extra time because the writers failed to finish a draft within 80 minutes; one *S1 writer group* finished design processes within the time range without involving the expert in the group at all. All of *S2 implied co-design teams* completed the guide in time. The fastest group, S2-W8, completed the design in 53 minutes with three feedback sessions. All *S3 explicit co-design teams* submitted the guides nearly in time but none of them "completed" the third phase: feedback and testing. This session had been integrated with the second phase by the participants according to observation.

Table 3

Time-to-complete of Nine Design Teams

Rank	***Study ID.***	***Diagram instruction***	***Iteration***	***t***	***Phases***			***Products***
				Total	***P1***	***P2***	***P3***	
1	S2-W8	No	-	53	-	-	-	Documentation
2	S3-W7	Yes	1*	76	28	48	-	Documentation
3	S1-W4	Yes	2	79	10	45	24	Documentation
4	S2-W6	No	-	80	-	-	-	Documentation
5	S2-W9	No	-	80	-	-	-	Documentation
6	S3-W3	Yes	1*	80	44	36	-	Documentation
7	S3-W1	Yes	0	85	28	57	-	Documentation + videos
8	S1-W5	No	1*	93	34	30	29	Documentation
9	S1-W2	No	1	123	43	80	-	Documentation + videos

Note. S1=writer's group, S2=implied co-design group, S3=explicit co-design group; W1=technical writer ID W1; Design cycle refers to either a group receive the design cycle diagram in the instruction; *t*=time-to-complete the design (minutes); iteration=a group completed three phases based on the design cycle in the instruction, not applicable for S2, 0=not completed, 1=completed one iteration, 1*=completed one iteration but with Phase 2 and Phase 3 merged together.

4.1.2 Conceptual interaction diagrams

In the following, two diagrams visualise interactions among team members and devices. Based on observations, the conceptual diagrams try to generalise and re-present those dynamic interactions in the empirical study.

Figure 4 and Figure 5 demonstrate the working mode of *S1 writer group* and *S3 co-design group*, respectively. The conceptual diagrams present two categories of interactions: intra-team interaction among three roles; human interaction with the devices such as with the gesture control armband Myo. It is hard to generalise interaction pattern for *S2 implied co-design teams* because their design processes are substantially dissimilar. For a detailed comparison between each S1 and three S3 groups, see Appendix G for participants interaction in each phase.

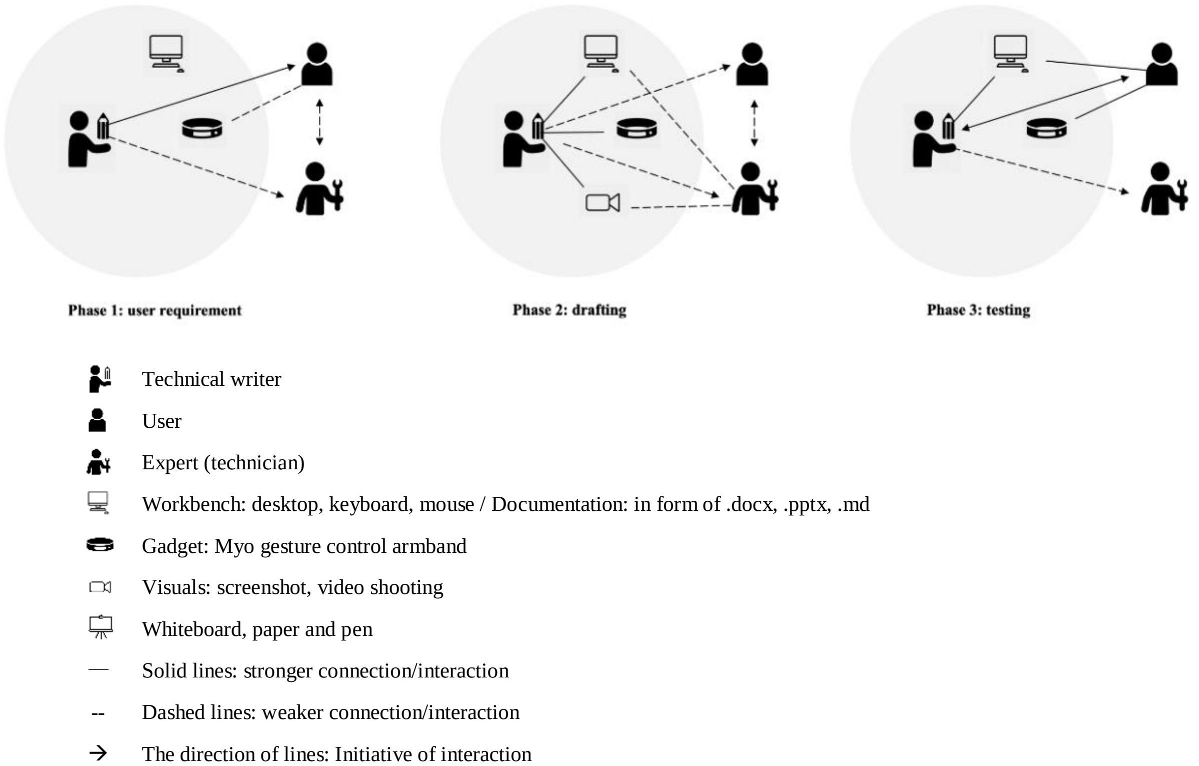

Figure 4. Conceptual interaction diagram of *S1 writer group*

In the *S1 writers' group* (Figure 4), the interaction lines feature in a one-way direction, which testifies the writers were more active and dominating than others in design processes. The interactions initiated by the writers to the other two roles. Started from Phase 1, the writers initiated requirement analysis by interviewing users. A solid arrow demonstrates a closer interaction between writers and users. Only with the requests from the writers, the experts explained the use of the Myo device to users so that a dashed line connects users and experts. The users sometimes were requested to try the Myo on. In Phase 2, the drafting phase, the writers took the entire design tasks and worked independently, referring to users and experts occasionally. Only the writer accessed directly to devices, but sometimes the experts were invited to check on the side. In Phase 3, the writers and users exchanged their feedback to the product more frequently than with the experts, and the users had access to use the Myo.

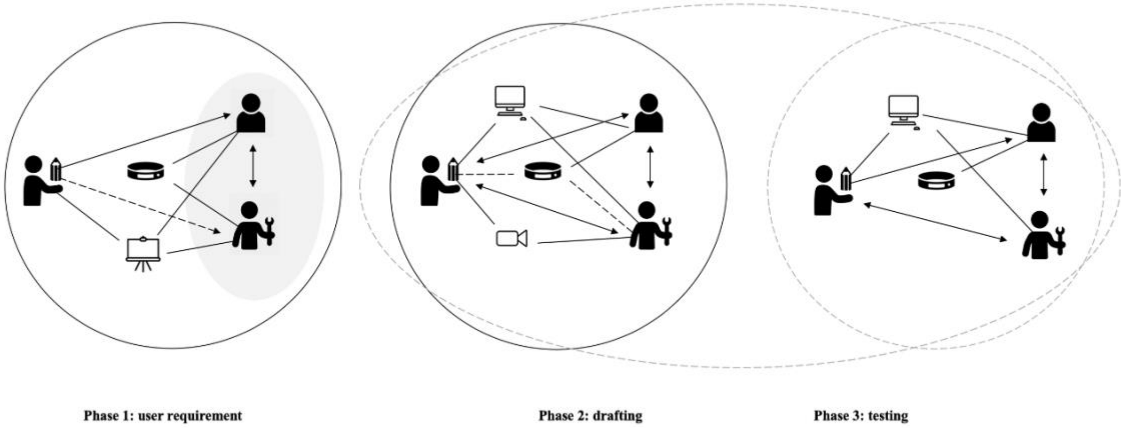

Figure 5. Conceptual interaction diagram of *S3 explicit co-design group*

*S3 explicit co-design team*s worked differently with intensive interactions in Figure 5. Three roles contributed equally to the quick start guides with their expertise. In general, the writers and experts were relatively more active and collaborated more intense than with the users. Unlike the S1 groups, these co-design groups preferred to use the whiteboard for brainstorming than to use the computer, especially in the first phase. In Phase 1, the experts focused on Myo demonstrations while the writers collected user requirements; the users responded to them and actively tried on the Myo. More specifically, the experts and users were more out-spoken because the writers frequently observed their interactions with the device, and noted down primary concerns on the whiteboard quietly. In Phase 2 and Phase 3, the co-design groups mixed the tasks of drafting and testing the guide. Therefore, the drafting session naturally consisted of the user testing part: the writers and experts performed as different levels of users. At the same time, everyone was performed as a writer, different but a better version of the writer. The users and experts continuously added detailed changes to the guide from their distinctive perspectives, which covering content, language, wording, structure and visuals. When disagreement happened, the writers balanced the needs of both roles.

Teams in *S2 implied group* cooperated more flexibly because their instructions did not frame them with fixed design phases. They started in their particular ways from the beginning: some teams started with a brainstorming session, drawing structures on the whiteboard, other teams started directly with an expert demonstration and then listed their structure in Google docs. The team members separated their tasks based on their assigned roles as well as personalities. In those groups, the interactions were intense that messages always transmitted to the right person at the right time directly. There were disputes, but they were solved quickly by seamless communication.

In *S2* and *S3 co-design groups*, one feature was commonly revealed in all of six teams: the role convergence. The three roles, i.e., technical writers, users and experts, converged and diverged in different phases. For example, they all play a role of the technical writer when designing the guide; when the technical issue occurred, the converged writer-role diverged back into the original settings that expert stood out and solved problems (see Appendix H for the role convergence in nine teams).

4.2 Interview results

The interview results include quotations analysed from those transcripts of 27 interview transcripts. The results are in the following discussed in four main categories: 1) team working efficiency, 2) individual working efficiency, 3) satisfaction with the team-related, individual-related, and product-related factors and 4) critical reflection.

The first two categories focus on Research Question 1 (working efficiency), and the third category responds to Research Question 2 (satisfaction), both from the team and individual levels. Within team working efficiency, *user involvement* (see 4.2.5 for comparing user involvement), *leadership*, *cooperation*, and *design mode* are the four elements that associate with team efficiency. As for individual working efficiency, the codes reflect the *contribution tasks* and *levels* of each role in a team. In the *satisfaction* category, *team*-wise, *individual*-wise, and *product*-wise evaluations from participants are summarized. The last category reviews some valuable reflections from participants, including the *future improvements* of the design and *constrains* factors of the study.

4.2.1 Team working efficiency

In this study, 'working efficiency' is defined as productivity in the design process. For *S1 writer group,* it means how efficient the writers worked during the process; for *S2* and *S3 co-design groups,* it means how efficient the team worked. Criteria of *leadership, cooperation* and *design mode* are contributing to the overall working efficiency of the design.

In general, the working efficiency decreased from *S2 implied co-design group* to *S3 explicit co-design group*, to *S1 writer group*. Although co-design groups were critical when it came to their efficiency, overall, they were pretty pleased with productivity. Basically, "the writer and also the expert can directly get necessary input from the user to make a guide (S2-W8-E1)" Especially S2 teams, i.e., co-design teams without an explicit design diagram rated their effectiveness with high scores. *S3 explicit co-design teams* stressed that their efficiency was not maximum because the strict and parallel task-division cut them from a natural working way. As for the *S1 writer teams*, the comments were neutral and negative. Even they received the same design diagram instructions as the *explicit co-design group* did, the distance between the writers and the user, the expert, decrease the efficiency.

