An exploration of involvement in the co-design of mammography machines: The power of the user's voice

Samantha Louise Bird

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

University of Salford

2016

Table of Contents

Table of Figures

List of Abbreviations

EBCD   Experience-Based Co-Design

MATCH   Multidisciplinary Assessment of Technology Centre of Healthcare

NHS   National Health Service (UK)

NHSBSP   National Health Service Breast Screening Programme

PD   Participatory Design

PPI   Patient and Public Involvement

UK   United Kingdom

Glossary

A reference point for terms used frequently throughout the thesis

Co-design	A design and development process where various stake-holders are guided and encouraged to develop solutions for products, services, and organisations. EBCD is a process of co-design which focuses on improving experience. Other terms used in the literature include co-design, participatory design and collaborative design.
Collaboration	A relationship between two or more individuals to achieve a common goal (Mattessich & Monsey, 1992), usually to produce something. Through collaboration, parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own perception of what is possible (Thomson & Perry, 2006).
Clinical Knowledge	Knowledge specific to clinical practice. This refers to the subject specific knowledge that health professionals gain from their education and experience of working in a particular health sciences profession.
Culture	A set of shared assumptions, values, and behaviours (Spencer-Oatey, 2012).
Design	The creation of a plan or convention for the construction of an object or system.
Emic Perspective	Perspective from inside a cultural group, focusing on understanding the meanings and beliefs of people inside a particular culture (Merriam, 1998)
End-User	A person who is the beneficiary of the use of a medical device, (i.e. the device used to diagnose or treat them). They may or may not also operate the machine.
Epistemology	The nature of the relationship between the knower and the knowable (Guba & Lincoln, 1994).
Etic Perspective	Perspective from outside the cultural group under investigation, usually from that of the researcher.
Experiential Knowledge	Knowledge gained through personally experiencing

	something.
Group	Two or more people brought together to achieve something. And in this case the unit of analysis.
Involvement	The term involvement, as used in this thesis, refers to design *by* the user, as opposed to design *for* the user. The definition is developed from the Patient and Public Involvement initiative INVOLVE (INVOLVE, 2012).
Mammographic Practitioner	A radiographer who has gained a post graduate qualification in breast imaging. In some cases shortened to practitioner.
Mammography Machine	The apparatus used to compress and x-ray a breast.
Mammography Screening Clients	Women aged 47 and above who are invited for breast cancer screening and have had a mammogram taken.
Medical Device	An instrument, apparatus, implement, machine, appliance, implant, or other similar article to be used for diagnosis, prevention, monitoring, treatment, or alleviation of a disease (ISO 13485:2003, definition 3.7). Here a mammography machine is considered as a medical device.
Narrative	An account of event occurring over time (Bruner, 1991)
Participation	Refers to methods that aim to gather user requirements or user feedback, this user research is then integrated into the design process. Designers develop solutions with this user research in mind. Therefore, participation refers to design *for* the user rather than *with* or *by* the user (Sanders & Stappers, 2008)
Power	A force that operates in between contexts and relationships. Power can be used and distributed between people and groups to influence, empower, and control.
Professional-User	A person who is specifically trained to use a piece of equipment as part of their occupation.
Subtle-Realism	An ontological viewpoint that all research involves subjective perceptions and observations and different methods will produce different pictures of the participants being studied (Duncan & Nicol, 2004). A reality exists but we can only come to know people's perspectives of it

	(interpreted by the researcher) (Hammersley, 1992).
The women	The group of ladies who were involved in the co-design process.
Users	Any person who uses or operates something, or has something used or operated on themselves. i.e. mammographic screening clients use the mammography machine service and mammographic practitioners use the mammography machine.

The women

This table can be used as a reference to the group. The names are anonymised through the use of pseudonyms. The pseudonyms used in this thesis and the women's user types are displayed below. It's also important to note that my name has been left as Sam in the transcripts.

Eve	Practitioner
Beth	Practitioner
Kate	Practitioner
Tina	Practitioner (Dropped out after first meeting due to other time commitments)
Ava	Practitioner (Dropped out after first meeting due to other time commitments)
Liz	Client
Jill	Client
Joy	Client
Anne	Client
Sam	Me – the researcher and design facilitator

Acknowledgements

Firstly, I would like to sincerely thank all of the women who participated in this study as members of the co-design team. Without all of you this would not have been possible. You have taught me a lot and I am truly grateful for your time and commitment.

For their time and support, I want to thank both my supervisors, Dr. Leslie Robinson and Professor Peter Hogg. Particularly, Leslie, who has supported, encouraged, and continually inspired me to get here. And thank you also Peter. You initially pushed me into applying for this PhD and have supported me throughout this candidature. No matter how I was feeling, there wasn't a meeting we had that didn't make me excited about the next steps.

Most importantly, I want to thank my nearest and dearest, who have been exceptionally patient and understanding. I am grateful for the support from every single friend who has listened, or pretended to listen, over the course of the past three years. Especially Jen, thank you for keeping me in touch with the outside world! To my grandparents, whom I am honoured to have made so proud, thank you for your ears when I needed to talk. I could not have written this without my parents. Mum and dad your unwavering confidence in everything I do is very much appreciated.

Finally, thank you, Sean. Thank you for being there in the first year, through the crying, the second year, through the confusion, and the third year, to motivate me. I love you.

Abstract

Aim

This study aimed to explore and analyse the co-design of medical equipment in order to make recommendations, by gaining an understanding of the involvement and aspects of the group that influence involvement in the process of co-design.

Method

This qualitative study followed one group made up of mammography machine users, mammographic practitioners and mammography clients through a process of co-design. Data was collected through individual interviews with group members and video footage of co-design meetings. An iterative exploratory approach was implemented using Framework Analysis (FA) as a tool to manage data and structure the argument presented in this thesis.

Findings

The knowledge each user held was found to influence their involvement in the design process. Experiential knowledge of both the practitioner and client was considered valuable and important in understanding the current problem. However, clinical knowledge, held primarily by the mammographic practitioner, was used to make decisions and evaluate ideas. The findings highlight the power of clinical knowledge in idea evaluation and decision-making. The thesis found that practitioners and clients need to re-negotiate their roles during co-design in order for both to actively participate in the development and selection of ideas and solutions. The time spent together had an impact on the user co-design group's dynamics as they moved through stages of development. This study has added to the existing theories on co-design between health professionals and clients, identifying power issues between client and practitioner sub-groups as well as instances in which they are likely to occur throughout the design process. This study has also added a unique contribution of studying co-design in the context of medical equipment design, as the majority of literature lies in the redesign of services.

Recommendations

Recommendations in the form of group member and support, along with suggestions for facilitators to consider, are specified for future design practitioners, when implementing the co-design of medical equipment.

Chapter 1: Background and Introduction

"*As far as healthcare is concerned one rich, and as yet largely untapped, corpus of knowledge and ideas is the wider field of design sciences and the design professions*" (Bate & Robert, 2006, p. 4)

This thesis explores a method developed through the design sciences in the area of medical imaging equipment development. The people who use medical equipment are not often involved in all stages of device design and development. Experience-Based Co-Design (EBCD) is a design method that involves collaboration between different users, in particular practitioners and clients of health care services. As a service redesign method, EBCD follows a number of stages through which users are engaged and encouraged to become designers (Sanders & Stappers, 2008).

The problem that this thesis addresses is how does EBCD work when applied to medical equipment? Current methods of involving the user in medical equipment design rarely consider the value of experiential knowledge. It has been highlighted as being difficult to integrate different users' perspectives into the redevelopment process. Co-design involves users with diverse perspectives and beliefs, therefore there may be some challenges and benefits to it, particularly as the co-design process occurs between health practitioners and health clients who can have predetermined views of one another before the process.

In response to the problem identified, this thesis has implemented and evaluated an EBCD process. The process was applied to the redevelopment of a more woman-friendly mammography machine. The study explored group member communication and involvement in EBCD when applied to medical equipment. With this in mind, the goal was to develop study outcomes in the form of recommendations for future co-design practice when applied to imaging, and medical equipment.

The Thesis Structure

This thesis contains eight chapters. Figure 1, highlights the overall thesis structure. Each of the chapters is described in brief before beginning the introduction, to aid the reader through the concepts and arguments underpinning the study.

This chapter, the introduction, brings to light the conceptual background of EBCD and defines terms relevant to the problem area. Experience, collaboration, and design are defined in chapter 1, before the scene is set for the specific field under study.

Literature Review and Theoretical Perspectives

The stages of designing
Socio-cultural theory and design
Collaboration
Experience-Based Design literature base

Methods and Analysis

Methodology – Subtle Realism
Data Analysis – Framework Analysis
Interviews – Thematic Analysis
Observations – Interactional Analysis

Initial Findings

Exploration of Involvement and Roles in EBCD

Basis for the key themes

Findings

Theme 1: Knowledge
Theme 2: Power and Empowerment
Theme 3: Time and Group Development

Theories

Knowledge creation and use
Theories on Power and Empowerment
Group Development

Discussion

Group members experience of co-design
Factors found to influence involvement in medical equipment co-design
Recommendations for future practice

Conclusion

Key Findings and their implications
Statement of originality
Limitations and Future Research

Figure 1 - The thesis structure outline

The literature review chapter examines the theoretical perspectives on collaborative design before critically analysing the existing literature surrounding client and practitioner collaboration in design. Glăveanu's (2011a) reconceptualised social-cultural theory (Vygotsky, 1980) and applied it to collaborative creativity. Social-cultural theory is regarded as a useful theoretical perspective for understanding how users are creative together. This theory highlights the kinds of research questions we should be aiming to answer and appropriate methods for studying group creative processes. As the EBCD process has been tailored specifically for use in the development of health services over the past 10 years (Donetto, Pierri, Tsianakas, & Robert, 2015), the literature on service redesign is analysed to gain an understanding of how the process currently works and how this might translate to the redesign of medical equipment. The current knowledge base on the benefits and challenges of EBCD in service redesign are reviewed and later examined in the discussion chapter if the process differs when applied to medical equipment.

Separated into two sections, the methodology chapter considers the design and research methods used in this study individually. The first section outlines the design method implemented and the methodological choices associated with the design method. It is important to highlight that the data collected with the design method **do not form the research data for this thesis**. The second section of the methodology chapter follows a traditional outline (Silverman, 2013). Philosophical considerations are stated first. Subtle-realism was the ontological basis for the qualitative methodology and drove the data collection and analytical choices. The two data collection methods used, interviews and video-recorded observations, are discussed and the justification for both is presented. Fitting with subtle-realism as the ontology of the study, Framework Analysis (FA) (Ritchie, Lewis, Nicholls, & Ormston, 2013), as the method of data an

alysis and organisation to structure the argument presented in the thesis, is also explained and discussed.

To show the development of the argument over the course of the study, the findings are presented over two chapters. The first chapter, labelled as initial findings, presents empirical data. The interactions identified as important to involvement in medical equipment EBCD, as described by the women and highlighted throughout observation, are

presented in the initial findings chapter. By developing an understanding of how the women perceived their role and the interactions that took place in the group, the three main themes were formulated. The second findings chapter brings together the empirical data associated with each of the key themes and the relevant theoretical perspectives from the literature. Each of the themes (knowledge, power, and time) was not pre-empted prior to data analysis, as the study was exploratory and qualitative in nature. Therefore, at this stage of the research process the literature was returned to in order to explain the findings and themes of the study presented here (as highlighted in figure 1). Each theme is grounded in existing understanding before the empirical data is presented.

The discussion chapter addresses each of the research questions in turn. The first section tackles the broad research question: what are women's experiences of co-design? Presented in the discussion chapter is a summary of involvement in the co-design group and discussion surrounding the current literature. The factors that were found to influence involvement in a co-design group are the focus of the second section. Knowledge, power, and time are discussed in relation to the existing body of literature in EBCD and service redesign. Finally, recommendations that aim to reduce the challenges identified through this study are suggested, for future medical equipment co-design processes.

To conclude, the key messages to be taken from this study are presented. The novelty of the findings is also discussed, highlighting how this study builds on the existing understanding and opens new questions for future EBCD practitioners aiming to redesign and develop medical equipment. Finally, the limitations of the current study and areas for future research are proposed.

Background

EBCD as a process and how it works when applied to the design and development of medical imaging equipment is the focus of this thesis. Nevertheless, the mammography machine is an important contextual component. Prior to focusing on the process of co-design, a review of the current literature on mammography machines and the associated discomfort and issues encountered by its users was undertaken. A brief outline of the current literature in this field will provide some understanding of mammography, the machine, and the need for redesign that may be important for the interpretation of the findings presented.

The vehicle for co-design: Mammography

Mammography is acknowledged as the gold standard method of detecting breast cancer for the majority of the population (Peart, 2005). Mammographic practitioners performing mammography hold a College of Radiographers' approved Postgraduate Award in Mammography Practice (Cavanagh, 2013). In the UK, mammographic practitioners must be female, due to the sensitive nature of the examination.

During the examination both the practitioner and the client interact with the machine. The client is required to undress from the waist up before being brought into a room containing the mammography machine. The practitioner positions the client in close contact with the machine. The breast is lifted and pulled onto the machine's image receptor by the mammographic practitioner to ensure it is in the correct position for imaging. Compression force is applied to the breast with a compression paddle. The breast is then compressed between the paddle and the image receptor. The mammographic practitioner acquires two images of each breast. Two-view mammography is required in each attendance. The breast is imaged first in the Cranio-caudal (CC) position and secondly in the Medio-Lateral Oblique Position (MLO) (Cavanagh, 2013; NHSBSP, 2006).

Figure 2 - Image of the mammography examination

Image from (NHSBSP, 2013)

The literature surrounding the client's pain and discomfort associated with mammography is extensive. Factors which influence pain and discomfort have been found to include compression force applied to the breast (Myklebust, Seierstad, Stranden, & Lerdal, 2009), communication and the demeanour of the practitioner (Goethem et al., 2003), anxiety (Hafslund, 2000) and the mammography machine itself (Doyle & Stanton, 2002; Poulos & Llewellyn, 2005; Robinson, Hogg, & Newton-Hughes, 2013). A negative experience of mammography may deter women from returning for a subsequent screening (Whelehan, Evans, Wells, & MacGillivray, 2013), which could result in missed cancers. Therefore, it is vital that interventions are put in place to reduce the discomfort and pain felt by the client.