Leadership

If the instruction assigns a participant with a dominant role, how will this role change in the process? Among nine teams, there were two unusual cases: one *S1 writer team* which the writer shared her role to the expert and the user; one *S3 co-design team* which the user and expert took charge of the whole process, the technical communicator was not well performed.

Participants reasoned this strange role-changing phenomenon with two factors: personality and knowhow. The latter factor is mainly related to the expert, especially in the last stage of study: S3. Due to the accumulated experience, the experts tend to point fingers, and even natural took control of the drafting process in his third study (explicit co-design). At the same time, if the technical writer in this team is a "person if someone took in charge then maybe I would just wait and see (S3-W3)", the crown of the technical communicator would be easily handed over to others.

The case from the *S1 writer group* (S1-W2) was on the contrary. The writer could not persuade herself to ignore the embarrassment of the other two so that she actively invited them to join her drafting process. This decision caused a severe consequence: failed to finish at the end even with extended time.

Apart from the above two extreme cases, generally writers took the lead in *S1 writer group*; three roles converged into one with increasingly equal contribution to the guides, or the leader's role shifted in different phases in *S2* and *S3 co-design groups*.

Cooperation

Cooperation is closely associated with the working efficiency during the process of creating a quick start guide. Once voices were valued (*valued voice*), the satisfaction of the speaker increased. Excellent communication directly contributed to high efficiency. *Shared responsibility, expertise sharing* and *communication* elements could influence the team efficiency positively or negatively.

Again in the unusual case S1-W2, when the writer realised only a few minutes before making the instruction video, the writer handed over these tasks entirely to the expert and user. The general writer team strangely became a co-design design team. In the interview, the writer admitted that she felt the working efficiency had boosted in the video shooting session with help from the other two.

In the co-design group, cooperation could be a double-edged sword. The pros are easy to be identified from the quotations: collective intelligence and circumvent weaknesses. On the one hand, the teams benefited from this collective working method. One user stated as follows:

> "Different perspective, different knowledge. So you can compare one to the other. I mean, for example, if the writer had to have the same knowledge as the expert, it would have taken her more hours to study all this stuff and how it works. But, yeah, here we only saw that the expert said a few things, but it takes a lot of time that you don't see." (S2-U9)

In co-design groups, roles shifted in different phases, especially in *S2 implied co-design groups*. One technical communicator gave an accurate summary of this trend as follows:

> "I think it was turn-wise. Like at the beginning, the expert, he took more of control because it was for the user to understand the device. So I didn't have anything to talk about. And then when the process was finished, everyone on the same page about the product. I think I took a bit over about my views and my ideas for the user guide. So I think it was a ping pong kind of... you know, everyone had to have the space to talk, and we did that. No one was holding back." (S2-W)

While three roles were sharing expertise in their field, the function of a technical communicator was extra special. This role functioned as a middle ground for the ideas between the experts and the users. Such a right balance increase the working efficiency, which has been illustrated in details in the discussion section.

On the other hand, the cons are evident as well. Without excellent communication, the *converged role* – into the writer – could be a waste of resources due to task repetition. For example, in one S3 team, an expert turned into the role of a second writer in the process, which was overlapped with the technical writer's tasks. The writer in the group commented: "In Phase 2, I'm supposed to architect changed information, and it was the expert who should add real content. We were doing the same thing: to write."

Design mode

For S1 and S3 comparison groups, the design diagram provided a good starting point for participants to carry out the design. While being questioned about “Without a starting point, will that be more effective if let you guys figure out by yourself?” All participants believed it would have taken more time. For example, the following quotation stressed their ideas about this: “I think it would have just taken more time and some of the stuff on that wouldn't be on that.” (S3-E)

The design diagram in instructions also made the design process more goal-oriented as well as connected every participant in the team on the same page. Participants in *S3 co-design group* said “the diagrams definitely helped” because they knew what the goal was and where to started. “And the roles were divided into steps and sub-steps, and every one had its role during each step, which told us when to say things or when not to say things,” said by one expert in an S3 team. Once they “followed all the steps and nobody talked too much, or no didn't have less input. Everybody was on the same page, and everybody followed the same cruise of action. So we were really focused,” added by writers.

However, participants held different views to the diagram instruction: whether a diagram should be configured in rigid and restricted phases. Some participants complained that their natural process had been interrupted by following every task of the instructions. For example, experts in S3 group critically reflected on the design cycle they received: “However, on the other hand, I feel like when we are forced to follow some strict phases, we are too rigid on the execution. It's not really natural.” However, technical writers were looking for even more detailed task divisions in each phase. It has been further explained in 4.2.5 Critical reflection section.

4.2.2 Individual working efficiency

‘Individual working efficiency’ was decided by the level and tasks a person contributed during the same period. It was challenging to identify who worked efficiently by observation, especially in a team of three. Low efficiency of one participant could probably be the maximum efficiency of others. First, it is associated with the team efficiency. An overall high individual working efficiency in the team leads to relatively higher team efficiency. Second, it contributed to personal satisfaction (see 4.2.3 Satisfaction).

In order to recur the personal contribution, two sub-categories were used in the coding process: *contribution levels*; *contribution tasks*. Due to the time constraints of the interviews, the personal performance was not covered completely. Therefore, the results of personal efficiency also came from the observation sheets.

Contribution levels

Producing, *advising* and *assisting* represent three degrees of *contribution levels*.

Producing includes direct contribution, such as typing on the laptop, making videos or making screenshots. In *S1 writer group*, writers took responsibilities of producing the guide, which is natural. The expert stepped into the design process only once in a particular S1 group to assist in instructional video making. On the contrary, in *S2 and S3 co-design groups,* nearly every role produced during the design process. Among intensive collaborations, the writers and the experts were more likely to be together to generate the content and structure than with users. In particular cases, however, users dominated the design process as a team leader and contributed the most to the product.

Advising is the most active level among those three levels. It refers to oral advice from whom did not directly ‘touch’ the facilities. In *S1 writer group*, the users and experts responded to their writers immediately. However, they did not contribute actively in most cases because they hardly answered something exceeding the question from the writers. In *S2 and S3 co-design group*, once the experts and users actively participated in the process, they continuously advise on the product, which was grouped as a “producing” with the same effect. That also explained why the *S3 co-design group* that had close cooperation but a relatively low advising level: most of them input orally to the guides.

Assisting refers to assistance on devices. In most cases, it was an effective way of contribution. However, the motivation of assistances was different in the *S1 writer group* and *S2* and *S3 co-design group*. In S1 group, users or experts were inert until the writer asked them to ‘put on the armband and try' or to ‘give instruction in instruction videos'. The S2 and S3 participants were actively offered help when they noticed the team met difficulties.

Contribution tasks

The tasks measuring individual contribution are related to the device and product. Specifically, they are from perspectives of the *device* (Myo armband, cameras, whiteboards), *content* (language, wording, technical details), *structure*, and *visuals* (picture, video, layout editing). In co-design groups, the whiteboard belongs to *devise* class, which for brainstorming among team members.

Overall, the technical writers achieved higher contribution in *S1 writer group* and performed their expertise in *S2* and *S3 co-design groups*. The experts and users contributed more to co-design groups. In extreme cases, they even dominated the process. One S3 writer complained, “I think the one who is dominant is the user, and then is the technical and technical guy.”

Table 4.

Roles Contribution Tasks in S1, S2, & S3 groups

Tasks	*S1 Writer group*	*S3 Explicit co-design group*	*S2 Implied co-design group*
Device related	E > U	-	E > U
Content	W > E > U	E > -	U > W > E
Structure	W	-	U > W
Visuals	W > E	-	E

Note. W=writer/technical communicator, U=user, E=expert; - = a relatively equal contribution, > = A contributed more than B.

In Table 4, three roles contributed to different perspectives. In all types of groups, the experts’ contribution was more device-related and covered the visual arts. The writers and users were both product-oriented. The users and experts were more connected to the device than with the users. Obviously, in *S1 writer group*, the writers contributed more to the content than the rest; in *S2 co-design group*, the users’ contribution was much higher in the sense of the content and structure than other users in other groups.

4.2.3 Satisfaction

In order to define the abstract *satisfaction*, the study measures satisfaction from those aspects: satisfaction to the *process, teamwork*, *team structure* for the team level (from *S2 and S3 co-design groups*); satisfaction to *process*, *personal*, and *product* for personal satisfaction were collected from all groups (S1, S2 and S3).

Satisfaction with the design process

Overall, *S2 implied co-design group* had the highest satisfaction to the *process*, and the attitudes from *S1 writer group* became moderate and negative.

In *S1 writer group*, the users and experts expected a higher involvement before they realised their actual participation was quite limited in the processes, which decreased their satisfaction. One expert from S1 group said: "Next time, I really want to be involved. That's bothered me a little bit." In *S2 and S3 co-design groups*, most participants rated the process 'fun', 'nice', and 'smooth'. According to two-third of the experts thought they enjoyed the co-design groups more than the writer groups.

However, high involvement of every stakeholder sometimes was troublesome. One S3 expert complained about "the user made the unnecessary movements (of the Myo) in some processes", which interrupted the writing tasks he and the writer were focusing upon.

Satisfaction with teamwork

Satisfaction with *teamwork* highlights participants' feeling of intra-team cooperation. It did not apply to the *S1 writer group* because those groups performed not in a team manner but writer-centred working mode. The results were significant that most of the participants enjoyed their teamwork in a co-design team. There is a no significant difference between *S2 implied group* and *S3 explicit co-design group*.

The reasons participants felt satisfied first vary from the roles. Users felt happy about the teamwork because they got to work with strangers and to meet new people. One participant said, "it was interesting because we work with people who never worked before and then started also feeling out of it that the different types of personalities they are." Technical writers satisfaction towards *teamwork* was related to their personal productivity. For example, one writer said she was super satisfied with the teamwork because they "formulated nice clean requirements." Experts valued their satisfaction from perspectives of involvement and practical inputs. One expert mentioned: "I think most of us also covered our tasks pretty much."

Secondly, a pleasant working vibe contributed to *teamwork* satisfaction. Notably, the users felt more satisfied with *S2 and S3 co-design groups*. Their comments on the co-design *teamwork* were like "a calm vibe and a nice environment to work in", or some "nice guys to get along really well". Therefore, thirdly, the personal characteristics of team members contributed to *teamwork* satisfaction. Especially for the experts, a kind technical writer in the team would be a blessing.

The neutral comments from S2 group on *teamwork* were classified in *involvement* (4.2.5) and *team structure* (4.2.3) as well. First, one user from S2 teams complained that he did not try the Myo armband on as a user during the entire process, "I was satisfied, but I would have liked to try the device more and then based on that, instead of imagination." Second, influenced by *expertise sharing* (4.2.3), if one role had a strong personality or strong expertise during cooperation, the voices from others' could be less likely to be accepted. In S3-W3, the expert refused to follow one solution of the technical writer. However, in the later stage, the expert found out the solution was better and would have solved their problem faster. "We were interactive," said the expert E3, "but the organisation could have been better." Third, *teamwork* satisfaction related to the team structure. The expert E3 mentioned he wanted to have more hierarchy in the team. It is illustrated in the next part: *team structure*.

Satisfaction with team structure

The *team structure* satisfaction is from participants' overall contentment of the way their team formed. It is partly connected with the *improvement* (see 4.2.5 for future improvement): some of the results are critical about the team building, such as the number of users the team. It does not apply to *S1 writer group*. Most of the *S2 implied* and *S3 explicit co-design teams* spoke highly of their team structure, but there are a slight difference between *S2 implied* and *S3 explicit co-design groups* that S2 group had more neutral reflections on their parallel team structure than S3.

Positively, the most mentioned reason by co-design groups was that the team benefited from the co-design structure: equally involved all stakeholders and maximised individual expertise. "Three people is a good balance because each role has one representative", concluded by one writer from S2 group. Most of the feedback from the co-design groups are positive. Their words accurately describe the benefit a team acquired from a co-design method like the following:

> "… Because sometimes the user cannot translate exactly what he means. Yet the user is not experienced enough sometimes to translate it into a manual. And the expert, even though if it is a real expert, he doesn't have the sensitivity of non-experience users. So he will say: 'Oh, no, this is irrelevant.' I think having those aspects is very good, but you need a link between those, so communication expertise is the link." (S3-U1)

In *S2 and S3 co-design groups*, the difference in *team structure* satisfaction was on the degree of the cooperation. One S2 expert (S2-E3), whose team did not receive diagram instruction, pointed about that their working structure was entirely parallel and he would want "a bit more hierarchy". The reason was although "there are positive sides of each role", "we also need to consider which role might be the best for this stage" during three phases of quick start guide creation. He continued stressing that "if we choose and stick with one role, I do think that there is going to be complete and more fulfilled than if we chose this rather parallel system." It also testified that diagram instruction could be influential (refers to 4.2.5).

Individual satisfaction

Individual satisfaction is how content a participant is with his or her work in the design process. It applied in all group types. The quotations featured in 'cooperation', 'personal contribution', along with participants' background, influenced individual satisfaction. Overall, the results indicate that participants in co-design teams achieved higher personal satisfaction compared with the participants in writer groups. Within the co-design groups, *S2 implied co-design group* perceived a higher individual satisfaction than *S3 explicit co-design group*.

The differences among groups are substantial. In *S1 writer group*, the overall results of *personal satisfaction* were relatively negative compared with co-design groups. First, the writers thought they could have completed the task better and designed a better version of the guide. Among their self-evaluations, one writer said, “I didn't have a clear structure before that, like how to do it.” Second, three experts in S1 group were entirely not satisfied with their input. Due to the unbalanced team structure, the experts said they were hesitated to step in when they found the writer encounter difficulties. The expert E3 explained, “I did not that cooperate, although I tried to be as much as an expert as I could, and I tried to make notes of these things. I do think that I could have stepped in, but I did not do this.” Third, the users’ satisfaction was low because of limited involvement. One user complained, “I’d like to be more involved in the process of making instructions, and maybe… do more things at the same time, because now I just sit there. Too bad.” In *S3 explicit co-design group*, the writers and experts polarized *personal satisfaction*. The technical writers were not satisfied with their working efficiency while the experts felt very satisfied with their increased input. The participants in the *S2 implied co-design group* relatively felt more satisfied with their individual work.

The differences among the roles are significant. The writers’ satisfaction in the *S1* and *S3 co-design groups* was comparatively the same, but notably higher in S2 group with less negative feelings to individual work. The users’ enjoyed the process more in co-design teams, especially when they had enough time to operate the device. The experts’ satisfaction increased significantly from S1 to S3. Two of the three experts mentioned that they were the most satisfied in S3 group because they achieved their highest contribution. The expert E2 concluded his last study, “I do think that I did tell most of my experiences, most of my hints. I communicated my insights for this which did help the user, maybe also that the writer.”

Satisfaction with product

Participants evaluated their quick start guides from the perspectives of *user-friendliness*, *content*, *structure* and *visuals*. Moreover, everyone gave an overall satisfaction with the product. Therefore, *product satisfaction* in this study only related to self-evaluation from the participants on the quick start guide their team designed.

The overall satisfaction mostly decided by the completeness of the product. When the team completed the guides within the time, participants felt satisfied with their product no matter which group. One typical quotation for this was: “It was ended up being rows because we do have time, but content-wise is great. So I'm partially satisfied.” Otherwise, they thought, “it is difficult to say you are satisfied with something unfinished.”

Every expert experienced all three groups from S1, S2 to S3, and compared the differences among those groups. Their *product satisfaction* increased in the same order of the study sequence. Two-third of the experts said they were most satisfied with two S3 products, and one expert thought one S2 product was the best. The users’ satisfaction with the product was not significantly changed: they all satisfied with the product in their team because they were “the representative” of their target group. For them, the guide was a personalised manual. One S1 user appreciated the product that she can quickly get access to any gestures and any actions she wanted to perform with the guide and “it is user-friendly”.

As for *user-friendliness*, the users in *S2* and *S3 co-design groups* found their guides more user-friendly than those created by *S1 writer group*. Firstly, they said the guides filled specific operational gaps for the official guide. Secondly, they felt their performance was improved using the guides. Thirdly, they thought the co-designed quick start guides had less information redundant. For example, one technical writer said, “I do think it is user-friendly because the information that's included is broken down. So it's only the most important things that the user has to know, in this situation, how to operate it. There’s no redundant information.”

As for *content*, the *S3 explicit co-design group* generated more contents compared with *S1 writer group*, according to the comments from experts, “Compared to the other times this time there were more things added because there was included troubleshooting in this one as well.” The rest does not very much among the comparison groups.

As for structure, most of the results have the same structure because the task itself was a procedure task. There were groups (both in writer group and co-design groups) used bullet point to break down information, or to highlight paragraph blocks.

Last, as for visuals, almost every group did not have a chance to improve the designs because of time constraints. The visuals elements like ‘pictures’, ‘videos and ‘layout’ were frequently mentioned in quotations. For example, one S3 user said: “The design is not to be attractive or is not concise enough. Visually needs more development.”

4.2.5 Critical reflections

In addition to above comparable features, abundant critical quotations from the interviews were coded. Although they did not directly answer RQs, they are valuable for this study. Those quotations were categorized in reality *constraints* and future *improvements*. The constraints were primarily related to *time pressure*. The future *improvements* include *user involvement*, *user numbers*, *expert involvement*, *design process* and *visuals*.

User involvement

All groups mentioned a need for involving users more actively. However, the motivation for involving users vary from different groups.

In *S1 writer group*, most of the participants indicated a demand for higher involvement of users. For example, the user U2 in an S1 group was involved primarily in Phase 1 (user requirement collection) and Phase 3 (user feedbacks) invited by the writer. That could be accepted as a successful “user involvement” based on the human-centred design approach in the textbook. However, this user still felt she could have contributed more to the final product. Not only the users, the writers in S1, believed they could have involved the users more. One writer stressed, “I had one, a very important one, is more users, and doing it more often.” The technical writers also thought they could have selected the interview questions “more specific” for the target group during the requirement collection. It suggests a need for a better effort to keep the target users into consideration.

In *S2* and *S3 co-design groups,* which provided an ideal theoretical environment for working together with users, the fact was that not all users were actively involved in the design process. Participants thought it was because, in the technical scenarios, the expertise of the technical writers and experts made them relatively dominant during the whole process. One extreme case was that one user even did not try the Myo armband on personally. The user could have asked for using it, but when he found ‘the technical writer worn the Myo’, he compromised and created his requirement based on “imagination”. He explained the reason why he did not ask for trying on the device, “It's just like they (the technical writer and expert) were already in the flow.” In the interview section, he said he could have contributed more by trying to ask for the device which “could have made it (product) better”. The technical writer and the expert in this group also noticed this problem during interviews. The writer reflected on this improvement, “I would definitely include more the user and ask him more questions. Then it makes it quicker. We will avoid mistakes that we made in writing like we could have started writing it as bullet points straight away not as texted form.” The expert said, “I might want the user to have some experience with the device so that they use it first.”

However, if the user took too much control during the design process, it would go out of track. In one *S3 explicit co-design team*, the user was the actual leader of the whole team because of personality. The expert and technical writer acknowledged his contribution but believed this should not have been a standard case.

User numbers

Should a co-design team invite more users in the process? If so, how many users in a team would be the right balance when design a quick start guide? Most of *S2* and *S3 co-design groups* considered one user good enough for the design team while some participants from *S1 writer group* requested to have more users.

Participants who thought one user was sufficient in the design process listed four reasons. One expert said in S3 interview, having one user in the team was reasonable because more users would decrease communication. He pointed out that, primarily, “the user was a writer as well. The thing is that when the group is larger; people tend to speak out less. People speak out less; they will be less direct.” Secondly, technical writers thought the writers and experts “ could have double roles”. Thirdly, one writer in an S3 team explained that a writer went through two levels (one user’s entry-level and one technical writer’s basic level), and an expert probably fully understood all the levels; she thought the writers and experts “can be as a part of the user group”. Last, increasing the number of users in the design process would make communication work of the technical writers even harder, which means they have to manage more people.

Others who proposed to invite more users in the design process mainly focused on usability testing phase. One S1 writer said to have an extra user for comparing “different uses” between two users in order to make sure the right direction. Moreover, many technical writers, no matter in which groups, mentioned having more users to do usability testing. One writer said: “You have one user with which you create the guide, and you have one or more users to test if the guide works.” For this second type of users, he suggested that “just let them try to do everything by their own only using the guides”. -

Expert involvement

The experts were not fully involved in the *S1 writer group*. The experts themselves thought they could have contributed their technical speciality more, which would help the team achieve a higher working efficiency. First, they thought they had to be involved from an early stage (*vocal*). For example, in one *S1 writer team*, the experts were involved in the later stage to make the instructional videos. During that period, all participants in that group agreed that they achieved their “highest productivity”. Second, they considered demonstrating the usage of the device to the user as early as possible (*demonstration*) was productive. In *S2* and *S3 co-design groups*, a demonstration from experts helped users understand the product better, according to the users. Technical writers agreed that this particular interaction made the process smoother from the beginning.

Design phase

The critical reflection from the participants consists of numerous quotations about the *design phase*. Those quotations featured in three topics: *co-design approach, diagram instructions,* and *task division*.

The users and experts in *S1 writer group* wanted more to apply a *co-design approach* in the design process than writers. Those two roles enjoyed co-designing the guide together. One expert indicated that he would ask for a discussion to set a "baseline" for the product. The expert said, "Before the guide creation process begins, at least, my idea is to have communication first, or natural discussion about what was the idea of the guide so that I can position myself better in the guide creation." The users said they preferred the way all people "really sit together". One technical writer from *S3 explicit co-design group* described her imagination of a good co-design process based on her professional experience and experiment feelings. She mentioned the following:

> "If I can have a short meeting or discussion with them first. And I add accounts or a manager to the existing content. Within it, I can have more time to think, to map the information together, to build the model by myself. I can process the content offered by expert or offer by the official guide by myself. After drafting the first guide, I might get some feedback from those two roles and further improve the documentation." (S3-W1)

Diagram instructions visually demonstrated three phases of the design process. It contributed to an overview *task division* and then improved working efficiency, according to the participants. The opinions on whether the team should have a design diagram diverged from one to another. The supporters suggested using the diagram instructions thought about to set more precise goals and specific task divisions in each phase, especially from the writers in *S2* and *S3 co-design groups*. Others who were careful to the instructions thought such division was too rigid and influenced flexibility in the design process. Moreover, some writers indicated to add extra usability testing in the later design iteration on the diagram.