Using mammography machines also causes the mammographic practitioners discomfort. The Society and College of Radiographers and the NHSBSP have both published on the injuries associated with operating mammography machines (Gale, Hunter, Lawton, & Purdy, 2007). Repetitive strain injuries and work-related musculoskeletal disorders are associated with the use of mammography machines, as positioning the breast on the mammography machine results in the awkward positions where there is a high risk of injury (Gale et al., 2007).

 A large variety of mammography machine alterations have been studied as methods to improve the woman's experience of mammography equipment (Chida et al., 2009; Mercer, Hogg, Szczepura, & Denton, 2013; Poulos, McLean, Rickard, & Heard, 2003). The literature on mammography machines appears to take a deterministic view of technology. Quantitative methods are used to test hypotheses. The deterministic paradigm of

technology whereby a machine or piece of equipment causes an effect on the patient, such as more compression force equalling more pain, has been challenged (Murphy, 2006). Murphy (2006) argues that it is too simplistic to view technology as impacting on the patient and, in fact, imaging technology can only be understood through the perspectives of the people who use it, both clients and practitioners. Quantitative enquiry is generally deductive in nature and aims to test a theory or hypothesis i.e. to reduce experience to well-defined variables in advance for investigation. Perhaps, then, in order to understand the relationship between the woman and the machine a qualitative approach is more appropriate. As qualitative research aims to develop rather than test theories, would it not be more appropriate to explore aspects of the machine that make the procedure uncomfortable from the perspective of the woman rather than to test a range of hypotheses and theories surrounding pain associated with mammography? One qualitative design method that encourages a focus on experience is EBCD.

The EBCD Process

EBCD is a group design and development process usually initiated in response to services and products that are not currently meeting user needs. In co-design, users attempt to become the designers.

Developed within and for the NHS, the EBCD process allows staff and patients to collaboratively discuss and design improvements. With a number of reported benefits to using the EBCD process, it has been used in emergency service (Iedema et al., 2010), cancer care e.g. (Bak et al., 2014), other redesign projects and in some cases medical device design (Ram, Grocott, & Weir, 2008).

The EBCD process is divided into six stages. These are shown in Figure 3 and include: 1) setting up the project; 2) gathering staff experiences; 3) gathering patient and carer experiences; 4) bringing staff and patients together to share their experiences and identify priorities for change; 5) co-design work in small groups formed around priorities identified.

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Setting Up	Engaging staff and gathering experience	Engaging patients and gathering experience	Co-design meeting	Small co-design team meetings	Celebration event
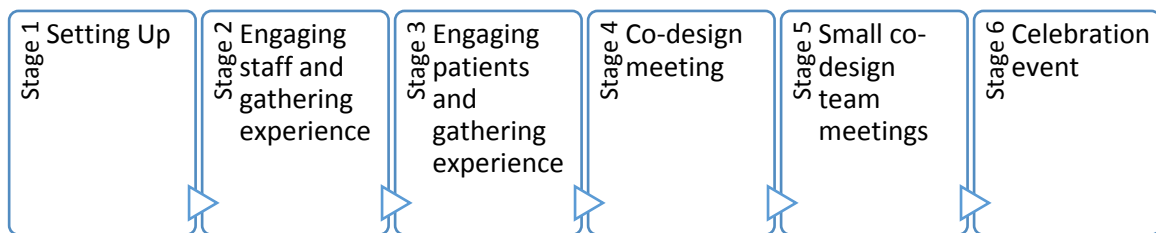
Figure 3 - The EBCD process

There are many modified versions of the EBCD process that have been altered to fit budgets, time constraints, and flexibility of the users involved (for example, if the users involved have mental health problems, or a serious illness, then the model has been altered to accommodate for this (Iedema et al., 2010; Larkin, Boden, & Newton, 2015)). With the large variety of co-design methods, it is important that co-design researchers identify their own study specific definition. The next part of the introduction chapter defines each of the key concepts associated with EBCD. Appendix 1 provides a detailed summary of the experience based co-design stages used in this thesis.

Defining Terms and setting the scene

To define the concepts and terms that are important to the study the term EBCD is broken down and each key component is explained. Firstly, ***Experience-Based*** as a concept is defined, drawing attention to differences in this method over other medical equipment design. The second aspect of the design method, the ***'Co-'***, is then defined as collaboration between various stakeholders, specifically health practitioners and health clients. Finally, a brief definition of ***Design*** provides some context, before discussing in depth the theoretical perspectives on design in the literature review chapter.

Experience-Based

Co-design is not new. Increasingly over the past three decades users have been given more influence in the design and development process (Sanders & Stappers, 2008). Developed as a form of Participatory Design (PD) (Bjerknes & Bratteteig, 1995), EBCD focuses on improving people's experiences rather than just improving a product or service. This requires the user to be at the centre of the project, involved throughout the whole process of design, from idea generation to testing, and trials.

Within the design sciences, there is a range of different methods used to capture the users' needs and thoughts. Data collected broadly fits into two domains, the quantitative and the qualitative methods, and includes focus groups, surveys, interviews, usability testing, and others (Shah & Robinson, 2006; Shah, Robinson, & AlShawi, 2009). The validity of quantitative methods has, however, been questioned, as the use of surveys to gather previous experiences and preferences for change may not give a full understanding (Davies & Cleary, 2005) and are limited in giving an understanding of the 'how' and 'what' questions designers need to answer (Silverman, 2010).

How EBCD differs is that the focus is not to only gain people's perspectives on a current service or product but to try to gain an understanding of the experience of using something. That is, how it feels. Experience guides our behaviour, attitudes, feelings, opinions, actions and reactions, therefore, is an important component to understand when redeveloping or designing something. As a result, design practitioners and academics should be focusing on understanding and then improving experience (Bate & Robert, 2006).

In spite of this, sharing and understanding experience is not something that comes instinctively, as people do not naturally focus on experience, and it generally remains implicit (Bate & Robert, 2006). The theoretical basis of phenomenology, the study of the essence of experience (Merleau-Ponty & Smith, 1996), was used to develop the EBCD method. Narratives provide a method of accessing the user's experience to identify moments of engagement between people and a phenomenon, in this case the practitioner, the client and the machine. These moments are labelled as touchpoints. Once the current machine touchpoints have been identified, new ones are created that are imagined as more positive.

"Co-"

Another important aspect of EBCD is that it is collaborative (Bate & Robert, 2006; Fund, 2016; Locock et al., 2014). As co-design is collaborative, it is important that both the practitioner and client are actively involved in the design process. Originally called Experience-Based Design, the 'Co' was added to EBCD to emphasize the collaborative meetings which needed to occur at the centre of the process, as academics and practitioners using the methods were not involving both staff and patients simultaneously.

The co-design workshops are vital in the process as here the users have to readdress and renegotiate their roles and expectationst is here that the two user groups must make decisions which benefit both groups. The original book (Bate & Robert, 2006) detailing the co-design meetings is relatively short, and a recent reflection on where EBCD is now (Robert et al., 2015) highlighted that the co-design meetings are still something which people struggle with and in reality it is these areas in which the users genuinely collaborate. This thesis aims to explore and analyse the group within the co-design meetings where users interact with each other and design tasks to produce design solutions.

The word *design* is commonly used as either a verb or a noun (Miller, 2005). The dictionary describes design as 1) the plan or drawing to show the look and function of an object before it is made and 2) to decide upon the look and functioning of an object (Merriam-Webster, accessed Aug, 2016). In this way, design is a process through which we make decisions to develop a plan of how an object will both look and function.

In this thesis, design refers to the process or method used to develop a solution or the design outcome. Throughout, design is differentiated between being the design process and the design outcome, where the design outcome refers to the physical sketch and notes developed by the group. How we come to make the decisions surrounding what an object looks like and how it functions, has been explored at length within the design sciences literature. However, EBCD follows a staged sequential process of design; therefore this will be used to explain how people design. Although they vary in the literature the stages usually follow the pattern of: research, ideas, models, and evaluation. The list below is an outline of the stages of involving the user in the design process according to theories based on user-centred design (ISO 13407; Sanders and Stappers, 2008). Design and its theoretical underpinning will be discussed further in the literature review chapter.

- o Step 1: Understand and specify the context of use
- o Step 2: Specify the user and organisational requirements
- o Step 3: Produce design solutions
- o Step 4: Evaluate designs against requirements.

Groups with diverse perspectives

Fundamental to co-design is the collaboration between various stakeholders who will have different knowledge, skills, backgrounds, and aims for the redesign. Traditionally, design was an individual activity where one person was responsible for all the decisions taken. However, in the last few decades, design has changed and converted into an activity that is mainly carried out by teams (Casakin & Badke-Schaub, 2013). It is not just up to one person. The designer cannot solely rely on themselves to make decisions but instead has to plan, proof and negotiate with other stakeholders. Therefore, team interaction is of large importance in designing (Casakin & Badke-Schaub, 2013).

The relationship between the client and practitioner: can they be partners?

This is a study of involvement and communication in a group who are diverse. The group may be described as culturally diverse. However, as culture could be interpreted in a number of ways it is important to explain what cultural means in the context of this thesis.

Culture can be defined as a set of implicit and explicit assumptions, values, and behaviours (S. Dahl, 2004) that are shared by a group of people and influence (but do not determine) each member's behaviour as well as their interpretation of the meaning of other people's behaviours (Spencer-Oatey, 2012). It is important here to expand on the definition of culture to include organisational cultures, as there will be one operating within the mammography context. Culture is often thought of as national or ethnic related, and influenced by our religion, language, upbringing, and other factors. However, organisational culture is specific to an organisation or profession. Culture can be understood as a common way of making sense of an organisation that allows similar people to see situations and events in a similar way (Davies, Nutley, & Mannion, 2000; Scott, Mannion, Marshall, & Davies, 2003). The NHS literature of Davies et al. (2000) presents the values and vision, behaviours, goals, and characteristics which are fundamental to their 'healthy culture' (Fund, 2016). Davies et al. (2000) present organisational culture on different levels to provide a helpful understanding of culture in healthcare. At the first level are the underlying assumptions that represent the unconscious, the taken for granted beliefs that structure the thinking and behaviour of an individual. They argue that these then give rise to the more visible values, standards and goals to which individuals attribute intrinsic worth. Finally, at the most visible level of

organisational culture is the artefacts that represent the culture, such as the uniforms, ceremonies, and traditions.

With NHS England expressing in their annual report that patients and staff need to be united in their values to improving care (England, 2013), it is no surprise that methods have evolved which emphasise the collaboration of both towards shared goals of improvement (Bate & Robert, 2006). Since the Francis Report and the failings identified surrounding the culture (behaviours, attitudes, and norms) which was operating within Mid-Staffordshire hospital and nationwide came to light, the NHS has been working to improve its organisational culture (Hunt, 2015; QIT(13660), 2015) with a motivation to being more open and transparent with clients. In turn, a change in culture has been reinforced by a number of government initiatives such as the Power of Information policy, PPI in research and organisational change, and service-user involvement in the development of services. This is important because any involvement of patients, clients, and service-users in methods different from the existing organisational culture may pose problems. People within the NHS organisational culture are required to alter their behaviours, assumptions, and values to see new ways of thinking and behaving wherein the clients' and practitioners' roles are different.

For any co-design group, diversity is encouraged. It is thought that as individuals differ in their interpretations and perspectives, diverse groups can result in novel creative breakthroughs (Page, 2008) which may not have been the case if the group was not diverse in nature (Paulus, 2000). As well as resulting in creative outputs, the diverse knowledge, skills and expertise can increase productivity (Baron & Kerr, 2003). The collaborative nature of EBCD encourages different people who are stakeholders in the design process to come together and in this way the group is diverse. The practitioners and clients have different perspectives and experience, therefore bring with them different knowledge bases which need to be shared to co-construct a joint collaborative solution. The EBCD group is comprised of the mammography screening client who will bring with them knowledge and expertise on what it means to have a mammogram taken. The practitioner on the other hand brings a different perspective on the machine and the way in which it is designed.

Diversity, in terms of different perspectives and experiences, within co-design groups is encouraged in EBCD, however diversity may have negative effects on the groups. The literature on groups highlights two types of claims relating to diversity. These can generally be separated into the positive and negative consequences on the group; the information/ decision making (diversity as variety), and social categorisation (diversity as separation) (Van Knippenberg, De Dreu, & Homan, 2004).

The diversity as variety perspective appears to represent the current view on why co-design works. Through discussion with people who have diverse perspectives, more elaboration and exchange of information takes place (van Knippenberg, De Dreu, & Homan, 2004). Thus, diverse viewpoints and perspectives about the task leads to the creation of knowledge through social interaction as new insights emerge through conceptual restructuring within groups (Jehn, Northcraft, & Neale, 1999). Other views on diversity relate to separation and intergroup bias. Intergroup bias can lead to less identification with each other and each other's perspectives. Conflict can exist within the group and therefore performance can decrease. Social categorisation processes manifest in intergroup bias and negative attitudes toward dissimilar others in the group. Social categorisation processes, include stereotyping and prototyping of certain groups (Hogg, 2001). Therefore, if the group comprised of these two different 'cultures' of the client and the practitioner fell into stereotyping behaviour, there becomes some depersonalisation of the individual group members. This could lead to negative outcomes, which could influence the co-design process and have an impact on the group members' experience of co-design. It seems that a focus of the exploration of the group should be: To what end does this diversity impact the process and the women's satisfaction with working in the group?

Summary and the study

EBCD is one of the only methods which encourages patients and staff to collaborate in small groups towards service and product redesign. The process consists of a number of steps aimed at understanding the current experience, giving patients and staff an environment to share their experiences and providing them with the tools and space to put forward their own design ideas. Although the benefits and barriers of EBCD have been explored through a number of case studies (Farr 2012; Grocott et al., 2013; Locock et al., 2014), it remains unclear as to how these groups work in the context of medical device redesign. In addition, there is a lack of good practice guidance for developers who wish to use this technique on medical devices.

In response to these initial questions developed through summarising the terms, background and context, this study will explore a co-design group, whose members are diverse, in the process of medical imaging equipment design. The co-design process, EBCD, was implemented on a piece of medical equipment, the mammography machine. This study follows the group through their experience of taking part in the co-design process. An in depth qualitative exploratory approach was used to shed light on how, if at all, EBCD works when applied to medical equipment. What we currently know about co-design is explored further through a critical literature review in the next chapter.

Chapter 2: The Literature Review

Co-design is a process wherein various participants in the design and development of an artefact are engaged and empowered to create solutions for themselves. The process consists of a number of stages which follow the traditional design process of idea generation, exploration, comparison, and selection. Central to the process is the collaboration between different users, where a number of people who hold different knowledge, skills, and experiences, come together to achieve their goals of making something more suitable for them.

The literature review therefore aims to address two areas. Firstly, what it means to collaboratively design and secondly to examine what we know about healthcare practitioners and clients collaborating in the design process. The literature review is separated into two sections before being collectively summarised to present the study's aims.

Search Strategy

The literature review on co-design includes studies undertaken within the medical, design, and social sciences disciplines. It was considered necessary to gather a broad range of perspectives on co-design, to gain an understanding of this relatively new and developing social process, where different stake-holders in health collaboratively design together.

The design and social sciences literature is critiqued first, to provide an understanding of the theories which provide a framework for understanding co-design as a development process. The medical and health related literature on co-design is predominately based within service redesign, these studies are included and critiqued to identify the evidence based on how practitioners and clients collaborate together and to identify an appropriate methodology for studying co-design when applied to the design and development of medical equipment.

The literature review was based on searches of relevant electronic databases such as Web of Science, Scopus, and Medline. The search began in 2013 and was revisited in 2016 (following the analysis of data, and the emergence of key concepts). In addition to databases, hand searching and citation tracking were used to identify appropriate articles and grey literature. The search focused primarily on locating literature that highlighted

collaboration between health professionals and clients, in a problem-solving or design situation. In total, 35 peer reviewed articles alongside some grey-literature suited to the inclusion criteria of health practitioner and client face-to-face collaboration in design situations are critiqued in the literature review.

Following the first pass of analysis, the literature was returned to in order to develop an understanding of key themes that had arisen. This literature is presented after discussing the first pass analysis findings, as an inductive approach to constructing the argument, wherein the analysis was done to highlight themes. The literature and key theories were then used to develop an understanding and further explanations of the themes (Gale, Heath, Cameron, Rashid & Redwood, 2013).

Theoretical perspectives on collaboration in design

The studies on co-design are presented in this section to highlight the different methods used to understand and evaluate co-design involving practitioners (healthcare staff) and clients (end-users). This literature will also be reviewed to highlight what we currently know about co-design and how these findings may influence the process when applied to medical equipment design.

Originally, Bate & Robert (2006) emphasised the understanding of experience for the success and development of EBCD. In response to a call for services and products which are viewed as patient and public friendly, co-design was based on gaining a phenomenological view of experience before applying design approaches to improve the experience. The expectation was that the experiential knowledge of the clients and staff would lead to higher service quality, more efficient services and cost reductions (Bovaird & Loeffler, 2013; Brudney & England, 1983).

Within the early literature, researchers aimed to show that co-design was a method which could deliver service outcomes that were sustainable and appropriate for clients and practitioners, with the influence of working in the group and the interpersonal skills developed as secondary benefits. This may have been why a number of studies only involved clients and staff in the first stages of co-design, during the gathering experiences, before leaving the design and development to service-designers, researchers and design professionals. As stated in the introduction, the creators of EBCD added the 'co' to the previously named experience based design to ensure that people who were going to use the method also focused on the partnership between the clients and practitioners in the later stages, which they named the co-design workshops. Over the past decade, as EBCD has been implemented in more settings and researchers have recognised the importance of evaluation of the process, the successes of EBCD appeared to lie in the collaboration between the clients and practitioners. With Vennik, van de Bovenkamp, Putters, and Grit (2015) even going as far to say

> *It is not so much what patients say that is important; it is the process and the way they are given their opportunity to have their say. Pg. 162*

However, it may be important to note that (Vennik et al., 2015) only interviewed the design practitioners and it may have been perceived differently by the patients. Nevertheless, the reported benefits of the co-design group's interactions, outside of simply creating an outcome, continue to be highlighted in research (discussed in this chapter in the section on co-design groups in health).

To understand what is required of the co-design group, the next section turns to the literature from the design sciences that specifies the cognitive functions associated with thinking like a designer, before suggesting a theory of design to understand the effectiveness of co-design.

The process of design is often described as a number of stages. Within the literature these stages can generally be seen to follow a similar pattern, although slight differences in their descriptions are evident. MATCH (the Multidisciplinary Assessment of Technology Centre for Healthcare), whose aim is to provide methods of user engagement for industry members, use the literature on product lifecycle to describe the process of design (Figure 4).

Stage	Details
Concept	Starts with idea generation and includes technical, financial, and commercial assessment
Design	Involves product development process from (re)design to prototype development
Testing and Trials	Starts with prototype testing in house and includes trails in the real field
Production	Includes production on large scale support by business and commercial rationale
Development	Includes product marketing, launch and use in the real field

(Shah et al., 2009)

Figure 4 - Product Lifecycle

The details of these stages do not provide a large amount of information on the process, in terms of what the people involved in the process actually do, rather they provide details of

the outcomes which are produced in each stage. Other models have focused on the cognitive aspects of the design process, such as Bevan, Robert, Bate, Maher, and Wells' (2007) model.

In a collaboration between the design sciences and the NHS, (Bevan et al., 2007) provide a more detailed model of the design process, upon which EBCD is based. This model follows the same pattern of research, ideas, models, testing, and evaluation. However, Bevan et al. (2007) describe the process of 'thinking like a designer' (Figure 5)

> 1. Reflections, analysis, diagnosis, and description: looking back, knowledge harvesting – establishing and codifying what we know

> 2. Imagination and visualisation: looking forward, hypothesis formulation, imagining what may be possible

> 3. Modelling, planning, and prototyping: knowledge exploitation – through prototyping and testing coming up with something that might work

> 4. Action and implementation: building and testing

Figure 5 - Thinking like a Designer

 (Bevan et al., 2007)

The sequence models of design provide us with a detailed description of the process (research, ideas, models, testing, and evaluation); this model highlights the cognitive aspects of design, which contribute towards developing a designed artefact, from problem identification to building and testing. The issue with these models is that they focus on what the individual designer does, which defeats the point of co-design, to bring together different perspectives. These different people involved in co-design have various narratives when they look back and reflect on their previous experiences that can lead to a different idea of what the problem is, and this is even before the creative activities of design begin (Bate & Robert, 2006). As designing alone is now considered rare, and design teams have become more multidisciplinary, design has been labelled a social process which has seen many design researchers focus on social interaction as well as cognitive functions associated with the design process during their analysis of the design process (Détienne, Baker, & Burkhardt, 2012a).

Design teams are becoming increasingly multidisciplinary and in co-design, and even include the users who are recruited to provide knowledge of their experience. These various stakeholders in the design process hold specialised knowledge and through interacting are required to complete the design tasks in order to produce a joint collaborative solution.

Collaborative design activities can be viewed as a socio-cognitive activity (Barcellini, Prost, & Cerf, 2015; Détienne, 2006), which is analysed through verbal interactions between participants in meetings (Darses, Detienne, Falzon, & Visser, 2001).

Socio-cognitive approaches to studying collaboration in design meetings generally code interactions between group members, under a pre-defined coding system. This quantitative method is used to analyse the design group in a controlled setting. The purpose of these studies is to understand the mechanisms and to optimise the outcomes of the group. They have highlighted a number of distinctive aspects of collaboration that contribute to successful design. These include certain communication processes, task-related processes, and cooperative orientation and motivation (Burkhardt, Détienne, Hébert, Perron, & Leclercq, 2009).

Communication processes such as grounding are thought to be essential to 'good design' (Olson, Olson, Carter, & Storrosten, 1992). Grounding, involves establishing a common frame of knowledge; where the members of a design team jointly establish what they mutually understand (Détienne, Baker, & Burkhardt, 2012b). The EBCD process is designed to ensure that grounding of experiential knowledge takes place, with the first co-design workshop requiring clients and practitioners to discuss their narratives together as a group. What is not currently specified is how other knowledge types are integrated into the design process, such as clinical knowledge. Empirical studies have highlighted that when grounding is bypassed (i.e. clarification of individuals level of knowledge is not explored) then the design team may not produce effective results (Stempfle & Badke-Schaub, 2002). Socio-cognitive researchers believe that this is why heterogeneous design groups have been shown to produce more successful design outcomes (Détienne et al., 2012b; Stempfle & Badke-Schaub, 2002), as they have to spend more time communicating in order to establish a common ground.

Task related processes concern the development of the design problem and solution (Détienne et al., 2012b). Détienne et al. (2012b) define task related processes as design activities and evaluation activities. These interactions are characterised by argumentation and negotiation between members of the design group. This approach reveals not only the cognitive functions of designers, but also how interactions between group members contribute to design outcomes. Researchers have shown that the negotiation of various perspectives involved in collaborative design process contributes to building design solutions (their generation, exploration, comparison, and selection). Generation, exploration, comparison and selection are considered the key cognitive approaches in problem-solving (Stempfle & Badke-Schaub, 2002). Argumentation and negotiation between members of a design team is seen as 'constructive conflict' (Baker, 1999) as it allows further elaboration of ideas and reanalysis of the solution-idea which can lead to the evolution of new and important insights (Détienne et al., 2012b).

Within the ergonomics literature socio-cognitive theories are applied to understand and study collaboration in design. Applying the theory to any creative process holds that the established outputs are developed from the minds of individuals (Perry-Smith, 2006) with external influence from variables observed in social interactions. Therefore, keeping with the positivist view, creativity can be coded and measured according to the cognitive and social variables that are observed in interaction. For example, Paulus (2000) highlights that the way the group interact could result in both high and low creativity, through social stimulation/inhibition and cognitive stimulation/interference. High creativity is associated with the social stimulation of competition and accountability and upward comparison and goals, and cognitive stimulation including factors such as conflicts, divergent style and incubation. Social inhibition includes factors such as social anxiety, social loafing and cognitive interference present production blocking and task-irrelevant behaviours as variables which may result in low creativity in groups. As shown by the model above, the method taken when trying to understand group creativity and design process from a socio-cognitive perspective means studying the group as an input (the group members) – process (cognitive and social) – Outputs (The final design idea(s)) (Glăveanu, 2011b).

The socio-cognitive theories of design tend to be based on groups which are given a problem and asked to solve it. Their aim is to understand how the individual goes about solving that problem with the help of other people. The models represent an 'input – process – output' view of design. Hence, the importance of coding the process (cognitive activities such as evaluation of ideas, and analysing the division of cognitive labour in the groups (Olson et al., 1992)) in order to examine how the process differs when the inputs change and how this might influence the output.

Some of the important aspects of interactions in design teams have been highlighted above. It is evident from the literature that socio-cognitive researchers emphasise the importance of interactions in developing a design solution that has been carefully considered and analysed.

Another theoretical perspective of design groups is socio-cultural in nature. Where socio-cognitive theories of collaboration view the 'social' as external and the creativity as embedded in the mind of the individual, socio-cultural theories view the social as intrinsic to creativity, in that creativity is embedded in interaction (Glăveanu, 2011b), i.e. knowledge is *co-constructed* through social interactions rather than *shared* through interactions.

Socio-cultural theories focus investigations on the process elements, (as socio-cognitive theory does), but also to issues of content (what is actually being created and with what resources) and the context of creativity (how the collaboration is embedded with wider social and cultural networks) (Glăveanu, 2011a). An important characteristic of socio-cultural studies is that they are studied as an ongoing and long term process (Glăveanu, 2011b). Researchers not only consider the cognitive dimension but also socio-emotional, motivational, cultural and identity dynamics which sustain it (Littleton, Miell, & Faulkner, 2004). They are also interested in the developmental aspects of the individual and the group's thoughts, beliefs, and interactions (Glăveanu, 2011b). Vygotsky's socio-cultural theory specified that development processes take place through participation in cultural, linguistic and historically formed settings such as group interaction (Lantolf, Thorne, & Poehner, 2000).

The socio-cultural perspective is a theory used in various fields, and is used to describe an individual's awareness of their surrounding circumstances, and how their behaviours are affected specifically by social and cultural factors. Vygotsky's socio-cultural theory argues that human mental functioning is a mediated process that is organised by cultural artefacts, activities and concepts (Thorne, 2005).

Whilst both socio-cognitive and socio-cultural theories of design are important to the study of co-design, socio-cultural theory seems more appropriate. Socio-cultural theories aim to describe and explain creativity in groups, as the theory posits that the group should remain as situated in the wider cultural context as possible in order to examine it. This is an important feature of socio-cultural theory and its application to this study, as cultural diversity between the client and practitioner is a key concept which this thesis aims to explore.

Glăveanu (2011b) proposes a framework to be used in the exploration and explanation of collaborative creativity. He argues that

> *"in a collaborative situation, individuals use symbolic resources intrinsic to their particular system of knowledge and, through communication, generate new and useful artefacts (the creative outcome) within the representational space of the group".*

The representational space may be explained by considering how the individuals in the group may develop a collaborative joint design. Within a design team there are multiple individuals who hold individual knowledge. In order to complete the design tasks and create a solution they must ***co-create*** group knowledge. How information is cognitively and socially transmitted through the designer's culture medium (i.e. the design tasks) affects the mapping of 'object worlds' into a 'shared world' (Dong, 2004).

Researchers have described co-design as a social process, recognising the cognitive, social, and cultural aspects of the design process (Iedema et al., 2010). In this they emphasised the method as fostering new and purposeful interaction between healthcare staff and clients, which produced new understandings and relationships: a socio-cultural developmental process that entwines people in having to develop new competencies and selves (Iedema et al., 2010).

Constructivist approaches, such as socio-cultural theory, reject that cognition and perception are processes where objects and characteristics impress themselves on our mind. Instead researchers look for processes of communication and social interaction. These processes are what construct our social world (Hammersley, 2000).A constructivist explanation for co-design therefore demands that the group and their interactions are crucial to design, and should be included in studies of the effectiveness of the process.

Co-design groups in health

The studies on co-design are presented in this section to highlight the different methods used to understand and evaluate co-design involving practitioners and clients. The literature will also present what we currently know about co-design and how these findings may influence the process when it is applied to medical equipment design.

Bate and Robert (2006), the pioneers of EBCD, encourage academics and practitioners using the process to evaluate its use using summative interviews with group members (Bate & Robert, 2006). However, a range of different methods have been employed to do this.