Visuals & Time pressure

It was frequently stated by all design teams that they were not satisfied with the visuals of their guides, mostly because of the restricted time. The layout became one of the most prominent parts for further improvement. Take one example from an S2 writer; she thought "they could have done just like a nicer layout using different programs, like InDesign or something, and makes it look more appealing" (S2-W6).

Almost every participant felt time pressure during the design process. Some of them compromised their imagination and creative ideas to "at least to have a complete content of the guide". They were more efficiently to achieve agreement because "arguing against the clock is not good for the things" (S3-U1).

In summary, results from the observations identify a clear difference in interaction and cooperation pattern. Results from interviews suggest comparable factors from the team and individual perspectives on working efficiency and satisfaction. Besides, critical reflections from interview results illustrate some reality constraints and future improvements of adopting the co-design approach.

5. DISCUSSIONS

This chapter concludes the main findings related to the research questions, discusses the theoretical and practical implications and argues the limitations of the study.

5.1 Main findings

The study demonstrates a correlation between the co-design approach with working efficiency and overall satisfaction of design teams in the context of user support design. Specifically, the results indicate that the co-design approach improves team working efficiency. By applying the co-design approach, the design teams maximised the expertise of each stakeholder through effective communication and cooperation (Research Question 1.1). With a higher working efficiency, the teams using a co-design approach perceived higher satisfaction with the design process, teamwork, team structure and the product (Research Question 2.1). The analysis shows that this design approach enhances the designers' satisfaction with their product (Research Question 2.3). However, the method can not increase the individual performance of every stakeholder in co-design teams regarding contribution levels and tasks (Research Question 1.2); nor make every one perceive a higher satisfaction with their work (Research Question 2.2). Those connections between the results and research questions are discussed in the following findings.

The empirical data suggests that the co-design approach is an efficient working method for designing a quick start guide in a team of three. Regarding product delivery, five-sixth of co-design groups submitted the quick start guide within time; only one-third of writer groups finished the guide in time. From interviews results, team efficiency and satisfaction were significantly different in two comparison groups S1 and S3. The main reasons that contributed to high working efficiency are closer cooperation and closer stakeholder involvement. As for personal efficiency, technical writers contributed more to the guides in writer groups than in co-design groups on content, structure and visuals. Their individual working efficiency, however, did not increase because of working independently.

The co-design approach improves team satisfaction but varies on an individual level. The co-design teams achieved higher team satisfaction during the whole process with satisfying teamwork and team structure. On the individual level, three roles had different satisfaction with their works. First, the individual satisfaction of the users and experts significantly improved because of intense involvement and contribution. Second, the technical writers perceived higher satisfaction with their working efficiency in the co-design groups that without design diagram instructions. Moreover, the experienced technical writers were less satisfied with their work because they had to spend more time to communicate with users or even be substituted by experienced experts or active users.

This design method contributes to team' satisfaction with their product. The co-design teams evaluated their creation with higher satisfaction than the writer groups did. The users from the co-design groups reckoned that the guides were more user-friendly regarding content and structure than the users in the writer groups did. From the technical writers' perspective, their satisfaction with the product did not change obviously, especially for the experienced writers. However, experts who experienced three different types of groups largely agreed that the products created by the co-design groups were better than the writer groups, regarding the content and user-friendliness.

5.2 Theoretical implications

The results fit with the current understanding of the benefits of co-design. The boundary of roles easily blurred with each other. It allows co-designer to shared understandings and settles disputes before the development process has gone too far (Bruce & Bessant, 2002; Kleinsmann, 2006; Penuel, Roschelle, & Shechtman, 2007). This overlapping and design approach indeed can result in an earlier delivery of a product than the traditional writing process. Co-design approach asks for a closer (Dodero, Gennari, Melonio, & Torello, 2014) and direct involvement of users at all stages in the design process.

These results build on existing evidence of the benefits of applying the co-design approach in the context of user support design. First, the empirical results indicate that co-design teams generate more user-friendly content and structure, which fit with the previous findings that collective design achieves a higher score in user benefit (Trischler, Pervan, Kelly, & Scott, 2018). Second, the study shows that the approach significantly improves users' satisfaction with the product, as described by Steen et al. (2011), and further improves user experience during the design process as well. Third, the study adds on the missing part of the intra-team effects of co-design on satisfaction and working efficiency.

The experiment provides new insight into the risks of adopting co-design. First, the role of a technical writer is more likely to be overtaken by an 'elite role' (Carbonell et al., 2012; Stappers, 2008; Von Hippel, 1986). This elite role can be an expert acquired writing guidelines, or a superuser who familiar with the device and user support design. It is because the co-design team members take more of their natural roles and how they would behave in a team as their personality than they are assigned to. Moreover, shifting of dominating roles may confuse experienced technical writers. Although co-design teams may not have a clear team leader, three roles dominant specific tasks based on their expertise. For example, if an expert is more dominant during the demonstration session, it will make the writer feel less vocal and even lost their control for the writing work. Third, the risk of compromising some original ideas considering the cost, delivery pressures and other facility constraints, as 'trade-off decisions' in a co-design process (Bruce & Bessant, 2002). Fourth, with a real user in the team, a professional description may not be used in documentation. On the contrary, the words in the manual are more informal and "user-friendly". The risk is causing problems on systematical consistency, especially for large companies, possess a considerable amount of technical documentation.

5.3 Practical implications

Generalised from the empirical results, the desired co-design team and its procedure for creating user support are suggested in this section. It may provide some insights for professional writing companies as well as education institutes to apply a co-design approach in the process of creating user support.

For professional companies, especially innovative start-ups, co-design approach can bring benefits not only of high working efficiency and fast delivery of user guides but also can add to the brand value by directly inviting users participated in the development stage of the product. The bond between technicians, writers and target users should be closer. Moreover, it can be achieved by proper utilisation of co-design approach in the process of creating user support. Considering the time and monetary constraints, a company can choose to hold design workshops not apply the approach in every design project.

A right co-design approach relies on effective teaming and professional communication. Those are two factors that lead to the creation of a high-quality product (Heil, 1999). Two lessons learned from the empirical study are about team structure and design procedures.

First, a good team structure of a co-design team for manual design may include one technical writer who bridges technicians and users; one technician who knows everything about the device; one user who participants in the development process. These three members are equally involved during the development process of a user guide. The formation of the guide may be documentation and videos which lower the entry-level for users. After the guides created, more users can be involved for usability testing (which is not the must depend on time and budget). At the testing stage, there are three manual developers and two to three new users.

Secondly, an effective co-design working process could start from a demonstration of the technician. While the expert explains details and the user experience the technology in person, the technical writer notes down potential gaps and disputes between the user and expert. After the quick overview of the device, the team may slow down and discuss the main problems that need to be addressed in the guide. With this short brainstorming, the team should agree on an outline of the structure, content, terminology and visual preference. This kind of planning before serious design will reduce future disagreement and improve working efficiency. Then it is time for designing. The primary design process is flexible in order to maximise the collective creativity from distinctive specialities. Once the team completed the first draft, one refines iteration needs to be conducted within the team. After those two rounds, the guides can be sent to the extra users for testing. The company may control the duration of the workshop based on the pre-evaluation of a product. The suggestion is that the manual should be broken down into tasks which will not cost a long design time.

Meanwhile, the company need to be aware of some extreme cases and prevent them from happening. Firstly, carefully consider inviting a ‘superuser’, who has experience with the technical part as well as the manual part. The user may contribute to the guide from a user point of view, adding on content, suggesting wording, and even solving technical problems. Secondly, understand that experienced technical writers may perform less effectively than new graduates. It is may because the traditional writing approach has influenced them, so that is unwilling to change, or at least, more easily confused by mixing up the old and new approaches. Thirdly, control the proper influence of a technician. Either too influential or less vocal of an expert will directly influence design efficiency.

The responsibility of a technical writer should be transformed from writing-oriented to communication-oriented. First, a technical writer may turn their focus back from writing contents to communication with stakeholders, i.e. users and experts in the team. Only by carefully listening to what users need and what experts demonstrate, a technical writer can identify communication gaps between those two “professionals”. Therefore, the writer can fill the gap and balance those two roles with their communication expertise. Secondly, a technical writer should prepare themselves with cross-cultural communication skills (Sanders & Stappers, 2008) in order to face an emerging needs of international corporates.

For educational institutions, especially for technical communication specialisation, a co-design approach can prepare young technical communicators with a better understanding of effective communication and a human-centred product.

5.4 Limitations

Due to the design of the study, the simulated design setting limited the generalizability of the findings. The study was taken place in a university, where participants were recruited. Even though some of the participants were experienced, the ‘users', ‘experts', and ‘technical writers’ in design groups were all students. The results may vary in a design company facing the mass market. Second, the role of ‘expert' may be an influential factor resulting in different team working efficiency between the general groups and co-design groups. Only three experts were recruited due to the device and training constraints. Each of them completed three designs. That means they may have acquired more experience from the previous designs and implemented it into the latter ones, especially regarding understanding design tasks. Even though the study controlled the pre-training and their group order, this limitation may still influence the working efficiency and satisfaction with a product. Third, as for technical writers, writers’ experience is not the same. Some have been worked in companies as a technical writer, and others were recruited from the first year and second-year university students who completed relevant courses.

An 80-minute design process was considered too rush to complete a start guide, although verified by a pre-test in the study design. The design teams experienced a pressure process. First, all teams focused on the feasibilities of one idea, not creativity. It probably makes the roles of technical writers and experts more prominent than users because users’ requirement could be considered as time-consuming or not feasible for the team to achieve in a short time. Moreover, due to the fast process, most of the design teams rarely had time to do iterations, which is one of the fundamental factors of the human-centred design (Gould & Lewis, 1985). Without iterations, the product stayed in a draft version that without many visual designs. It limits the measurement of an individual’s satisfaction with a product.

One unanticipated obstacle that emerged during the design process: not every participant can manage the three extended-screen display in the laboratory. During the process, when the users and writers encountered problems with the display, they looked for help the experts. This reason results that experts made a higher individual contribution in co-design groups. Moreover, the study only provided one work station (desktop). Although all participants were suggested to bring their laptop, not everyone did so. The groups that without other laptops may spend more time in drafting a start guide. This difference among groups was not considered in the findings.

It is beyond the scope of this study to evaluate the effect of co-design on product quality. The product-related evaluation came internally from each team. The actual user performance of using the quick start guide or general usability of the design was not tested. Due to lack of data, the results from this study cannot confirm whether the co-design approach improves the quality and usability of a product.

5.5 Suggestions

Based on the limitations, the following part addressed some suggestions for future research and practice. First, future studies need to keep investigating the effect of co-design on team working efficiency in other settings in order to generalise the main findings, especially from more validated empirical data. Second, systematic evaluation of the impact on product quality is needed. Third, research on establishing specific criteria for selecting participants from groups of users and technical writers is preferred.

For practice, design teams that consider applying the co-design approach in the process need to notice the feasibility of arranging stakeholders together at the same time slots and the potential investment in preparation time and cost. Moreover, the co-design approach needs visual instructions like a diagram of a design cycle, but it should have certain flexibility so that co-designers can appropriate the process by themselves.

Conclusion

The study shows that the design process matters for designers. Higher team working efficiency and satisfaction contributed to faster delivery of the product. In a task of quick start guide design, applying the co-design approach can result in better team working efficiency and overall satisfaction. Improvements of those two factors are prominent for users and experts who are actively contributing to co-design teams. More research is needed to further explore these effects of co-design in other user support design tasks, especially for mass documentation design.

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APPENDICES

APPENDIX A. Detailed Participants Geographic Info

Table 5

Participants Geographic Information, Groupings and Background

Study No.	*ID*	*Assigned role*	*Background*	*Experience with Myo*	*Experience with QSG*	*Gender*	*Country*
E1		Expert	MSc. Computer Science	Trained	No	Male	Indonesia
S1	W5	Writer	Bs. Communication Science	Trained	Yes	Male	Bulgaria
	U2	User	MSc. Communication Studies	No	Yes	Female	Germany
S2	W8	Writer	Bs. Communication Science	Trained	Yes	Male	Italy
	U7	User	Bs. Business & IT	No	No	Female	Netherlands
S3	W7	Writer	Bs. Communication Science Computer science	Trained	Yes	Female	-
	U1	User	MSc. Sustainable Energy Technology Bs. Interdisciplinary Systems Design	Yes	No	Male	Brazil
E2		Expert	Bs. Mechanical Engineering	Trained	No	Male	Pakistan
S1	W2	Writer	PhD	Trained	Experienced	Female	China
	U5	User	MSc. Computer Science	No	No	Female	China
S2	W6	Writer	Bs. Communication Science	Trained	Yes	Female	Germany
	U9	User	Bs. Communication Science	No	Yes	Male	Kenya
S3	W3	Writer	PhD	Trained	Yes	Female	China
	U4	User	Bs. Technology & Liberal Arts & Sciences	No	No	Male	Belgium
E3		Expert	MSc. Biomedical Engineering	Trained	No	Male	-
S1	W4	Writer	MSc. Communication Studies	Trained	Experienced	Male	Netherlands
	U3	User	MSc. Industrial Design Engineering	No	No	Male	China
S2	W9	Writer	Bs. Communication Science	Trained	Yes	Female	Germany
	U8	User	MSc. Communication Studies	No	No	Male	-
S3	W1	Writer	MSc. Communication Studies	Trained	Yes	Female	China
	U6	User	Bs. Business & IT	No	No	Female	Malaysia

APPENDIX B. Instructions

1.1 instructions for S3 Explicit co-design group

Instruction

Thanks for participating in the study!

You are in a team of three participants. Each of you has already been informed about your role in the team: the user, the technical communicator, or the technical expert.

In the following 80 minutes, your team is going to work together to create a special user guide for Myo, a gesture control armband, based on the existing official Getting Started Guide. Unlike the official guide which focuses on setting up the armband, your guide will be used as a Quick Start Guide in a particular scenario: to control the presentation software (Microsoft PowerPoint) with gestures and motion in a university setting. This means that with the support of your guide, a new user can easily use Myo to control and present the slides. In order to help you understand what Quick Start Guide is, a brief introduction and 3 samples of this kind of user manual have been provided.

During the design processes, all of you are important to make a user-friendly design. Every role in your team should contribute to the design, which includes but not limits in the following:

- The user: operates the armband, asks questions, gives feedback to the design…
- The technical writer: transforms user requirements into a proper manual content with a logical structure, and evaluate the manual from usability and user experience perspectives…
- The expert: demonstrates the operation of the device, provides solutions to technical problems, give feedback to the manual…

Your team is suggested to follow the Design Cycle Diagram on the back of this instruction. ‘E’ refers to the expert, ‘U’ is for the user, and ‘C’ is the role of Technical Communicator/Writer.

Your team needs to inform the researcher when you’ve finished each phase by removing the stickers in front of you. You have 80 minutes in total to work on your design. After that, you need to submit a final version.

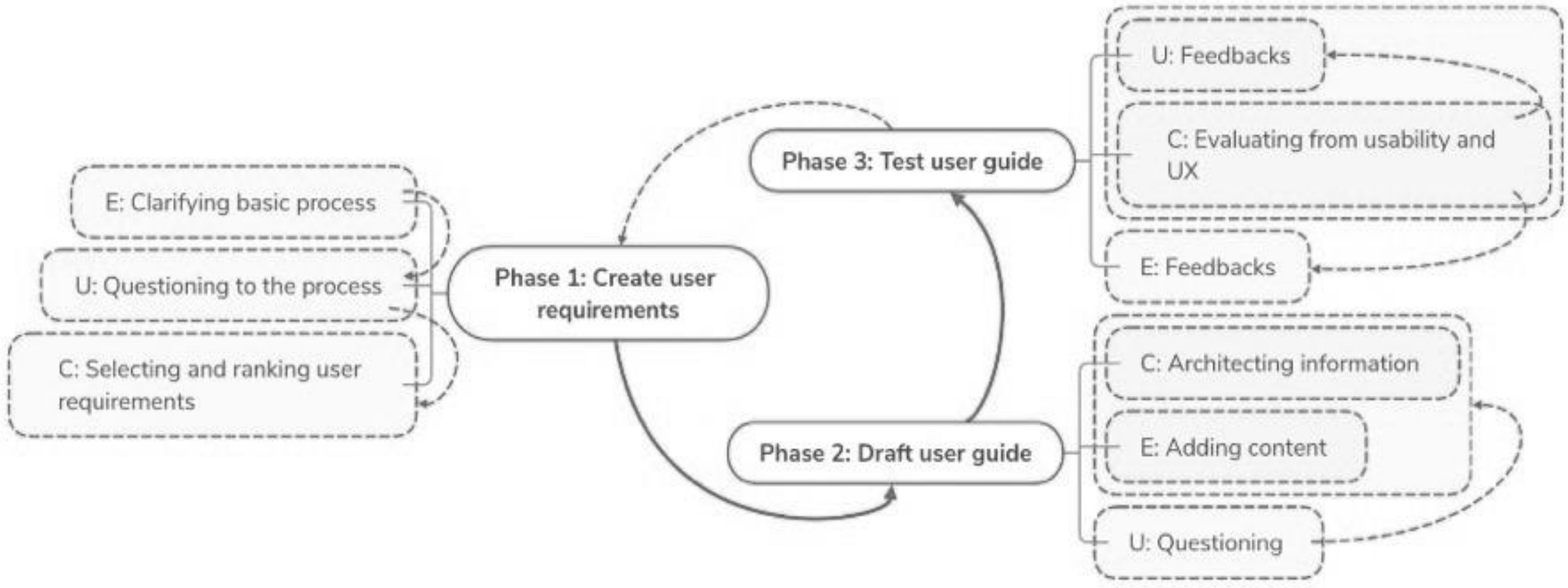
The following materials are provided for your team:

- a Myo Gesture Control Armband
- a desktop with Myo Connect (software) installed
- a .pptx file used for a presentation
- the official Myo User Support website: https://support.getmyo.com/hc/en-us
- a brief introduction of Quick Start Guide and 3 Quick Start Guide samples from other applications
- 3 stickers labelled with ‘Phase 1’, ‘Phase 2’, ‘Phase 3’

There’s no words limitation to your final product, but your Quick Start Guide should meet the following requirements:

- Focus on your user group.
- It includes screenshots or pictures of the device and software.
- It includes the introduction of basic gestures (no limitation to the numbers of gestures).
- No special requirement for the format.

Feel free to ask any questions to the researcher before your team starts. The researcher will not answer or provide any support related to the design during the processes.



Design Cycle Diagram

Your team is suggested to follow the design life-cycle above.

E: the expert. U: the user. and C: the Technical Communicator/Writer.

1.2 Instructions for S2 implied co-design group

Instruction

Thanks for participating in the study!

You are in a team of three participants. Each of you has already been informed about your role in the team: the user, the technical communicator (writer), or the technical expert.

In the following 80 minutes, your team is going to work together to create a special user guide for Myo, a gesture control armband, based on the existing official Getting Started Guide. Unlike the official guide which focuses on setting up the armband, your guide will be used as a Quick Start Guide in a particular scenario: to control the presentation software (Microsoft PowerPoint) with gestures and motion in a university setting. This means that with the support of your guide, a new user can easily use Myo to control and present the slides. In order to help you understand what Quick Start Guide is, a brief introduction and 3 samples of this kind of user manual have been provided.

During the design processes, all of you are important to make a user-friendly design. Every role of your team should contribute to the design, which includes but not limits in the following:

- The user: operate the armband, ask questions, give feedback to the design…
- The technical writer: transforms user requirements into a proper manual content with a logical structure, and evaluate the manual from usability and user experience perspectives…
- The expert: demonstrates the operation of the device, provides solutions to technical problems, give feedback to the manual…

You have 80 minutes in total to work on your design. After that, you need to submit a final version.

The following materials are provided for your team:

- a Myo Gesture Control Armband
- a desktop with Myo Connect (software) installed
- a .pptx file used for a presentation
- the Myo User Support website: https://support.getmyo.com/hc/en-us
- a brief introduction of Quick Start Guide and 3 Quick Start Guide samples from other applications

There's no words limitation to your final product, but your Quick Start Guide should meet the following requirements:

- Focus on your user group.
- It includes screenshots or pictures of the device and software.
- It includes the introduction of basic gestures (no limitation to the numbers of gestures).
- No special requirement for the format.

Feel free to ask any questions to the researcher before your team starts. The researcher will not answer or provide any support related to the design during the processes.

1.3 Instructions for writer group – writer's role

Instruction

Thanks for participating in the study!

You are a technical writer who specialized in user support.

In the following 80 minutes, you are going to create a special user guide for Myo, a gesture control armband, based on the existing official Getting Started Guide. Unlike the official guide which focuses on setting up the armband, your guide will be used as a Quick Start Guide in a particular scenario: to control the presentation software (Microsoft PowerPoint) with gestures and motion in a university setting.

During the design process, you should work independently. If you meet any technical questions, feel free to ask the expert (with the 'Expert' badge). Also, you have a user as a representative of your user group (with the 'User' badge). You can ask the user about his requirements and invite him to do a usability test after you finish the guide. You are suggested to follow the design cycle below.

You need to inform the researcher when you have finished each phase by removing the stickers in front of you. You have 80 minutes in total to work on your design. After that, you need to submit a final version.