An online survey highlighted that only 40% of 107 respondents had conducted some form of evaluation (Donetto, Tsianakas, & Robert, 2014). Respondents to the survey were asked open ended questions on the evaluation stage of their EBCD projects. A respondent to the survey commented that "*it is difficult to find ways to evaluate the work*" (Donetto et al., 2014, p. 26). However, a number of studies have both formally and informally evaluated the impact of co-design using a variety of different methods, which are explored in this section of the literature review. Donetto et al's (2014) survey with co-design practitioners highlighted the range of method used including: survey evaluations, post implementation surveys, interviews with stakeholders, interviews with new patients using a service in which EBCD had been implemented, observations of pathway, group meetings where improvements were discussed, informal conversations with staff and patients, measuring quality indicators before and after the project, document analysis and real time measurements using mobile hand-held devices (Donetto et al., 2014).

Methods that have examined the co-design process in health include researcher reflections on the process (Boyd, McKernon, Mullin, & Old, 2012; Dewar, Mackay, Smith, Pullin, & Tocher, 2010; Donetto et al., 2015; G. Robert et al., 2015). Other methods have gained the perspectives of the group members through interviews as part of the evaluation (Bowen et al., 2013; V. Tsianakas et al., 2014; Williamson et al., 2014). Studies have investigated the co-design group over time using ethnographic approaches, with various data collection methods (Bak et al., 2014; Farr 2012; Locock et al., 2014). There appear to be very few studies that have considered co-design as a social process, using socio-cultural theory to

describe it, which, as has been argued, may be more appropriate. These include Iedema et al. (2010), who used socio-cultural theory to describe the process of co-design, and Sjöberg and Timpka (1998), who used socio-cultural theory to examine the different intentions and voices of a multidisciplinary group in a co-design situation.

Methods that aim to evaluate the process have reported a number of different benefits and barriers relating not only to the design outcomes but to the group members themselves (Donetto et al., 2015; Farr 2012; Williamson et al., 2014). The EBCD process has been used in a number of different contexts including: emergency services (Iedema et al., 2010), e.g. cancer care (Bak et al., 2014), other service redesign projects and in some cases medical device design (Ram et al., 2008).

A common method of evaluating the process has been from an etic perspective, as a researcher reflection of the process. Boyd et al. (2012) and Dewar et al. (2010) reflected specifically on their own projects. While others (Donetto et al., 2015; G. Robert et al., 2015) have reflected on the process as a whole and on their continued involvement in various co-design projects with support from publications and grey literature surrounding EBCD.

Boyd et al.'s (2012) evaluation of co-design was aimed at describing how clients' experiences were captured, understood, and the improvements made as an outcome of the EBCD process. The authors reflect on the co-design of an NHS breast service that used the stage process outlined by Bate & Robert (2006) of engage, plan, explore, decide, and change. Patient journey mapping and experience based surveys were used to capture clients' experiences and co-design workshops were used for the later 'explore and decide' phases of the design process. The reflection undertaken by Dewar et al. (2010) only describes the strengths of using emotional touchpoints, where users identify specific aspects of their journey interacting with a service or product to identify moments that are particularly emotive and therefore important to the design focus. This is the initial stage of the co-design process (explore and decide), or the experience-based aspect as defined in the introduction.

Dewar et al (2010) also found that learning arose from hearing the narratives of experience and allowed the practitioners to see in a more balanced way both the positive and

negative aspects of the service. The authors also reflect that co-design helps service users take part in a more realistic and meaningful manner. Dewar et al.'s (2010) study does however only evaluate one aspect of the co-design process- the first stage of sharing perspectives. The results of their study highlight the benefit this stage has for both clients and practitioners in terms of gaining an understanding of the issues they face; it does not however, go beyond the first stage.

Boyd et al.'s (2012) evaluation also highlights some practical aspects of implementing co-design, noting findings such as involving patients early and the importance of staff buy in. However, they also reflect on the success of the co-design workshops, claiming that the process makes staff and patients equal as they actively participate in the design process. Boyd's (2012) findings highlight the ideological view of co-design as a method which enhances communication leading to a partnership between clients and practitioners.

Both Boyd (2012) and Dewar (2010) reflect on the initial stage of the co-design process, the collecting and understanding of user experience. Both report that the process helped to readdress the power imbalance between the client and practitioner (Boyd et al., 2012; Dewar et al., 2010). They emphasise the change in the practitioner's perspective on how 'things are done' currently in the NHS. However, in attempts to explain why this happens, Boyd et al (2012) claim that the design tools used involve new ways of thinking and challenging the existing ways in which things are done, and Dewar (2012) states that the change in perspective is a result of hearing clients' narratives of their experience. What both these papers do agree on is that enhanced communication between the client and practitioner is beneficial as it results in learning about the other and building relationships (Bowen et al., 2013; Dewar et al., 2010) which helps to readdress the power imbalance between the two.

Considering that the aim of co-design is to understand experience and improve it, these papers do not consider the participants' voices in evaluating the co-design process. It may have been beneficial to gain the perspective of the healthcare practitioners and service users as part of the evaluation to see how the process impacted them on an individual level in order to establish how the process allowed the development of different views on how things are done currently.

Using semi-structured interviews as a method of evaluating the co-design process has been done by a number of design researchers, to uncover the key characteristics and value of co-design from an emic perspective (Bowen et al., 2013; Tsianakas, Maben, et al., 2012) and to explore the impact of client involvement in the design process, both on the individual themselves and the designed outcomes (Williamson et al., 2014).

Tsianakas, Robert, et al. (2012) describe how they carried out the process of EBCD in breast and lung cancer services and as a secondary question they aimed to explore the participants' reflections on the value and key characteristics of the approach. Four staff and five patients were interviewed after the process had been carried out. The interviews highlighted four key characteristics of the EBCD approach which were key to its successful implementation; client involvement, client responsibility and empowerment (staff also commented on empowerment), a sense of community, and a close connection between their experiences and the subsequent improvements that were made. Like Boyd et al (2012) and Dewar (2012), Tsianakas, Robert, et al. (2012) state that the key to the success of the project "has been the strong relationship between patients and staff that has been built" (Tsianakas, Robert, et al., 2012, p. 2644). The authors also found that the meetings of both staff and patients were crucial in the process and led to an increased understanding of the other perspective, which they comment could result in a potentially broader cultural change in mind-sets and behaviours.

Bowen et al. (2013) also conducted post project interviews, their focus was on the participants' experiences of the process rather than individual gains of the people involved. The evaluation by Bowen et al. (2013) highlighted weaknesses within the process relating to issues of power between the participants. Semi-structured interviews were carried out with a sample of the participants, selected to represent the group, in order to gain their perspective of the process. A weakness of EBCD was that the participants involved in the design team did not feel as if they were 'doing the designing', which is note-worthy as this method claims to be the most participatory of the design methods. This is interesting as giving users an opportunity to design is often stated as a benefit of co-design (Bate & Robert, 2006; Bowen et al., 2013). The author suggests this was down to a lack of ideation tools within the EBCD process. However, a number of the participants did not recall what

each of the techniques were and occasionally got confused. Some of the interviewees felt it was long winded and others commented about the input from people who did not understand the process. Bowen et al. (2013) found that the participants perceived benefits and barriers in using the approaches related to empathy, group cohesion, and conflict. The authors report that initially the participants felt tension toward the process however, the participants reflected on commonality of experiences, which contributed to group cohesion. Interestingly group cohesion did not occur in a linear way, which may be explained by models of group development such as Tuckman's stages (Tuckman, 1965; Tuckman & Jensen, 1977), as some conflicts did still occur. In later stages of the process the group may have been moving through the 'storming' stage of development. Bowen et al's (2013) findings provide some insights into the workings of the co-design group. They highlight social aspects of the group such as empathy, cohesion and conflict, and cognitive aspects relating to the designing of the product, that the clients felt was lacking. While these findings are both interesting and important to the study of the co-design group, it may have been beneficial to study the group's interaction in context to explore further what the clients did in terms of the designing, by possibly coding the interactions in the group as collaborative design researchers have done (e.g. Detienne, 2012) to understand what each of the users in the group did. This may have also shed some light on the content of conflict between group members, as well as their development as a group, which Bowen et al (2013) state was not linear.

Most studies that go beyond the initial stages of sharing narratives have highlighted the ideological aspects of co-design, that it encourages active participation of both user groups. While Williamson et al. (2015) focused on the impact of the public participation on the designed artefact, others (Bowen et al., 2013; Tsianakas, Robert, et al., 2012) have specified that it is important to the people involved that they have responsibility over the project outcomes, are empowered and that they were doing the designing. These more ideological views of co-design appear to be a motivation for many to conduct the EBCD process (Vennik et al., 2015), as the process should empower people to make joint, deliberate decisions (Iedema et al., 2010). Co-design is thought to be empowering for both the clients and practitioners as they are involved in decisions that concern their lives and therefore should be given an opportunity to influence decision-making (Van de

Bovenkamp, Trappenburg, & Grit, 2010; Vennik et al., 2015). However, Bowen et al. (2013) highlighted that this may not always be the case. Robert et al. (2015) suggested that issues with unequal involvement concern the power relations between the client and practitioner in the design process. This was also echoed by Farr (2012), and implied by (Bowen et al., 2013).

The researchers (Bowen et al., 2013) took a realist approach to evaluation and combined open-ended questions on the participants' experiences with statements to test the researchers' previous hypothesis relating to their views of the process, therefore combining the etic and emic perspective of the process (i.e. viewing the process from both inside the culture and from an outside researcher's perspective). To do this a thematic framework of analysis was implemented which combined both inductive and deductive reasoning. By focusing on their accounts of experience, the authors describe five themes that emerged. They then separated these into interviewee's experiences of the particular techniques and interviewee's reflections on their emergent experiences of the whole project. Bowen et al's (2013) study highlights some methodological issues for studying the co-design group and exploring how the process works. Although these studies show the perspectives of the participants involved, it may have been beneficial to take a more in depth look at how issues related to the group happen in action, through a framework that considers the interactions of the group as it occurs. As highlighted, cohesion within Bowen et al.'s (2013) study co-design group did not occur in a linear way, therefore an approach that aims to evaluate the process at different points throughout the cycle may have strengthened this evaluation, to highlight where issues relating to conflict within the group occurred, and how members of the group managed this. Another issue surrounds the limitation of the participants being interviewed following the process of design, as they struggled to remember the different design tools used and got confused during the interviews (Bowen, et al 2013).

Williamson et al. (2014) conducted mid and post project interviews in order to evaluate accepted good practice guidelines of public involvement, specified by INVOLVE, when redesigning assistive technology. Both individual and group interviews were conducted with a ten strong team, and also the research team members. The results highlighted that

public involvement was seen positively by the research team, who reported a positive impact on device and study designs. The public highlighted a number of positive impacts including skills, confidence, self-esteem, enjoyment and improving the care of others

Observational case studies have been employed as a method of studying the EBCD process over time. Farr (2012), Bak et al. (2014) and Locock et al. (2014) conducted studies employing an ethnographic approach, however their research aims varied. Bak et al. (2014) aimed to gain a better understanding of EBCD and explore the strengths and weaknesses of the key features of the process. Whereas Locock et al. (2014) and Farr (2012) both used realist methods of evaluation to study the process of co-design.

These ethnographic studies have used a number of different methods of data collection, including document analysis, semi-structured interviews, and observations (Bak et al., 2014; Farr, 2012; Locock et al., 2014).

Bak, et al (2014) analysed a range of cultural artefacts as well as research generated data to evaluate the use of EBCD in Cancer Care Ontario (CCO). These included document analysis, meeting minutes and audio recordings, email communications, and evaluation surveys and interviews. The paper provides evaluation of approximately 20 EBCD teams, with diverse types of stakeholders including: program managers, patients, nurses and students. Surveys and interviews with these stakeholders were conducted as part of the evaluation to establish the effectiveness of EBCD, together with documents and audio-recorded conference calls. Thematic analysis highlighted 10 key themes which are summarised as lessons learned in terms of the practical aspects behind implementing EBCD. The ten key themes were specified as outcomes of the design process. These included staff gaining new insights from the patient's perspective which enhanced their understanding of patient experience, and that experience led to successful quality improvement insights.

Locock et al. (2014) and Farr (2012) both took a programme evaluation approach to understanding the co-design process. Their evaluations focused on exploring how co-design worked to understand how it may cause a transformational change in both perspective and culture in the NHS surrounding both the designed outcomes and how

things get done. Bate and Robert (2007) stated the transformational aspect of co-design lays in the understanding of one's own and others naturally implicit experience. Locock et al.'s (2014) study explored an alteration in the existing process, while Farr (2012) took a critical approach to understanding power and participation between the client and practitioner in the co-design process.

Farr's (2012) critical realist approach to studying collaboration between staff and patients includes: how and why co-design processes might prompt changes; the management practices needed to support these mechanisms; the influence of contextual conditions; power relations; and the impact of collaboration. Farr (2012) took a critical approach to studying the collaboration during design meetings to assess whether service-users and staff can participate together. Working within the NHS, Farr (2012) explored the processes and outcomes of various co-design projects using a critical realist theoretical framework. The realist evaluation carried out by Farr (2012) is based on realist evaluation (Pawson & Tilley, 1997) and a morphogenesis approach (Archer, 1995). Aiming to identify context-mechanism-outcome relationships between the process of design and change, Farr (2012) asked research questions relating to the strengths and tensions within co-design projects, the impact of the institutional context, and whether (or not) underlying power relations can be challenged through co-design (Farr, 2012). Interviews were carried out with eight facilitators and service user improvement specialists. This was followed by two longitudinal case studies within the NHS and local government using an ethnographic approach. The local government case study data collected included participant observation at 3 events and 16 interviews. The NHS case evaluated a project using EBCD within cancer services in two large hospitals. Data from this case consisted of participant observation of staff and user co-design events and 71 feedback questionnaires from participants which were completed post project. Farr (2012) reports that the interviews uncovered a number of benefits including the importance of emotions in catalysing change within services. She observed how the openness of the meetings enabled staff to show a deep level of recognition and also supported their concerns about the service, which fits with Bate and Roberts' (2006) understanding of transformational change. Another reported benefit was that the co-design meetings gave staff 'time to think' and allowed them to reflect on their own practices. The interviews highlighted that participants felt that these spaces can

enable the development of relationships and trust, as both staff and service-users begin to see things from a different perspective. The findings show that challenges centred mainly on facilitation and planning; commenting that when to involve both the service-users and staff should be carefully considered. The interviews with experts also highlighted a challenge, in that the focus of the design outcomes tended to be on the client rather than staff members.