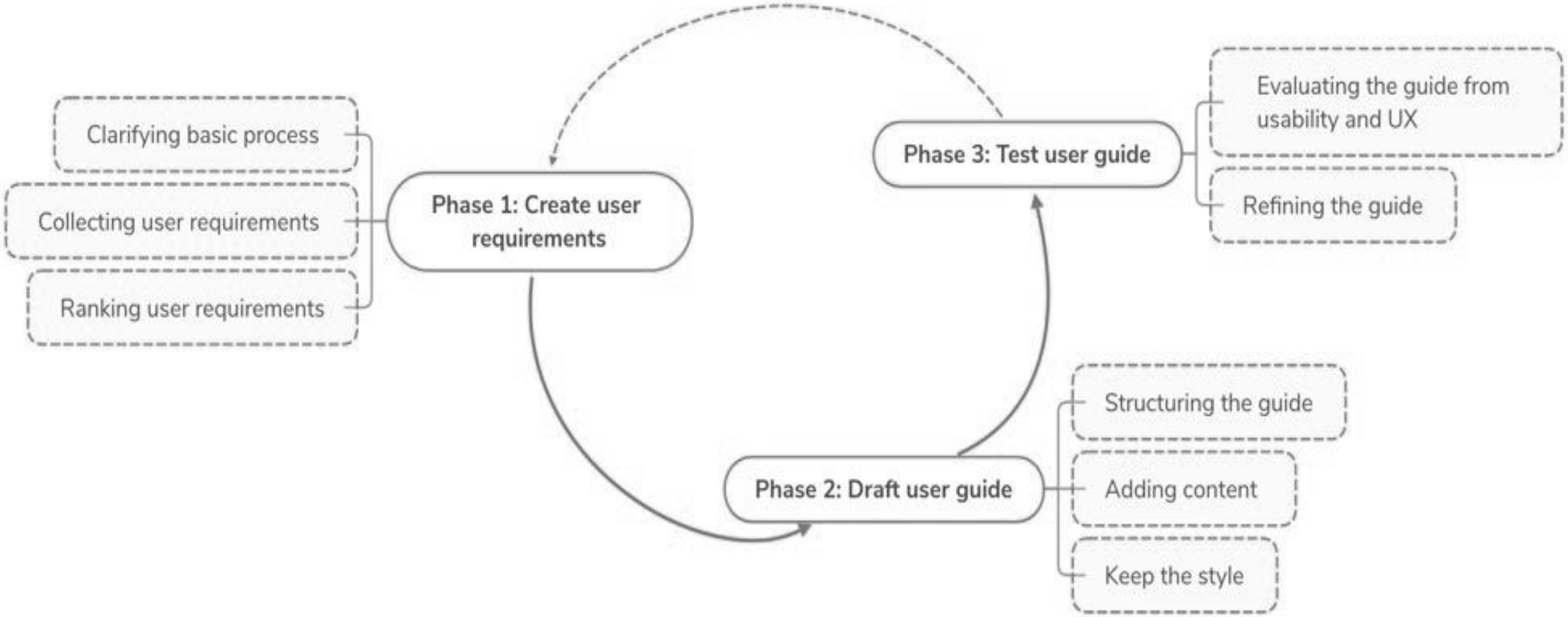
The following materials are provided for your team:

- a Myo Gesture Control Armband
- a desktop with Myo Connect (software) installed
- a .pptx file used for a presentation
- the official Myo User Support website: https://support.getmyo.com/hc/en-us
- a brief introduction of Quick Start Guide and 3 Quick Start Guide samples from other applications
- 3 stickers labelled with 'Phase 1', 'Phase 2', 'Phase 3'

There's no words limitation to your final product, but your Quick Start Guide should meet the following requirements:

- Focus on your user group.
- It includes screenshots or pictures of the device and software.
- It includes the introduction of basic gestures (no limitation to the numbers of gestures).
- No special requirement for the format.

Feel free to ask any questions to the researcher before your team starts. The researcher will not answer or provide any support related to the design during the processes.



Design Cycle Diagram

You are suggested to follow the design cycle above.

Instructions for writer group – the writer's role – the expert's role

Instruction
Thanks for participating in the study! You are a technical expert who is familiar with wearable gadgets. You know a lot about the operation of the Myo Gesture Control Armband. In the following 80 minutes, you are responsible for providing technical support and advice to a technical writer. The writer is going to create a user guide for Myo. **Feel free to ask any questions to the researcher before you start. The researcher will not answer or provide any support related to the design during the processes.**

Instructions for writer group – the user's role

Instruction (with experience)
Thanks for participating in the study! You are a user who has certain experience with the gesture control device. You want to use the armband Myo to control your presentation slides. In the following 80 minutes, a technical writer is going to create a user guide for Myo. The writer may ask you questions and invite you to use the device. Please feel free to help the writer. **Feel free to ask any questions to the researcher before you start. The researcher will not answer or provide any support related to the design during the processes.**

Instruction
Thanks for participating in the study! You are a user who is interested in trying some innovative gadgets. But you don't have any experience with the gesture control device. You want to use Myo, a gesture control armband, to control your presentation slides. In the following 80 minutes, a technical writer is going to create a user guide for Myo. The writer may ask you questions and invite you to use the device. Please feel free to help the writer. **Feel free to ask any questions to the researcher before you start. The researcher will not answer or provide any support related to the design during the processes.**

APPENDIX C. Materials for QSG

About Quick Start Guide

Some technical writers describe "Quick Start Guide", QSG in short, as follows:

> "Users often want documentation in a format that will give them the basics and get them on their way as fast as possible…The brief format requires you to right-size content and decide the most important information the user needs to know. Additionally, you must describe with extreme concision and clarity processes that usually require dozens of pages to explain." (Johnson & Minson, 2009.)

Typically, a quick start guide consists of:

- Title, product name
- Company name
- Relevant images
- **Its core: working (operating) instructions to get started right away**
- Remark where to find background information
- Trouble shootings

3 QSG Samples

- Codex Quick Start Guide (a software for writing in DITA), 1 page
- Sony WH-1000XM3 (wireless noise-cancelling headphones), 2 pages
- Walt Disney World® Resort Quick Start Guide (amusement park), 5 pages

Codex
Version 5

Quick Start Guide

1 Install Codex

Windows

Double-click **Codex.msi** and follow the instructions. If prompted "The publisher could not be verified. Are you sure you want to run this software?", click **Run**.

Mac

Double-click **Codex.dmg** and follow the instructions. If prompted "Codex can't be opened because it is from an unidentified developer", go to System Preferences > Security & Privacy Settings, and at the bottom of the window click **Open Anyway**.

2 Start Codex

Windows

Either double-click the **Codex** shortcut on your desktop or select **Codex** from the Start menu.

Mac

Click **Codex** in the Dock.

3 Activate Codex

From the Welcome window, click **Enter a License Key** and enter the license key that was emailed to you. If you don't have a license key, click **Request Free Trial**.

4 Watch the videos

From the Welcome to Codex window, watch the Getting Started video that's best for you.

5 Open the sample files

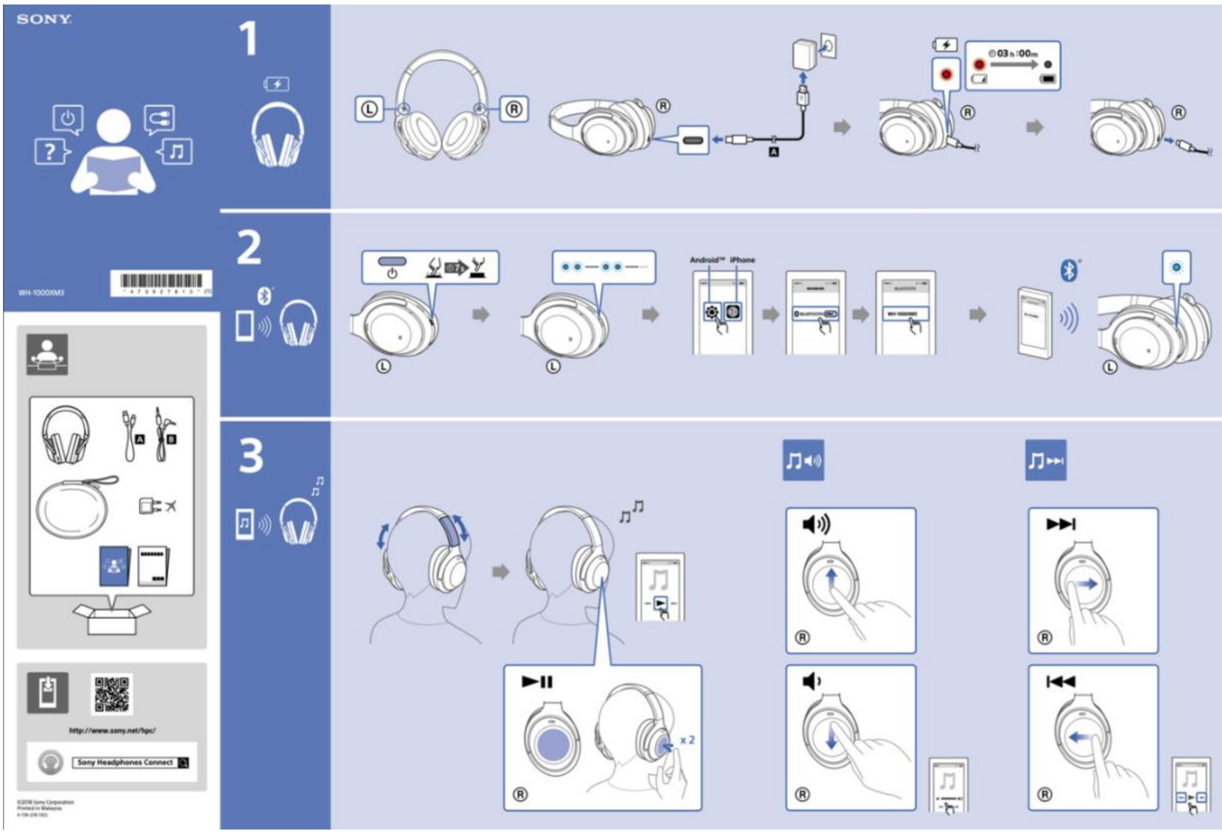
In the **Samples** folder, open **CodexHelp.ditamap** and the various topic files to see how they are composed. These are the source files for the Codex help system.