The EBCD process has been applied to a number of different contexts, each of which has its own time and cost constraints as well as various other factors, including the type of thing being developed through the design process and the users who are asked to participate. Therefore, alterations in the implementation of EBCD have varied depending on these factors. Locock et al.'s (2014) approach also used a programme evaluation methodology, which evaluated an accelerated method of EBCD, AEBCD. The accelerated method used national archives of patient experience rather than getting patients to discuss their experiences with practitioners. Their approach was to compare their results to previous findings relating to EBCD, highlighting that EBCD is used to trigger discussion and enable people to share thoughts and ideas, with the direct mutual encounter and active partnership being vital to the co-design process. Locock et al (2014) focuses on the idea of a partnership, arguing that the link between the process and outcome is explained with 'partnership synergy' theory. Partnership synergy theory claims that shared decision making and building trust are key to building partnerships and transforming contexts.

Similar to the findings of Tsianaksa et al (2012) and Bowen et al (2013), these studies focus on the partnership between the clients and practitioners as a key aspect of understanding co-design. Both Farr (2012) and Locock (2014) highlight the social factors of the group as critical to the effectiveness of co-design. They emphasise that the building of trust between the two is essential to developing an active partnership which can help to reduce the power imbalance between the group members in order for both to have a voice in the design process (Farr, 2012). Farr's results suggest this is as a result of sharing experiences with each other and learning about them in an open environment (Farr, 2012).

Farr (2012), Locock et al. (2014) and Bowen (2013) used realist evaluations to explore the co-design process. Realist evaluations differ from other types of theory-based programme

evaluations in that they specify the mechanisms and outcomes expected prior to undertaking the study so that the study can be designed to test whether these work or not. The focus of realist evaluations is to uncover what works when and for whom (Pawson and Tilley, 1997). This is appropriate for service-design improvements but may not be for medical equipment design improvements as the context is different and we don't know how the model may apply. A realist evaluation may also not illuminate the wider cultural mechanisms which influence power and participation between group members. While a number of studies took a realist approach to studying the co-design process, some have used constructivist methods which may be more suitable to studying the collaboration between the group members towards a shared goal.

Focusing on the relationship between service-delivery staff and their customers, Iedema et al. (2010) addressed the issues of how government agencies increasingly attempt to involve users in the design of public services. Iedema et al. (2010) conducted post project interviews with the users involved in an emergency service redesign project. Interview transcripts were analysed to identify discursive themes. They found the co-design consists of four themes, 1) co-design as 'deliberative' that engages patients and caregivers (patients felt they were listened to and staff felt it was important to hear their views); 2) co-design as a reflexive process that enables frontline staff to appreciate the effect of their practice and the clinical environment on their patients and caregivers, wherein staff felt they were able to see their service through the 'patient's eyes'; 3) Co-design as a research methodological capacity-building process for project staff (PPI issues, maintaining patient involvement and project facilitation); and 4) co-design as a dialogic process through which practical solutions can be derived (outcomes of the process). They conclude that the new co-design discourse consists of unpredictability, intensity and learning. "The principal parameters of the new discourse: unpredictability (of the co-design process), (the challenge of) shared meaning making, and (the importance of) learning."

Both Sjöberg and Timpka (1998) and Iedema et al. (2010) took constructivist approaches to studying co-design.   The theory on design groups advocates a constructivist approach to studying design groups as researchers aim to study interactions as they occur during meetings (Détienne, 2006). Sjöberg and Timpka (1998) and Iedema et al. (2010) stress the

importance of the group in co-design. The theory supporting co-design is socio-cultural in nature, recognising the situatedness and intersubjectivity of meaning-making (Gillespie & Cornish, 2010). Both focus on the communication between the health professional and the client searching for what makes involvement meaningful in a co-design group.

Although not labelled as EBCD, a project undertaken by Sjöberg and Timpka (1998) had many of the same principles: both healthcare staff and designers were involved and collaborative design meetings took place. Sjöberg and Timpka (1998) took an approach to understanding the processes involved during participatory design (of IT system), by analysing video-recorded project meetings. Using grounded theory, Sjorberg & Timpka (1998) aimed to develop an understanding of the involvement of different perspectives and users in the design process. Three research questions were posed. Firstly, the focus was on the content of the design discussion, asking the question: 'what issues did the group deal with?' The second question was related to the different intentions of the group members, and asked 'how the different intentions of group members influence their way of expressing themselves in design discussions?' The third question related to the context, and asked: 'how was the external context and conditions referred to by the group?'. Using social-cultural theory, they define 'voice' and found that three design voices are present during the participatory design healthcare meetings. These design voices were used as a method of analysing how the different intentions of a multidisciplinary group influence their way of expressing themselves in design discussions. They identified 1) the voice of participatory design, 2) the voice of practice and 3) the voice of engineering. Interestingly the voice of participatory design became independent of background and involved 'coordination, consensus, and comparative stories'. They found that the developing system was discussed mainly from a clinical and practical viewpoint as opposed to a technical one. The longitudinal approach to analysis allowed the researchers to uncover developments in the group.

The literature has highlighted a number of processes that are central to co-design's success. Learning was specified by nearly all the co-design process literature as a report benefit (Bak et al., 2014; Dewar et al., 2010; Farr, 2012; Gustavsson, 2014; Morrow, Boaz, Brearley, & Ross, 2011; Springham & Robert, 2015; Tollyfield, 2014). Through sharing

experiences, staff can see aspects of the clients experience in a more balanced way (Dewar et al., 2010) and gain insights (Bak et al., 2014) which produce new understanding (Iedema et al., 2010). A further aspect of the co-design process was the building of relationships and trust between members of the group. Co-design has been described as a process which builds relationships (Bowen et al., 2013; Dewar et al., 2010; Iedema et al., 2010) between clients and practitioners, bringing stakeholders together across impervious boundaries (Iedema et al., 2010).

However, the stakeholders involved must be willing and prepared to renegotiate their roles (Larkin et al., 2015; G. Robert et al., 2015). This can result in issues of power, where existing cultural beliefs and attitudes to the existing client-practitioner relationship can influences the group members' abilities to equally participate in the co-design process (Bowen, et al. 2013; Farr 2012). In a report by Robert (2015) it is noted that issues relating to power can often emerge between patients and staff, suggesting that a highly participative co-design process may not always be the best option. A number of studies have found these power relations can be an issue in the co-design meetings (Bowen et al., 2013; Farr 2012).

Summary: What we know about co-design in health

The range of methods used highlights that many focus on the outcomes of the design process, including both the impact on the people involved and on the final designed solutions. This may be due to difficulties in evaluating a process in which a range of methods have been used. Evaluating a process requires more qualitative methods, and more time and effort, to observe and record interactions over time (Salter & Kothari, 2014). The realist evaluations of the co-design process used highlight that multi-method data collection using ethnographic methods are useful for identifying mechanisms and contexts where co-design functions to produce successful outcomes. These methods do not however consider the interactions and communication between members, which if co-design can be explained as a social process may be vital to understanding how the group work in co-design. The literature on co-design has validated its use as a method for improving experiences for people. However, aspects of the process still cause barriers.

What is unclear in the current body of literature on collaborative design between client and practitioner relates to questions of who does the designing, and how each person's (or sub group's) voice contributes to the design process, i.e. what is involvement for both the client and the practitioner and how do they contribute to the final designed artefact. None of the papers on co-design have considered the wider literature on design interactions that are beneficial between members in the design process, nor, have they used the group literature to explore whether what we currently know about small groups and how they work, into the analysis of the 'co' of design.

An ideal methodology for understanding the influence of the co-design group on solution development would take into account both the social and cognitive aspects of the design process, by focusing on the group and their interactions as they unfold in design situations. The approach would need to collect data over time to see how, if at all, an active partnership is developed in the group. The approach would benefit from taking into account an emic perspective from the people involved. However, as outlined by Bowen et al (2013), interviews at the end of the project may be unreliable as the participants might not remember certain aspects. Therefore, the method chosen would need to consider interviewing participants at various stages of the co-design process.

The aim of this study then is to explore the process of design in the specific setting of medical equipment design. To explore whether learning more about the way the groups developed and function may be used to provide recommendations for more effective, productive, and healthy group environments for the design and development of medical equipment using Experience Based Co-Design. This led to the overarching research question:

The Research Questions
Overarching question

What are the experiences of women during the co-design of mammography machines?

To be answered by addressing the following two sub-questions:

1. *What are the factors that influence involvement in a medical equipment co-design group?*
2. *What recommendations can be put in place to support the use of Experience-Based Co-Design in the development of medical equipment?*

Chapter 3: Methodology

The broad topic area for this study concerned co-design groups consisting of both health professionals and clients in the redesign of a product. The co-design group included mammographic practitioners and female mammography clients who participated in a co-design method similar to that of Experience-Based Co-Design (EBCD) (Bate & Robert, 2006), organised and facilitated by myself. The overall aim was to provide recommendations for future co-design projects when applied to the development of medical equipment.

The overarching research question was exploratory and aimed at discovery rather than to test any priori hypotheses or assumptions.

This chapter will now outline the key theoretical and methodological considerations. This chapter will present the philosophical position- subtle-realist- as the ontological approach underpinning the study. Subtle-realism is discussed in relation to how it fits within the research as well as what this means for the design of data collection and analysis methods. The co-design method that was implemented is then detailed, highlighting when data was collected over the process and explaining my role as the co-design process facilitator and researcher. The final section of this chapter presents the ethical considerations and steps taken to ensure that the study represented the experience of the women, through explaining quality measures taken in this qualitative research.

The Design Method

This study has two different levels; for both of these qualitative data has been collected. Firstly, qualitative data has been collected for the EBCD process to contribute towards mammography machine redesign as part of the design method, *this is not research data*. Secondly, data has been collected to evaluate the project; *this is research data* which has been analysed. This study is concerned with evaluating the co-design group over the course of a co-design process.

Over the course a year, from Oct 2014 to Sept 2015, a model of co-design has been implemented. The model of experience-based co-design is similar to that described by (Bate & Robert, 2006). Using the online guidance (King's Fund, 2015) provided by the King's Fund on EBCD and the literature a version of the process which has been implemented at the university. The process can be described in stages. These included an introductory meeting and two co-design meetings. These are presented in the flow chart below (figure *6*). Figure 6 briefly describes the method which was implemented. A few changes were considered and made to the process of design. Each of these changes is then expanded on and explained.

Stage/ Meeting	Method and Design Tasks
Stage 1 Introductory Meeting	Two meetings were held*. One at the University of Salford and one at a breast cancer screening facility in the Northwest local to the University. The meeting at the University of Salford was attended by two practitioners and one client. The meeting at the screening facility was attended by two practitioners and two clients. Tasks undertaken involved: - Introduction to the project and the process of co-design - Step-by-step narrative discussions of both the clients' and the practitioners' experiences with mammography machines - Identifying touchpoints - Looking at existing mammography machines in the breast screening centre (second meeting only).
Stage 2 Co-design workshop	A daylong creative workshop attended by both practitioners and clients. All group members to attend. Tasks to be undertaken: - Ranking touchpoints - Affinity Diagram Small Group Sketching
Stage 3 Co-design meeting	The final meeting was attended by all group members; however, the external technical feasibility member did not attend. Tasks I undertook prior to the process: - Sent sketches of ideas developed in the co-design meetings to a medical physicist for feedback of technical feasibility. Tasks undertaken by the group - Read and interpret technical feasibility feedback - Discussion surrounding ideas developed in the co-design group - Decisions on the design outcomes

Figure 6 - Implementing EBCD

The first introductory meeting had to be altered. Firstly, two meetings were held instead of the intended one, and the location was changed for the second meeting. The first meeting was intended to be held with all the group members at once, however the women who

had expressed an interest were unable to attend. The other women had already made arrangements for work cover to attend the meeting, therefore it went ahead with three of the women. The intention was to repeat the meeting again with the rest of the group of women. However, in the first introductory meeting at the University of Salford there were some difficulties with visualising the mammography machine. Therefore, I felt it would have helped the discussion if the women could see the machines. It was arranged for the next meeting to be held at the breast screening centre.

The Research Method

Philosophical considerations

This study takes subtle-realism as its ontological basis. Subtle-realism lies between the two 'extreme' poles of ontology, realism and relativism (or idealism). In order to explain the orientation towards subtle-realism and the implications this has on the study, first realism and relativism are defined.

A realist ontological perspective considers the world to be constructed of structures and objects, that there are objective truths out there to be discovered, and that phenomena can be studied to identify cause and effect relationships (Finlay & Ballinger, 2006). On the other hand, the relativist perspective emphasises the diversity of interpretation. The meanings that individuals attach to a phenomenon, in terms of how they experience it, are multiple (i.e. relative and open to considerable variation) (Finlay & Ballinger, 2006). Relativists argue that knowledge is constructed and co-constructed locally and specifically, meaning that we construct knowledge through our lived experiences and through our interactions with other members of society (Denzin & Lincoln, 2011). This worldview claims that the social world does not exist independently from our constructions of it. Therefore, taking this ontological position encourages researchers to explore the way in which we produce these constructions, leading to methods which study discourse and conversation.

While relativists believe that we construct reality through language, Hammersley's subtle-realism argues that the social world does exist however we can only come to know it through participants' interpretations of it (which are further interpreted by the researcher) (Hammersley & Campbell, 2012), therefore our perceptions or interpretations are representations of the social world rather than reconstructions. This view of the nature of knowledge does not aim to study how people construct their reality, but aims to present the various representations of it. Subtle-realism has been labelled a 'weak social-constructivism', as it is driven by constructivist beliefs that we cannot come to know the absolute truth about a phenomenon, but we can explore people's perceptions of the phenomenon, whether that is an observation or description of their experience.

Epistemological questions consider how knowledge of the social world is possible (Hammersley & Campbell, 2012). Ritchie (2003) separates epistemological considerations

into several key criteria. The first of these concerns the relationship between the researcher and the researched. The second criterion surrounds theories of truth and the final one concerns the way in which knowledge is acquired; whether or not we take an inductive or deductive approach (Ritchie et al., 2013). Hammersley (2013) does address some of these points within his argument for subtle-realism.