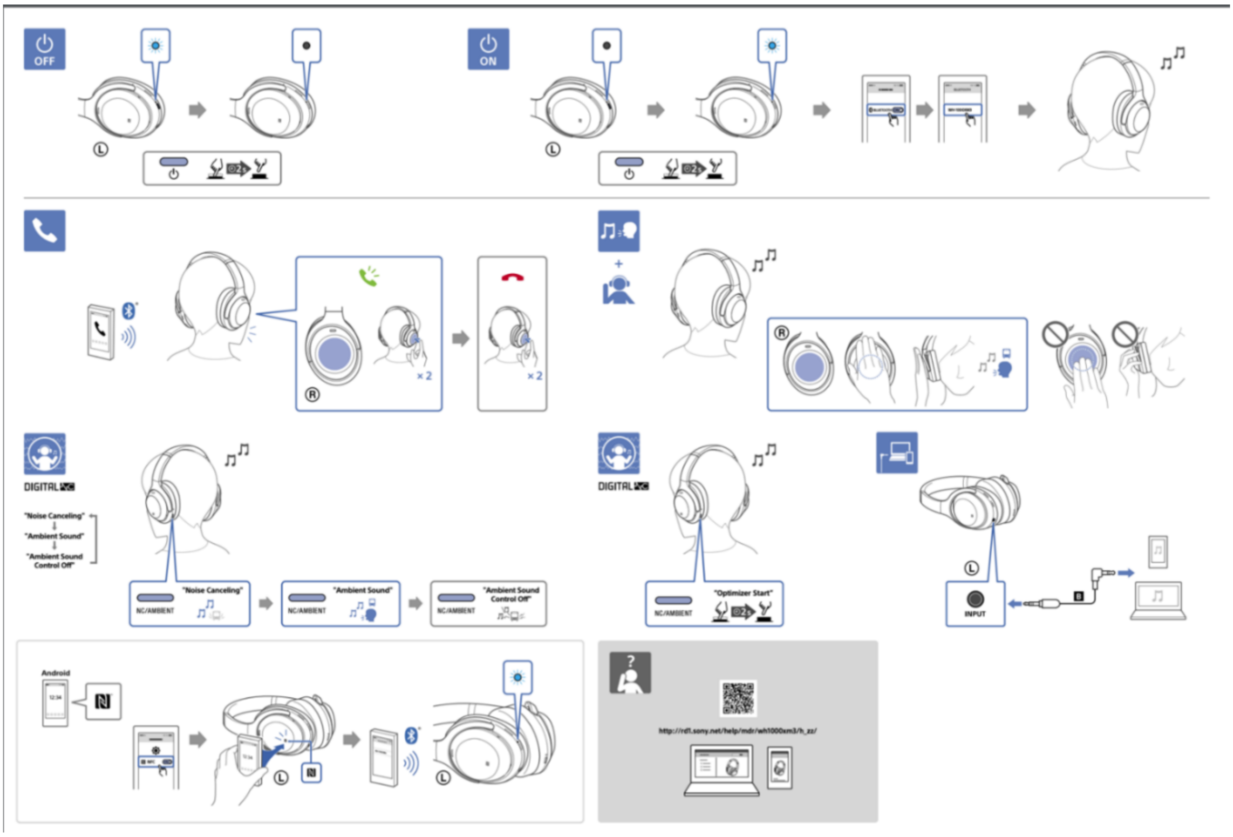
6 Open the template files

In the **Templates** folder, open the various topic files. You can use these files as templates for starting your own topics, or as a source for copying elements to other topics.

7 Get support

If you have a problem or question about using Codex, email **contact@codex.ca**


SONY
1
2
3
Android™ iPhone
http://www.sony.net/hpc/
Sony Headphones Connect


OFF
ON
DIGITAL
"Noise Canceling"
"Ambient Sound"
"Ambient Sound Control Off"
NC/AMBIENT
"Optimizer Start"
INPUT
Android
http://rd1.sony.net/help/mdr/wh1000xm3/h_zz/

PAGE 1

UNDERCOVER TOURIST
The trusted name in attraction tickets.

A QUICK-START PLANNING GUIDE

While it's a *hoppin'* good time, the *Walt Disney World*® Resort isn't a *toadally* care-free vacation. As the most-visited resort destination in the world, it brings in tens of thousands of guests each day. That's a lot of frogs in the pond! Even during slow times, there can be long waits and difficulty getting popular dining reservations. Who wants to spend two hours in line for a two-minute ride? Not us. We've hopped around the parks long enough to know all the must-visit attractions, best restaurants and tips so that you and your family have a great trip.

You'll find more printable guides and in-depth planning information at:
undercovertourist.com/planning/

OTHER PRINTABLE GUIDES:

- Quick Start Guide for the Universal Orlando® Resort
- Seasonal Packing Lists
- The Complete Guide to FastPass+
- Flexible General Plans & Maps—Plus When to Visit Every Ride!
- Touring plans for Disney World, Universal Orlando and SeaWorld Orlando parks

Ultimate Walt Disney World Resort Planning Timeline

Up to 365 Days Out

→ Decide when to visit using our 12-month Crowd Calendar at:

undercovertourist.com/orlando/crowd-calendar

→ Book your Disney World resort hotel at:

undercovertourist.com/orlando/hotels

Up to 190 Days Out

→ Plan which park to visit on each day of your trip using the Crowd Calendar.

→ Create a My Disney Experience account on Disney's website to make dining and FastPass+ reservations.

Up to 180 Days Out

→ Make Advance Dining Reservations and reservations for special activities (Bibbidi Bobbidi Boutique, fireworks dessert parties, etc.). Resort guests can make up to 10 days of ADRs at 180 days (7 a.m. EST), giving them 1st dibs on the popular restaurants. Off-site guests must make reservations for each day.

Up to 80 Days Out

→ Order your Disney World tickets so they arrive before your FastPass+ booking window opens.

undercovertourist.com/orlando/walt-disney-world-resort

Decide which rides and experiences you want to make reservations for.

(continued on page 2)

APPENDIX D. Sample observation Sheet

OBSERVATION SHEET

Date: 13-05-2019 **Study number: S1-WriterGroup-W4**

Participants: Writer: W4 User: U3 Expert: E3

Time	*Writer*	*User*	*Expert*	*Note*
0- 10 min				
10- 20 min				
20- 30 min				
30- 40 min				
40- 50 min				
50- 60 min				
60- 70 min				
70- 80 min				

Design pattern sketches:

Notes:

Reflection:

APPENDIX E. Interview Questions

For **co-design teams**, the interview will be conducted individually with each team member. Approximately, each interview for one team member will take 10 minutes, and 30 minutes in total for a team.

Theme 1: Team-oriented

- (lead-in question) How was it? Did you enjoy the design process?
- Can you describe how your team worked?
    - Did you encounter any difficulties during the design process?
        - How did your team work out those difficulties?
    - Who took the lead in your team? Why do you think so?
- How do you think about your teamwork?
    - Do you think your team worked efficiently during the process?
        - Why do you think your team have a high/low working efficiency?
    - Did you enjoy the way your team worked?
        - Are you satisfied with the way your team organized?
        - Are you satisfied with the way your team cooperated?
    - What made you feel satisfied (or unsatisfied) with your teamwork?
    - Do you have any suggestions for your team if you could work together again?

Theme 2: Individual-oriented

- Can you describe your role in the team?
    - What did you do in the process?
- What do you think about your own contribution to the team?
- Do you think you worked efficiently during the process?
    - Why or why not?

Theme 3: Product-oriented

- What do you think about the guide you’ve made?
    - Do you think it is user-friendly?
    - Do you think it will improve user experience?
- Do you feel satisfied with your Quick Start Guide?

  - Why you feel satisfied with the result? (or don't feel satisfied)

For **writer teams**, the interview will be conducted individually with each team member. Approximately, each interview for one team member will take 10 minutes, and 30 minutes in total for a team.

Theme 1: Process-oriented

- (lead-in question) How was it? Did you enjoy the design process?
- Can you describe how you worked?
  - Did you encounter any difficulties during the design process?
    - How did you work out those difficulties?
- How do you think about your work?
  - Do you think you worked efficiently during the process?
    - Why do you think you have a high/low working efficiency?
  - Did you enjoy the way you worked?
    - Are you satisfied with the way you cooperate with the user?
    - Are you satisfied with the way you cooperate with the expert?
  - What made you feel satisfied (or unsatisfied) with your work?
  - Do you have any suggestions for the working method if you could work together again?

Theme 2: Product-oriented

- What do you think about the guide you've made?
  - Do you think it is user-friendly?
  - Do you think it will improve user experience?
- Do you feel satisfied with your Quick Start Guide?
  - Why you feel satisfied with the result? (or don't feel satisfied)

APPENDIX F. Codebook

Categories	*Codes*	*Parallel*	*Sub-codes*	*Descriptions*	*Notes*
Category 1: Team Efficiency					
Note: This category is mainly used for co-design groups (file name is S2/S3)					
	W.E. = WORK EFFICIENCY			It is about how a participant thinks about the working efficiency of their team	
			W.E. POS	Positive	
			W.E. NEG	Negative	
			W.E. NEU	Neutral	
			W.E. SCORE	Score from 1 to 5 given by a participant	A quotation should not be coded as a SCORE and general codes at the same time.
	U.I. = USER INVOLVEMENT			It describes a type and degree of involvement of the user.	
		1	**U.I. POS**		Code 2 is also applied to the observation sheets
			U.I. NEG		
			U.I. NEU		
		2	**U.I. REQUIREMENT**	The user's needs have been involved.	
			U.I. DEVICE	"Device" refers to the tech. gadget - Myo gesture control armband. It's about the user's usage pf the device.	
			U.I. QSG DRAFTING	"QSG" refers to the Quick Start Guide. The user has been involved in drafting the guide.	
			U.I. FEEDBACK	The user was involved in the feedback session. Please notice, the feedback session can happen simultaneously with the drafting session.	

L. = LEADERSHIP			
	1	**L. KNOWHOW**	Participants have a specific speciality
		L. PERSONALITY	A participant's personality is an influential factor.
	2	**L. W**	(writer)
		L. U	(user)
		L. E	(expert)
		L. NONE	It's an equal collaboration.
COOP. = COOPERATION		**COOP. TC MIDDLE GROUND**	When Technical communicator acts as a balance to the other roles
		COOP. SHARE EXPERTISE	A participant in a team shares his/ her role expertise
		COOP. SOLVE PROBLEMS	Any difficulty the team encountered and had been solved or not solved.
		COOP. COMMUNICATION	
		COOP. ROLE CONVERGENCY	Three roles are merging into one role in different phases. Alternatively, the roles evolved to a functional similarity.
		COOP. SHARED RESPONSIBILITIES	The participants feel they share responsibilities toward the product.
		COOP. VALUED VOICE	An idea, opinion or suggestion has been respected. The opposite factor is a non-valued voice.
D. I. = Diagram Instructions			
		D.I. POS	The participant stated that the design cycle from the instruction was useful, helpful, and improves their working efficiency.
		D.I. NEG	Negative to the previous one.
Category 2: Personal Efficiency			
Note: Personal efficiency is associated with the team efficiency. And those two codes in this category are applied to the observation sheet as well.			