Subtle-realism has been criticised for having no epistemological basis. However, Hammersley (2013) argues that there is a position between realism and relativism, and that to some extent a large amount of ethnography and observational methods are based on this 'subtle form of realism'. He summarises the key elements as:

1. The definition of knowledge as beliefs whose validity is known with certainty is misconceived. Based on this definition we can never be certain or sure about the validity of any claims. Therefore, we should define knowledge as beliefs about whose validity we can be reasonably confident. Assessment of claims therefore must be based on judgements of plausibility and credibility: on compatibility of the claim with the assumptions about the world we currently take to be beyond reasonable doubt and the likelihood of error given the conditions in which the claim was made.

2. There are phenomena independent of our claims about them, which those claims may represent more or less accurately. Knowledge is 'true' by virtue if it corresponds to the phenomena it is intended to represent. In the one sense we are all part of reality so cannot be independent of it – so making a claim does not change relevant aspects of reality. For the most part reality is independent of the claims that social researchers make about it.

3. The aim of social research is to represent reality, but not to reproduce it – social research aims to represent reality "in its own terms". Representations must always be from some point of view which makes some features of the phenomena represented relevant and others not. Thus, there can be multiple, non-contradictory and valid descriptions and explanations of the same phenomenon.

The way in which knowledge is best acquired in this study was considered in light of the literature review, as the research aim highlights that the primary focus is to explore a co-

design group in the context of medical equipment design. Currently the evidence surrounding the impact of the group on the process of design is lacking, particularly regarding an approach which considers the perspectives of those involved and the interactions and behaviours that help or hinder the process. Therefore, an inductive approach that builds knowledge to describe and explain the phenomenon was deemed most suitable.

The second key issue concerns the relationship between the researcher and the researched and how this influences the connection between knowledge and values (Ritchie, 2003). I take the perspective of Denzin and Lincoln (2011), that all research is interpretive: it is guided by our set of beliefs about how something should be studied. Research cannot ever truly be value-free; by selecting the approach and methods we use to conduct research, our values and beliefs become imposed on the research.

Interpretivist and socially constructed knowledge claims are often combined (Mertens, 2014), both of which hold the assumptions that people seek understanding of the world they live in (Creswell, 2013). Therefore, the meanings we attach to certain aspects are subjective and multiple, which leads the researcher to look for a range of views.

An interpretive framework has been selected for this research project due to a number of reasons. The philosophical considerations and the choice of subtle-realism will the an ontological position, which emphasises that knowledge of the social world is subjective, multiple, and developed between the researcher and the research participants. Secondly, the aim of this study is to provide a detailed in depth understanding of the behavioural aspects of the co-design group throughout a process of EBCD when applied to the context of medical equipment. Positivist frameworks encourage a reductionist approach, reducing aspects of experience into objective variables that are tested as hypotheses. This approach would therefore limit the detail and depth that could be achieved. The goal within this study is to explore the co-design process through the constructions of the women's experiences and through understanding and interpreting their behaviour.

Having outlined the philosophical orientation, this section will now expand on the design of the study, providing justification and rationale for the decisions made throughout. The women who took part in the study are discussed first. Following this, the method of data collection and analysis will be discussed.

The research questions, approach, collection, and method of analysis are outlined below before discussing the study design.

What are the experiences of women during the co-design of mammography machines?

1. *What are the factors that influence involvement in a co-design group?*
2. *What recommendations regarding involvement in co-design can be put in place?*

Research questions	Exploratory, seeking to describe and explain involvement in the process of co-design
Research Approach	Inductive and Interpretive
Data Collection	Observational data consisting of video footage (20 Hours), interviews Transcripts
Data Analysis methods	Thematic content analysis of Interviews, Interaction Analysis of video recorded data
Data Management Method	Framework Analysis*

Figure 7 - Outline of the Study Design

*Added later following first pass analysis

The women involved

The co-design group

A number of decisions had to be made prior to the recruitment of the co-design group; these included the size of the group, where recruitment was aimed, and the criteria to make sure the group was made up of key informants who could contribute to the process due to their past experience of mammography machines.

The size of co-design groups differed widely in the literature (Bak et al., 2014; Bowen et al., 2013a; Boyd et al., 2012; Iedema et al., 2010) and was not often made clear. However, it is recommended that the number of people in a study which takes place over the course of a year should be 10 – 12 (INVOLVE, 2013) to account for people leaving or not being able to attend meetings. The creators and developers of EBCD (Bate & Robert, 2006) recommend that ideally small groups of between 4 -6 should develop design ideas (G. Robert et al., 2015). Therefore, the strategy aimed to recruit 6 mammographic practitioners and 6 mammographic clients.

Recruitment was aimed in the North West of England, UK, mainly in the Manchester area. Due to the length of the design process, which took place over 12 months, it was important that the women involved had an interest in the study and were able to attend the relevant design and research activities. Therefore, targeting women who were in close proximity to the University of Salford was deemed the most appropriate. Within the methodology, a probability sampling method was not considered appropriate as the aim was not to make generalisations through statistical analysis of the group, but to study one group in detail to suggest how these findings may assist others in the future.

The recruitment approach was most similar to purposive sampling in that the group of women were recruited on the basis of their previous experience (Ritchie et al., 2013).

The experience needed which was relevant to this study was actual personal experience of using mammography machines. The women were all required to tell their stories of mammography in order to contribute to the design and development process. The problem area which this thesis used as the vehicle for exploring the process was mammography machines and the associated problems and implications with the contemporary design that have been specified in the background chapter. Therefore, with

this in mind, recruitment was aimed at mammography clients as key informants of being end-users, and mammographic practitioners as key informants of being professional-users.

Mammographic practitioners are radiographers who hold a College of Radiographers approved post graduate award in mammographic practice (Cavanagh, 2013). In the UK, mammographic practitioners have to be female.

Recruitment

Mammographic practitioner recruitment involved reaching out to the mammography community within the North West region. I gave a presentation at a breast screening seminar held at the University of Salford during the first year of this study. The seminar was aimed at mammographic practitioners, and other mammography professionals, and students at the university. Following the presentation on the intended aims of this study an email was sent out to the attendees of the seminar asking if they would be interested in becoming a member of the co-design team. Further recruitment of mammographic practitioners was undertaken through the professional networks of the University of Salford.

Clients were recruited through websites which co-ordinate opportunities for patients and the public to be involved in research studies. Adverts (Appendix 2) were placed on two websites that advertise to people in North West England, UK. These were North West People in Research (http://www.northwestpeopleinresearchforum.org/) and Salford Citizen Scientist (http://www.citizenscientist.org.uk/)

Although the PPI websites initially gained a lot of interest, further recruitment of screening clients was needed part way through the study. Therefore, a different recruitment strategy was put in place. This involved contacting a group who were predominately made up of women and were within the mammographic screening age range (50 – 70). A community choir who meet in the Manchester area were contacted via email to recruit more clients. Two of the women (Jill, and Liz) were from the same community choir group and therefore knew each other prior to the meeting. This was not considered an issue, as members of a co-design group are often recruited through a patient community (and the EBCD online guidance recommends this approach to recruitment (Fund, 2013)), therefore many projects would have group members who are familiar to each other prior to the co-design

study. Having people who are familiar with each other prior to the process will have had an impact on their interactions, relationships, and perspectives of each other (Spencer-Oatey, 2005); therefore, the analysis of this is important, rather than trying to restrict people who are familiar with each other as this would not be the case in a natural setting.

The women who responded to the recruitment strategy are presented in Figure 8. Pseudonyms have been used to protect the anonymity of the group members.

Name	Type of User	Recruited From
Liz	Client	Community Choir
Jill	Client	Community Choir
Joy	Client	Citizen Scientist
Anne	Client	Citizen Scientist
Nell	Client	Citizen Scientist
June	Client	Citizen Scientist
Eve	Practitioner	Through University of Salford
Beth	Practitioner	Through University of Salford
Kate	Practitioner	Through University of Salford
Tina	Practitioner	Following Seminar
Ava	Practitioner	Following Seminar

Figure 8 - The Co-design Group

This section explores my journey, leading up to and undertaking my PhD. As I am discussing myself and my previous experiences this section is written in first person. I have presented this section to highlight my methodological choices and my influence on the research findings. I have chosen not to explore my role in the design process here, and only to describe it in the research process, as I feel these two need to be separated and explained in relation to what they may have influenced. Therefore, in this section within the methodology chapter, I discuss myself in relation to the research design and activities. Within the findings chapters, I present my role as facilitator from a reflexive point of view to analyse my role within the group and the impact that had on the women's experiences and interactions, and therefore, the findings of this study.

Subtle-realism's link to social constructivism indicates that people have different interpretations of experiences, or reality, due to our past social and cultural experiences. This perspective acknowledges that different researchers may not get the same results due to their own beliefs and perspectives. Therefore, reflexivity and transparency are vital to improving the quality of research in this philosophical position. Mauthner and Doucet (2003) have argued that there is a tendency to simplify the complex processes of representing the 'voices' of participants as though these voices speak on their own, rather than the voice of the researcher who interprets the data and ultimately chooses which transcripts to produce as evidence. They suggest there are three interrelated aspects of reflexivity researchers should pay attention to: 1) our academic and personal biographies, 2) institutional and interpersonal contexts, and 3) ontological and epistemological conceptions of subjects and subjectivities (Mauthner & Doucet, 2003). Consequently, before discussing the choice of data collection and analysis methods, I will explain a little about myself and my background. I came to my PhD from a positivist background in mechanical engineering when during the final year of my Bachelor's degree I was asked by one of my PhD supervisors, Peter Hogg, to apply for a position where I would continue the work done for my dissertation on compression paddle design. The move from mechanical engineering to health sciences was a big change, which felt even larger when I began to consider a qualitative methodology to study women's perspectives of mammography machines.

However, reflecting on my previous experience of quantitative research and the reading I had done during my dissertation highlighted the disconnection between myself and the individuals involved in the study. I felt that the motivation and theories which led me to focus on co-design needed to be continued throughout my research design. That is its motivation towards the subjective experience and emotions of individuals in evaluating 'something'. Therefore, I found myself leaning towards a qualitative methodology to explore the process of co-design starting from the women's perspective.

Some of the methodological choices made over the course of the study were partly due to the usability and usefulness of data. This was both my personal opinion and also strongly related to the department and field of radiography. Within this field, the research is mainly post-positivist and interpretive. Researchers in the department tend to take more pragmatic approaches to research focusing on the research approach that best answers the research questions.

It was not really until the second year of my PhD that I was able to understand some of ontological and theoretical underpinnings of qualitative research, and I felt split between two research paradigms. It may be due to this that I leaned towards an ontological position between both realism and relativism: subtle-realism.

Although, I had begun to understand that as the researcher I could not 'detach' myself from the research, I still took a fairly positivist approach to the way I presented my research, leaving my own voice out as much as possible trying to make myself sound like the 'objective' researcher. I struggled to be honest and transparent in the way I wrote up my research methods, analysis, and findings and strived for the validity, rigor, and reliability associated with positivist research. The group I researched included mammographic practitioners and screening clients, both of which I have never been. During the early stages of the research, particularly during recruitment, I felt this was a weakness; I was uneasy around practitioners and tended to avoid contacting them. I knew less than them about mammography and if I spoke to them too much they wouldn't consider becoming involved with the study. I felt more comfortable contacting screening clients. The power difference between researcher and researched was greater which actually made me feel more in control.

Not having the experience of the health practitioner and client relationship has been both a benefit and disadvantage during the research process. During the analysis of the data, I was in parts more favourable to one group over the other, the clients over the practitioners. The literature I had read also influenced this. I knew there was a power difference between the practitioner and patient in similar contexts to the one under study and my first pass of analysis amplified this, as I made 'power' a theme. However, as I continued to analyse the data and become more immersed in the data I realised it was not the existing 'power relations' that were at work during the meetings, but that power was a consequence of the value the women had given to different types of knowledge.

My aim throughout the research was to limit as far as possible the power relations between myself and the women. This included the way I approached the data collected, and the design of the research. I felt it was vital to ensure that the women felt they could express to me any strengths and weaknesses of the design process in a comfortable environment. The selection of interview venue and style were methods of trying to reduce the power imbalance. The environment in which the interview took place was carefully considered. The women in the group were asked where they would feel most comfortable having the interviews. The venue should feel comfortable to women to make the setting as non-threatening and non-judgemental as possible (Stewart & Shamdasani, 2014). It was, therefore, considered inappropriate to hold interviews at the University, where the differences between me and women in the group may be most prominent. The interviews were held in a range of different locations. However, one interview was held at the University, as Joy lived very close and chose the University as the most convenient place for the interview to take place. Three of the five interviews were held at the interviewee's homes and one of the interviews was held at a practitioner's place of work.

Having highlighted that I am not part of the culture under study, it feels appropriate here to discuss the emic and etic viewpoint used in qualitative research. The emic viewpoint is generally the perspective from inside a culture, whereas the etic perspective results from studying behaviour from outside a particular system (Pike, 1954). The etic viewpoint is usually considered to be the perspective of the researcher who is external from the group. This viewpoint implies a research approach where structures and criteria developed outside the culture are used as a framework for studying the culture (Willis, Jost, &

Nilakanta, 2007). On the other hand, the emic viewpoint focuses on the potential meanings and beliefs from within the system, wherein the researcher aims to uncover the language and meanings of a defined group (Merriam, 2009). Both are beneficial when studying a group, an etic perspective can be useful as it allows comparisons across multiple groups (Lett, 1990) and can be used to examine a culture's emic perspective as it may diverge dramatically from those held by insiders.

Data collection

The approach taken to gather the research data resonates with the theories and motivations behind co-design. The focus was on understanding the women's experience in a co-design process. The interactions and relationships with others in the group spurred the choice to use observations and interviews. The initial method of data collection and analysis focused on the women's subjective representations of their experience. Although guided by the interview schedule, the interviews were used to give the women an opportunity to access their experience of the co-design process. This in turn, through my interpretation, identified areas that required further analysis and focus. Like many design methods, observations of actions were also incorporated into the evaluation process. This involved video-recorded data of the co-design meetings which took place for further analysis. In design terminology then, the overall aim of the thesis is to develop an artefact in the form of a developed design model by understanding and critiquing experience in order to improve it.

Interview Data

Interviews allow researchers to develop an understanding of how people perceive things (Silverman, 2010) by talking to those who have knowledge of experience relating to a problem (Rubin & Rubin, 2011). Several factors were considered before selecting individual interviews over focus group interviews as a method of gaining an emic perspective of the group. Firstly, conducting a focus group may have impacted on the quality of data if a hierarchy between participants had been present as the women may not have felt comfortable to share information (Kitzinger, 1995). A focus group with the design group members may have restricted the conversation regarding their perspectives towards each other and the group (Kitzinger, 1995). It is important to achieve high levels of comfort to make participants feel at ease in an atmosphere which is non-evaluative and non-threatening (Stewart & Shamdasani, 2014), which may not have been possible in a focus group or group interview, as participants were asked to discuss their opinions regarding the group.

Individual interviews are widely used by healthcare researchers to gain an understanding of an individual's perception of events or experiences (DiCicco-Bloom & Crabtree, 2006). There are a number of different types of interview, e.g. open-ended, structured, and semi-

structured. A semi-structured interview appeared to be the most useful for the initial interview conducted in this study. The loose structure allowed for areas of the research problem to be covered whilst allowing for the interviewees to add anything which may not have been as obvious.

The interview involved asking a range of questions that were predetermined by the research problem and questions. The order and flow of the interview was altered depending on the dialogue during the interview (DiCicco-Bloom & Crabtree, 2006). The more informal flow had the feel of a conversation rather than an interview. I found this to be important in limiting the existing power relations which may be present between the researcher and the researched. The semi-structured interview also allowed for probes and the addition of follow up questions which were important for exploring and testing ideas as they emerge from the interviews (Rubin & Rubin, 2011).

The interview guide (see appendix 3) was developed through reviewing the literature and developing an understanding of the research problem. The questions concern the women's experience as a whole over the course of the project, and included some probing questions surrounding the group, and their role within the group. Some questions were also asked relating to the future of co-design groups and how they thought the process could be improved to gain an understanding of what they believed would be appropriate recommendations for co-design processes.

The interview guide contains a number of questions which are written verbatim. However, they were not read in full and the interviews did not all follow the order of the guide. The aim was for the women to speak about their experiences of working in the co-design group in their own words in depth and also cover all the issues that I was interested in. Each interview began the same, with a broad question surrounding the interviewee's experience of the first meeting. However each interview proceeded in a different way. Often the interviewees discussed issues and questions from the interview guide without being asked. Therefore, in these situations my role was to probe and ask follow up questions which gave a more conversational style and allowed discussion of what was interesting to them and what was interesting to the researcher.

Over the course of project, two interviews were scheduled to gain an evaluation of the women's attitudes, opinions and experiences of working in a co-design group. The initial interview was aimed at eliciting the women's perceptions of the project in order to build an understanding of their experiences and involvement in the co-design process, and to develop an understanding of the strengths and weaknesses of the co-design meetings they attended.

The aim of the final interview was to gain further information on the women's experiences of co-design once the process was completed. It also allowed me and the women to reflect on how changes had taken place over the course of the project. This interview was not structured. No questions or prompts were taken, but the aim was to have a conversation relating to the women's experience as a whole. This was to ensure that the analysis was grounded in their own words and interpretations of the co-design process, and to gain the women's perspectives on the development of the group over the whole process.

One-to-one interviews were conducted with 6 women who had taken part in the entire design process. There were nine interviews in total. Two interviews took place over the course of the project, a mid-project interview and an end of project interview. All the women who were still actively involved in the process of design, and who had attended an introductory meeting and the co-design workshop, were contacted about being interviewed at the mid-project stage. For the end of project interview, all of the women who had attended the final co-design meeting were contacted about being interviewed. The only woman who did not want to be interviewed was Anne; she dropped out of the project following the co-design workshop. Anne is a retired practitioner who was away a lot when I had tried to organise interviews and meetings. She thus decided that she wouldn't be able to commit as much time as she had originally thought to the process.

```
┌─────────────────────────┐      ┌─────────────────────────┐
│    Design Activity      │      │    Design Activity      │
│    October 2014         │─────▶│    January 2015         │
│    Co-design Meeting:   │      │    Co-design Meeting:   │
│ Introduction and        │      │ Introduction and        │
│ discussion of           │      │ discussion of           │
│ experience (1)          │      │ experience (2)          │
└─────────────────────────┘      └─────────────────────────┘

┌─────────────────────────┐      ┌─────────────────────────┐
│    Design Activity      │      │   Research Activity     │
│    March 2015           │─────▶│    May 2015             │
│ Co-design Workshop:     │      │ Mid-Project Interviews  │
│ Developing Designs      │      │                         │
└─────────────────────────┘      └─────────────────────────┘

┌─────────────────────────┐      ┌─────────────────────────┐
│    Design Activity      │      │   Research Activity     │
│    October 2015         │─────▶│    November 2015        │
│ Co-design Meeting:      │      │ End of Project          │
│ Deciding on Designs     │      │ Interviews              │
└─────────────────────────┘      └─────────────────────────┘
```
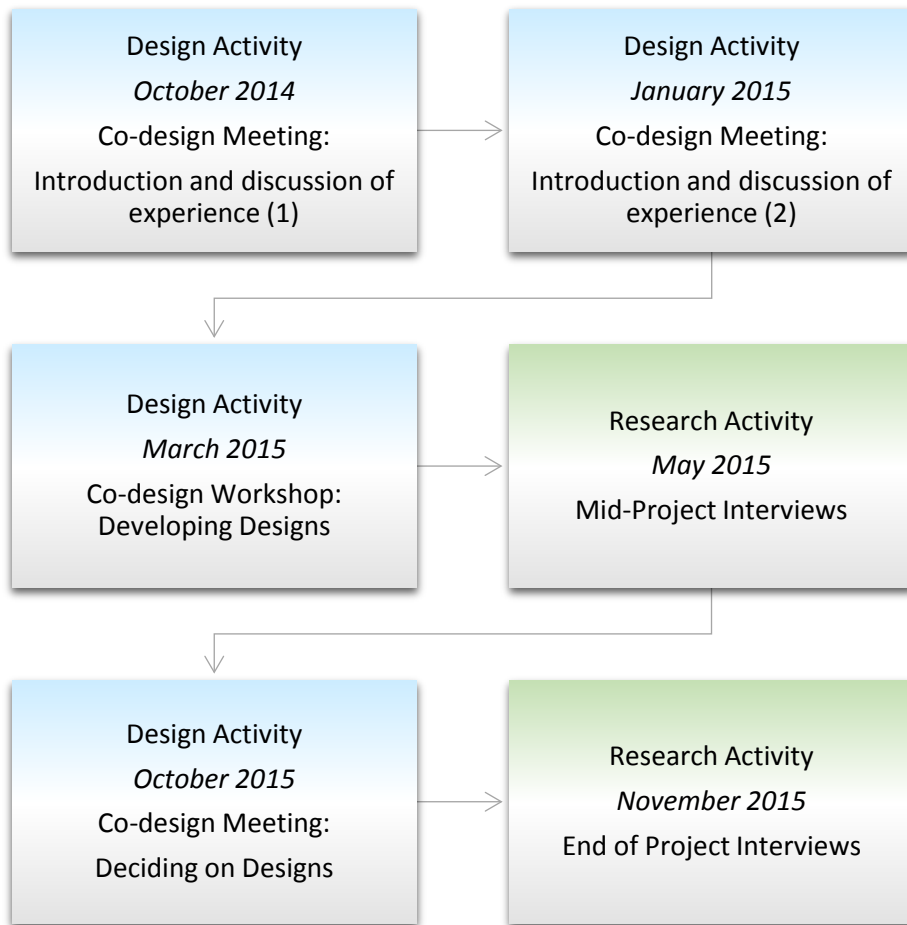
Figure 9 - Timeline of Design and Research Activities

Although interviews provided insight into the experiences of the women, a more detailed exploration of the interactions that occur during the meetings was required. As highlighted in the literature review, the gap in the knowledge appears to be related to how problems arise in co-design groups, therefore the structure of interactions was an important aspect of this study. Interviews only provide one representation of the process, and within the subtle-realist perspective it was acceptable to study different data sources in order to gain a further understanding of the problem to come as close as I can to a valid interpretation of reality. Interviews are also prone to bias (Boyce and Neil, 2006), particularly if the interviewees suspect the researcher is looking for an answer. The women may have discussed the co-design process as better than they experienced due to myself being the facilitator and interviewer, or they may have been more critical. Video recordings were selected as a method to observe the group and enable detailed analysis of the interactions occurring between group members (Silverman, 2010).

There were a number of reasons for selecting video as a method of observational data collection. Firstly, field notes taken during the meetings did not seem appropriate, as I was involved as the co-design group's facilitator. Therefore, taking detailed notes of the groups behaviours while it was happening may have had an impact on the flow of the meetings and possibly the way the women behaved.

Video recordings were selected over audio-recordings to identify who the speaker was during interactions, to see whom the speaker was addressing during interactions, and to note body language. In face-to-face interactions it is important to see who is addressed by an utterance, or where a participant's attention is directed (which can generally be inferred from the direction of her gaze) (Ten Have, 2007).

Another reason for using video footage was that it allowed me to also study aspects of the physical environment (Ten Have, 2007). Researchers are able to review how tools, technologies, and other artefacts play a role in and impact the action and activity under study (Heath, Hindmarsh, & Luff, 2010). Throughout the process a number of different creative design tools were used. These included emotional-mapping, affinity diagrams, and group sketching. Using the video footage to complement the interviews allowed for a

detailed exploration of how these tools, and other aspects of the physical environment, were involved in the interactions between group members (Jordan & Henderson, 1995).

Using video data allows the researcher to play back in order to re-frame, and re-evaluate the analytic gaze (Heath et al., 2010). For example, you are then able to focus on another aspect of interaction as the picture of the group emerges through analysis. This was considered important to the process of analysis as it serves as a powerful method for the researcher to explore different issues on different occasions, unlike field notes where you are constrained by the form in which you made them at the time (Silverman, 2013). As the findings emerged it became clear that there was a need to explore different aspects of the process which did not initially seem 'important'. As stated by Carson, Gilmore, Perry, and Gronhaug (2001), qualitative researchers avoid structural rigid frameworks and adopt more flexible structures. Using video allowed me to adapt my analysis methods as insights developed, which would not have been possible without having the video footage to refer back to. Video recordings allowed me to scrutinise the data multiple times (Ten Have, 2007).

Video recording has been criticized as there is a belief that the presence of a video recorder may impact upon the behaviours of the people under study. This has been labelled as reactivity. However, Heath (2011) argues that the presence of a video recorder does not impact the people under study as after a short period of time this reactivity is reduced considerably. Others with a similar point have argued that people are familiar with video cameras in their everyday life, and get used to the machine and sometimes forget that it is there (Johnstone, 2000).

The position of the camera also has to be carefully considered before conducting data collection. As the aim of this study was to analyse interaction, the camera was set at a wide angle to ensure that gestures or movements were still captured in the frame without having to move the camera. It was vital that the camera remained as unobtrusive as possible (Ten Have, 2007), therefore a stationary camera was considered the most appropriate. For meetings when the co-design groups were required to split into smaller groups, two cameras were used to capture each of the smaller group's interactions (see Appendix 4).

Data Analysis

The data collected consisted of both interview data and observational data gathered during 4 co-design meetings. Framework Analysis (FA) was chosen as a method of data analysis and organisation. The analysis process was iterative, and developed as findings emerged in order to develop a better understanding of the group. The analysis began with thematic content analysis of interview transcripts, prior to selecting the FA tool for data organisation. The initial analysis of interview transcripts is described first under the heading, first pass analysis, and then the process of FA and rationale for choosing it as an analysis method is explained.

First Pass Analysis

The interview data served as the primary data source, as it was considered vital to gaining an understanding of the co-design process through the women's experiences prior to analysing the video footage. The study was exploratory in nature, and in order for the recommendations developed to be beneficial to all the people who took part in the process it was important to understand how they made sense of the co-design process and experienced it (Schwandt, 2001). These findings would then focus the analysis of the video-data, according to what involvement was to the women in the co-design group. The initial approach selected to analyse interview transcripts was thematic analysis, as described by Braun & Clarke (2008). This approach allowed the content of the women's interviews to be grouped into related conceptual themes. The stages of thematic analysis as described by Braun and Clarke (2006) include: familiarisation with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and finally presenting data. The initial stage, familiarisation with the data, involves transcribing the interview transcripts, reading and re-reading and noting down initial ideas. The second stage, generating initial codes, involves open-coding of the entire data set to explore features of the data. During the third stage, where data organised into open codes is grouped together under headings, the integration of other data sources and examining the individual cases against each other became a problem. It was here when it became clear that I needed to look for other thematic methods of data analysis that matched the aims and philosophical considerations presented in the thesis. Framework analysis was identified as a good fit.

Framework Analysis (FA) was developed in the 1980s by the National Centre for Social Research (Ritchie et al., 2013). It is similar to a grounded theory method (Srivastava & Thomson, 2009) in its staged approach to organising an argument inductively from various data sources. However, rather than the aim being to create theory, the FA approach's prime concern is to describe and interpret what is happening in a particular setting (Lewis and Ritchie, 1994). It is a matrix-, or chart- based analytical method (Ritchie et al., 2013), wherein the researcher creates a thematic framework that is grounded in the raw data. The matrices consist of columns made up of the theme headings and sub-headings and the rows represent different cases, which were the type of user in the group: the client and practitioner. This allowed me to view the themes which had arisen from the open-coding done in the first pass analysis of data from different perspectives. Thus, I was able to view the differences in opinions surrounding learning from the different women in the group.

The method of FA undertaken consists of five stages (Ritchie & Spencer, 2002). These stages include: familiarisation, identifying a thematic framework, indexing, charting, and mapping and interpretation (Ritchie & Spencer, 2002; Srivastava & Thomson, 2009), each of which is explained in the following section.

Stage 1- Familiarisation

Familiarisation is the process of becoming immersed in the data and it involves watching and transcribing video footage and reading interview transcripts (Srivastava & Thomson, 2009). This stage occurs before any sorting or organising of data, allowing me to view all the data as a whole. Although during this stage I had acquired all of the data, reading the transcriptions allowed me to put hunches and ideas into context, as a form of conceptual scaffolding (Ritchie et al., 2013).

Stage 2- Identifying a theoretical framework

Identifying a thematic framework occurs following familiarisation, when the researcher begins to recognise themes within the data (Srivastava & Thomson, 2009). Although some authors state that framework analysis should be used when the researcher has priori issues, it is vital that this stage is grounded in the data (Srivastava & Thomson, 2009). The theoretical framework should relate to the key issues, concepts, and themes expressed by

participants (Srivastava & Thomson, 2009). The theoretical framework is only tentative at this stage and open to development through further analysis of data.