	P.C.L. (W./E./U.) = PERSONAL CONTRIBUTION LEVEL (W./E./U.)	1			
			P.C.L. (W./E./U.)PRO =PRODUCING	"Producing" includes directly typing, screenshotting, video-shooting.	
			P.C.L. (W./E./U.) ADV =ADVISING	"Advising" refers to oral advice but not directly edit the guide.	
			P.C.L. (W./E./U.) ASIS =ASSISTANCE	"Assistance" refers to support from a participant to the primary operator.	
	P.C.T. = PERSONAL CONTRIBUTION TASK	2	**P.C.T. (W./E./U.) DEVICE RELATED**	"Device related" to operate with the MYO.	
			P.C.T. (W./E./U.) CONTENT	"Content" includes language, like grammar and wording.	
			P.C.T. (W./E./U.) STRUCTURE		
			P.C.T. (W./E./U.) VISUALS	"Visuals" includes a picture, video, and layout editing of the guide.	
Category 3: Satisfaction					
	SAT. P. = SAT PROCESS		**SAT. P. POS**	Satisfaction with the process.	
			SAT. P. NEG		
			SAT. P. NEU		
			SAT. P. SCORE		
	SAT. TEAMWORK		**SAT. T POS**	Satisfaction to the teamwork	Team satisfaction: evaluation to teamwork and team structure, especially for co-design groups but not excluding writer groups.
			SAT. T NEG		
			SAT. T NUE		
			SAT. T SCORE		

	SAT. T STRUCTURE	**SAT. T STRUCTURE POS**	Satisfaction with the team structure	
		SAT. T STRUCTURE NEG		
		SAT. T STRUCTURE NUE		
	SAT. PERSONAL	**SAT. PERSONAL POS**	Personal satisfaction: self-evaluation of a participant about his/her workload and working efficiency during the USDP.	It is associated with Category 2 Personal Efficiency.
		SAT. PERSONAL NEG		
		SAT. PERSONAL NEU		
		SAT. PERSONAL SCORE		
Category 4: Product				
Note: the evaluation of, the quality of the final product (guide), is subject. Therefore, it may be mixed with the satisfaction of a participant.				
	SAT. PRODUCT	**SAT. PRODUCT POS**	Satisfaction with the final product	
		SAT. PRODUCT NEG		
		SAT. PRODUCT NEU		
		SAT. SCORE	Personal satisfaction, more subjective	
	PD UF = PRODUCT USER-FRIENDLY	**PD UF POS**		This code generally includes the comments about usability and user experience of the product.
		PD UF NEG		
		PD UF NEU		
		PD UF SCORE	Satisfaction towards a product, more objective	
	PD CONTENT	**PD CONTENT POS**	The content includes language, wording, technical details of the guide.	
		PD CONTENT NEG		
		PD CONTENT NEU		
	PD STRUCTURE	**PD STRUCTURE POS**	Focus on logic	
		PD STRUCTURE NEG		

		PD STRUCTURE NEU		
	PD VISUAL	**PD VISUAL POS**	"Visuals" includes a picture, video, and layout editing of the guide.	
		PD VISUAL NEG		
		PD VISUAL NEU		
Category 5: Critical reflection				
	IMP. = IMPROVEMENT	**IMP. USER INVOLVEMENT**	To involve user more/less often	By meeting those factors, the efficiency of the guide will be improved.
		IMP. USER NUMBERS	To involve more/fewer users	
		IMP. EXPERT DEMONSTRATION	To be demonstrated by the expert	
		IMP. DESIGN PHASE	To update the design cycle, improve the instructions of each phase in the cycle.	
		IMP. VISUALS	To refine the layout, pictures, videos…	
		IMP. CONTENT	To add on the content	
	PROJECT SCALE		Participants talked about the project scale, which includes both the project and the team.	
	TIME CONSTRAINS		Participants talked about time limitation.	

APPENDIX G. Comparison Table of S1, S3 Interaction in Phase 1, 2 & 3

Table 6

S1 Writer Group' Participants Interaction in Phase 1, 2 & 3

Group / Phase	Phase 1 Requirement elicitation	Phase 2 QSG drafting	Phase 3 Testing & feedbacks
S1 writer groups			
S1W4	The writer invited the user at the very beginning when he wanted to explain his goal to the user. Active interaction between the user and writer. Invite the user to stand next to him and look at the screen together. You can come here to view with me. My job is to give you a guide to start in a minute. Maybe we can put it on you. Question raised from the writer and answered by the user. No interaction with the expert.	The writer did not ask for any help from the expert nor the user. The writer focused on how to connect the Myo to the computer first. The writer continued creating the guide by himself. Starting to try the Myo on while continuing typing.	The writer first asks the user to read through the guide. In this process, the writer refined the guide when the user was reading and feedbacking. Then the writer asked the user to try the armband on following the guide, under his oral guidance. Very active between the writer and the user. The writer asked the user to come and read the guide he created. "Go step by step, issuing what the trouble is.", "Oh, sorry, I did something wrong here." The user started reading. Reading with feedbacks
S1W5	Writer asks questions to user, moderate active interaction between user and writer. Working mode: writer ask and user answer Interaction between writer and user. No interaction with user nor expert. User, expert seems bored. Active interaction between writer and expert: question, discussion. Working mode shift to writer + expert because the expert starts being a part of creating the guide content. Expert: Active. Do you need to explain to users about how it works?	Active interaction between writer and expert: discussion, moderate cooperation. Both are laughing to a mistake. No interaction with the user. Writer asked more help from the expert. Expert = user? It seems expert being the role of a "superuser", doing the usability pre-thinking. And the writer listened to all the feedbacks from the expert.	Finished the guide, asking user to read. User tries this armband under the guidance of the writer. User and writer interact together in testing the Myo while reading the guide. The user wore the Myo and started performing under the oral guidance of the writer. Feedback while using the guide to control the armband, with oral guidance from the writer.

			During the extra minutes, the armband does not work on the user. Also, the writer failed to offer a solution to this problem.
S1W2	Writer is taking control. Writer asks the preference and experience the user, asks the expert to explain the function. Writer asked user preference in a very nice way. Writer is very insightful, Expert explains the five gestures to the user without the official guide. User asks questions. User answers the questions from the writer, and sometimes ask for reconfirming. Finished questioning the user.10min Experts and user interact. Writer note down mistakes from her observation. The writer Decided to let the expert guide the user to try the armband. The user put the armband on, try the Myo from the start. The writer tests the user. Discussion between 3 participants starts. Around 15 minutes. During these 20 minutes, writer communicates successfully and efficiently with the expert and writer. They are more interacted than before. User trust in the expert, but writer sometimes raise questions to the expert and persuade the user to follow her way to use the Myo. The writer takes in charge to guide the user to control the slides. Can you make the zoom in? Give comments to user's reaction: good! You're an expert.	The writer takes the chargeback from the expert. The writer started to design the guide alone. User and experts are talking with each other. The writer keeps creating the guide on a .pptx file. During this time, user and expert are sitting on the sofa, away from the writer. When there's a question related to the guide, the writer asks the user to answer the specific question. User and expert seem bored Start recording the voice of the expert while operating the pc screen. Writer operates the screen, and clicking [content, structure]. The words of the operation are decided by the expert. An extra 43 minutes, the writer shoots video with the user and expert. Writer asks feedback from users, using experts expertise and explanation to the video. This period was more like Participatory design pattern seems occurred. it takes quite around 20 minutes. During the recording, writer gives instructions to user and expert what to do in the video recording. Later, three participants discuss the product. Expert gives his idea of the guide.	No independent feedback session due to time limitation.

Table 7

S3 Explicit Co-design Group' Participants Interaction in Phase 1 & 2

Group / Phase	Phase 1 Requirement elicitation	Phase 2 QSG drafting
S3 explicit co-design teams		
S3W7	Expert started to give a demonstration. TCer note down the procedure of the demo, and user listening, learning, and raising questions. The user tries the Myo and Discuss the type of guide, which should include the image or video. Discussion about the content: TCer refers to her notes to reconfirm her points with the user. Expert added on some details which are essential but have not been noticed by the other two. User keeps raising his requirement and preferences of the guide. Sum up what is going to be made (content, structure, type), to achieve an agreement with the other two	Drafting the structure and content of the guide on the whiteboard. (TCer wrote down with clear structure. Expert added on procedure, notes, and tech terms.) TCer discussed mainly with the expert, especially on the tech gesture and procedures. Start digitalised the content from the whiteboard on the PC. TCer kept user in mind. She asked user's opinion when she started to create the image and text. User gave nice feedback once he saw the expression (right during the typing process) was not clear. TCer accepted his feedback and gave an oral compliment. Expert adding on terms (like from "profile" to "….profile"). This is like user is doing the proof-reading while the guide is generated. Finished digitalize content (text) on the .docx: 12 min left Adding all pictures to the right position of the text. Free chat a bit: what are you learning
S3W1	Expert demonstrated the use of the Myo. He guided the user to go through the customized calibration function with the help of the official tutorial. The expert followed the first learning session with a try out by letting the user control the slides by herself. TCer was making notes and also learning more technical details of the device. User tried to control slides by herself, questioning the gesture. Expert added on gesture hints. After the first round of user try out, TCer and expert both asked the user if she still has questions. The TCer finished two rounds refinement of the user requirements. The term provided by the expert was not that professional. TCer controlled the user requirement session. She did a very well-organised user	Start drafting the content and adding pictures. While drafting the content, the TCer is the only one who types in the content, but the expert adding an explanation of basic gestures by speaking out aloud. User added an excellent suggestion about term choice: Whether to make consistency with the official guide. However, what turned out finally? Keep generating the content. Cooperation and discussion have been more natural. The interaction between writer and expert is more prominent. User also actively provide suggestions to expressions. Successfully avoid a mistake: Want to add the "wave right" Test whether the "wave right" has functional meaning during the presentation mode. Expert Disagree "there's no wave right" Suggests to test it.

	requirement collection: pair-reviewing the user requirements, ranking it, and refining it. The expert suggests adding the troubleshooting part, which accepted by the TCer.	User Put the Myo on and test.
S3W3	The team decided to let the user try and learn how to use Myo at the very beginning. Expert carried out a quick tutorial, and the TCer assisted the expert aside. The user played around the Myo, raising questions immediately (speak out). Brainstorming user requirement: writing down on the whiteboard in bullet points. Discussions were quite fierce during this period. The user is very active Explain all his requirements precisely (very detail: “maybe including a click on there…”) First thing， I think this is essential Start trying to use Myo again, and talk to expert and writer to note down his difficulties.	Discussion on the type of QSG. Decide the type and design tool of the QSG. Together generating the content of the QSG. TCer was the one who was typing into the slides. But she was not as active as the user and expert. User and expert speak out most of the content sentence by sentence. Expert refused to add on extra content because he thought that should not a start. Making a short video screenshot to explain how to do a calibration. [expert give a chance to user]Video is one shot, all laughed. System error 23’PowerPoint no responding Start rewrite the content [user] User typing down the content, sometimes actively put the sub-step in a smaller size. Expert refer to their notes on the whiteboard and speaking out to the user. TCer continuously adding on the content, like troubleshooting. Discussion between user and expert about the choice of words to express one gesture/function.

APPENDIX H. Role Convergence Table

Table 8

Role Convergence in the Design Process

Study Type	***Participant ID***	***Assigned role***	***Real role***	***Notes***
S1	E1	Expert	-	
	W5	Writer	-	
	U2	User	-	
S2	E1	Expert	C	
	W8	Technical Communicator	-	
	U7	User	C	Contributed the most
S3	E1	Expert	-	
	W7	Technical Communicator	-	
	U1	User	-	
S1	E2	Expert	C	From video shooting
	W2	Writer	-	
	U5	User	-	
S2	E2	Expert	C	
	W6	Technical Communicator	-	
	U9	User	C	Not involved with the device
S3	E2	Expert	C	
	W3	Technical Communicator	-	Not active
	U4	User	C	For drafting
S1	E3	Expert		Not involved during the whole process
	W4	Writer	-	
	U3	User	-	
S2	E3	Expert	C	
	W9	Technical Communicator	-	
	U8	User	-	
S3	E3	Expert	C	
	W1	Technical Communicator	-	
	U6	User	C	

Note. Role in the process, - = the role of a participant remained the same; C = the role converged into a role that unifies writer + X, X is the assigned role.