Stage 3 Indexing

Indexing involves identifying sections of the data that correspond to a particular theme. This process was applied to all textual data (Srivastava & Thomson, 2009) and helped to refine the initial thematic framework (Ward, Furber, Tierney, & Swallow, 2013). The draft thematic framework was applied back to all transcripts, and notes were made. Based on Ward et al. (2013)'s suggestion that NVIVO is a useful tool to complete the indexing stage as emerging themes can be noted and can be moved when thinking about how themes link to each other, the qualitative analysis computer programme (NVIVO, version 10) was used to develop matrices.

Stage 4 Charting

The specific pieces of data that were indexed in the previous stages are arranged in charts of themes (Srivastava & Thomson, 2009). Data is lifted, or moved, from its original context and placed in charts under headings and subheadings which can be derived from stages 1-3, or priori research issues depending on what is the best way to report the research (Ritchie & Spencer, 2002). While the data has been lifted from its textual context, the cases must be kept in the same order.

Stage 5 Mapping and Interpreting

The final stage, mapping and interpreting, involves the analysis of the data laid out in the charts (Srivastava & Thomson, 2009). This stage allows for comparison of themes and sub-themes (Ward et al., 2013) to develop the thematic framework and to makes sure that it covers the most important issues raised by participants. Gradually characteristics of and differences between data are identified, possibly generating typologies, interrogating theoretical concepts (either priori or ones grounded in the data) or mapping connections between categories to explore relationships (Gale et al., 2013). At this stage the analysis goes beyond description, and starts to suggest explanations for some of the findings of the research (Gale et al., 2013; Smith & Firth, 2011).

FA is a method of data analysis, not a research paradigm (Ward et al., 2013). As a method of thematic analysis, framework analysis is essentially independent of theory and epistemology, which can be applied across a range of approaches (Braun & Clarke, 2006).

FA does, however, align most closely with the subtle realist ontological position (Ward et al., 2013). Subtle realism implies that the social world does exist however we can only come to know it through participants interpretations of it (which are further interpreted by the researcher) (Hammersley & Campbell, 2012). Braun and Clarke (2006) call this the contextualist method. They describe subtle realist analysis as sitting between the two poles of constructionism and essentialism. The contextualist method acknowledges the ways individuals make meaning of their experiences, and the ways in which the broader social context impinges on those meanings (Braun & Clarke, 2006).

Framework analysis was chosen as it provides a method of organising and structuring data analysis that is systematic and methodical (Srivastava & Thomson, 2009), where obtaining a holistic overview of the entire dataset is desirable (Gale et al., 2013). I felt during the initial stages of analysis I was lacking structure and a data management method. FA involves a structured approach with 6 stages which can increase the time taken to analyse data and is a useful method for novices in qualitative research (Ward et al., 2013).

The FA approach provides findings which are grounded in the data, as it is heavily based in and driven by the original accounts and observations (Srivastava & Thomson, 2009). FA also ensures researchers pay close attention to the participants' own voice/experiences before moving onto their own interpretation (Gale et al., 2013).

As data was collected over time and my interpretations of data changed, a method that allowed change or addition throughout the analysis process was considered essential. FA does this as it is dynamic (Srivastava & Thomson, 2009). If the same analysis method and thematic framework were used for the analysis of the first and second interview and the videos (with new themes added as appropriate) it allows for new and old data to be displayed side by side (Ritchie et al., 2013); a framework organising data in a way that makes it possible to integrate later stages of data into the analysis (Ritchie et al., 2013).

NVIVO version 10 was used throughout the stages of FA to help to organise the large amount of data and stages of analysis and interpretation. NVIVO has a built in matrix function which was used to view the data in the frameworks developed.

Ethical approval was granted from the University of Salford Health Sciences Ethics Committee during the first year of the study (HSCR14/57). This section will discuss decisions made to ensure ethically sound research was conducted, focusing on the frequently raised questions associated with ethics in research: codes and consent, confidentiality, and trust (Silverman, 2016).

Codes and consent refer in particular to informed consent, meaning that research participants have the right to be informed about the nature and aims of the research and the right to withdraw at any time (Silverman, 2016). To address this concern, an information sheet was provided at the beginning of the study which detailed the aims of the research and what was expected of the participants (see appendix 5). The women were given an opportunity to ask questions concerning the research either over the phone or email prior to taking part in the study, and face to face when we met for the first time before beginning the video-recording. Following this opportunity to ask questions, the women all signed a consent form (see appendix 6). At the beginning of the second meeting, it was clear that some of the women had forgotten that they were going to be video-recorded. Therefore, a reintroduction was included prior to each meeting. Each of the women who were involved in the study were contacted via email to arrange any meetings, each email specified that they were free to withdraw from the study at any time, for any reason.

The second consideration concerns confidentiality. This means as researchers we are obliged to protect each person's identity, work place, and location (for example) (Silverman, 2013). To adhere to this the group member's names were anonymised following data collection, and any personal data about them was stored without reference to their name, on a locked, secure hard drive. Pseudonyms are used throughout the thesis and in any presentation of the findings, and no personal data concerning the centres where the practitioners worked is provided.

The final concern was trust, which concerns the relationship between the researchers and researched. This concern, therefore, is also related to how trustworthy the findings are and the researcher, which is discussed in the next section on quality in qualitative research.

Rather than be considered prior to the process, as the other two concerns are, trust unfolds and develops throughout the research process (Silverman, 2016). However, a few considerations were put in place. The first relates to the discussion of breast cancer screening, the women may have been uncomfortable with discussing this information or may have become distressed during these meetings. Having the practitioners in the group was a benefit in this situation as if the situation arose where a woman felt distressed, practitioners could answer any questions. Fortunately, none of the women brought up any discomfort or distress at revisiting stories of mammography.

.

Trustworthiness in qualitative research refers to ensuring that the findings reflect the meaning of participants as closely as possible (Guba & Lincoln, 1994). A number of criteria are available for ensuring that trustworthiness is achieved in interpretive research, these include;

Credibility

Dependability

Transferability

Confirmability

(Murphy & Yielder, 2010)

Credibility

Credibility represents the fit between the participants' and the researcher's representations of them. One way of ensuring that the data produced from this study is credible has been achieving prolonged engagement. Baxter and Jack (2008) claim that prolonged engagement with the phenomenon under study allows for rapport to be established with participants. Over the course of the year, I had been engaged with the process allowing a rapport to be built with the participants.

Triangulation of data sources is also considered to be a method of assuring credibility and quality in qualitative research. As multiple data collection methods have been used in the study, findings may be triangulated with different data sources which can promote data credibility (Baxter & Jack, 2008). The method of triangulation used in this study was data collection method triangulation. The two methods of data collection, interviews and observation, were used to look for patterns of convergence to develop the overall interpretation (Mays and Pope, 2000).

Member checking refers to the participants viewing and interpreting the data they themselves provided. However, this assumes that there is one reality out there which is knowable (Hammersley, 2012). Mays and Pope (2000) argue that it may be better to see member checking as a method of error reduction, rather than as improving the credibility

or validity of research. Member checking was not considered appropriate for this study, as it may not validate the women's reflection on their experiences over time. Their representation of their experiences changed and developed throughout time, as I found when conducted the two interviews. Their narratives about the process altered.

Dependability

Dependability is often described as the qualitative version of reliability (Murphy & Yielder, 2010; Shenton, 2004), implying that dependability relates to whether the study could be repeated in the same context, and achieve the same results. Shenton (2004), however, argues that due to types of phenomena that qualitative researchers study this is problematic. Therefore, researchers should aim to describe the processes of their study design in depth, enabling researchers to repeat the study, however not necessarily gaining the same results.

In order to achieve this, a detailed and clear audit trail has been kept over the course of the study. A reflexive diary has been kept, the purpose of which was firstly to note reflections on the researcher's impact on the research project and secondly, to ensure that all findings or ideas relating to the data were detailed. The audit trail, following my steps through FA, can be found in Appendix 7. Using NVIVO software to develop data analysis has allowed a time and dated detailed trail of analysis. NVIVO allows memos and notes to be attached to transcripts. NVIVO was also used to keep a journal on days when I was conducting analysis, providing a clear trail of ideas and finding as they emerged.

Transferability

Transferability relates to the generalisability and the extent to which the findings can be applied to other situations The aim of the study is not to produce generalizable results, however it is hoped that the research findings may be used to explore other situations similar to co-design, or to apply them to the wider content of end-user and operator involvement in groups. To try to maximise this, the study aimed to provide thick descriptions of the context so that judgements (Koch, 1999), and informed decisions can be made about the transferability of this study to other specific contexts (Guba & Lincoln, 1994; Houghton, Casey, Shaw, & Murphy, 2013).

In the attempt to provide a thick description of this study, the context has been provided with a detailed explanation of the background on mammography, and co-design as well as the group under study. The design method and research methods have been described in detail. In the following chapters, where the analysis and findings are presented, raw data is displayed and the process through which the findings were developed is provided in an appendix (see appendix 7)

so that the reader can consider my interpretation (Houghton et al., 2013; Popay & Williams, 1996).

Confirmability

Confirmability is generally compared with quantitative researchers concern for objectivity (Shenton, 2004). It relates to how closely the findings are the results of the participant's experience and not as a result of researcher biases. Murphy and Yielder (2010) suggest a clear audit trail as a method for ensuring confirmability of results, while Shenton (2004) advocates a critical approach to method selection and justification as a method of ensuring confirmability.

The researcher's standpoint is also considered in respect to the trustworthiness of the findings. As I am neither a mammographic practitioner nor a client, any bias towards one side may be limited towards one or the other when analysing the group. Although in instances where I believe I started to favour one group over the other these, other reflective comments are included in the findings section or highlighted in the appendices.

A number of considerations were put in place to ensure trustworthiness. This includes building a rapport with the women. Throughout the course of the project I have met with the women on at least two occasions and have been in contact through emails. A group on a social media site was also set up to discuss aspects of the project. The relationship between the researcher and researched was also considered over the course of the project by offering options for the setting of the interviews and the way in which the interviews were conducted.

Summary of Method Chapter

The research is motivated by making a change for women through giving them a voice in the process of designing the medical equipment that impacts their lives. The power relations between the researcher and researched has been limited as much as possible, both through building rapport and a supportive environment for the women involved, and through conducting interviews in an environment where they feel most comfortable. A reflexive approach has been taken to data collection and analysis. A diary was written in daily and a journal completed during data analysis allowed reflexive notes to be kept and explored to assess the impact I had on the study, and the affect the research had on me.

The interaction between members of the group are sociocultural processes, as different cultures generate divergent experiences (Hammersley & Campbell, 2012). The aim, therefore, was to study these processes, which occur through social interaction and communication. A method that allowed the detailed and in depth analysis of a co-design group was selected which aimed to study social interaction and communication in situ, combined with an emic perspective of the women involved in the study. Design meetings were video-recorded to collect detailed data on the interactions between the group members. This was supported with semi-structured focused interviews conducted with the group members in order to gain an emic perspective of the group culture.

The analysis of data was inductive. The initial stage of analysis was a thematic analysis of interview transcripts, which highlighted areas of interest to focus the analysis of video. Framework analysis has allowed a structured approach to organising data and the argument. The next chapter on this study's findings highlights the initial findings generated through analysis before examining the themes in relation to the literature.

Chapter 4: Initial Findings

Involvement in the co-design group

This chapter highlights the initial findings. What the co-design group did is explored, presenting empirical data from the women's interviews to highlight what the roles of the group members were and what involvement in co-design meant to them.

In order to undertake co-design, as defined by Bate and Robert (2006) in the 6 stage model of EBCD and implemented in this study, the women were required to engage in designer-like thinking and interacting. This section will examine the interactions which the women perceived as 'doing' designing. In the group, the participants contribute to the discussion to enable the joint construction of knowledge surrounding the problem area, and then solutions which may combat the problem. The clients and practitioners had similarities and differences in what they perceived their role in the design process to be, which underlines that the user's involvement in the design process differed depending on user type. Consequently it is argued that there are factors which influence equal involvement as co-designers in medical equipment EBCD. Data is presented to highlight influential factors; these include knowledge, power, and time with the group.

The table below (figure 10) shows the basic interactional functions that the women experienced when participating in the EBCD of mammography machines. The interactional functions are categorised by user group to highlight the different experiences of each.

	The Client	The Practitioner
Remembering past experiences	*"I just wonder if that experience hadn't been recent I don't think I would have been able to give such an input."*	*"I'm a user I know every aspect of it it's as natural as brushing my teeth"*
Understanding an alternative perspective	*"it gave me a real insight into their problems of managing this equipment"*	
Combining viewpoints		*"it makes you address or readdress what you initial considerations were 'cause we look at it from one view*

		point and they're looking at it from a different view point"
Listening	"You know they were very good listeners they were very open minded."	"listening to what the patients wanted was interesting"
Learning (Clinical knowledge)	"You're learning all the time and that's what I love about it. We all learnt on the project, I felt like we all learned together"	
Explaining (Clinical knowledge)		"Explaining the terminology to the patients"
Visualising the equipment	"I found it difficult to visualise them even though we had the diagrams"	
Idea Generation	"we were trying to think about really novel solutions"	"we all managed to get across our ideas"
Idea Elaboration	"coz they were trying to describe it to me and you gerrit on a chest of draws and it's like a shell"	"those evolved as you hear other people's opinion and you sort of think about well actually yer that would work quite well with this idea of mine so let's see if we can get the two together"
Idea Elimination and Selection	"I felt some of the ideas we had where thrown out really or abandoned"	"we just had to say we just can't do it cause of infection control"

Figure 10 - Functional and Task-Related Interactions

The clients and practitioners both perceived their roles to be slightly different. However, common to the practitioner and client were 1) reflecting on and remembering past experiences, 2) listening, 3) idea generation and 4) idea elaboration. The practitioner also perceived their role to include 1) combining viewpoints 2) explaining clinical knowledge and 3) idea elimination or selection. The role of the client additionally included 1) gaining an understanding of clinical knowledge and 2) visualising the machine.

Each of the interactions are explained below. Through analysing how the women talked about each of the interactions the differentiation of roles and possible factors which influence this in co-design is shown.

What does doing co-design involve?

Reflecting on past experiences

All the women in the group reflected on their past experiences of mammography during the co-design process and shared these narratives with the group in discussion. The clients shared their previous experiences of what it was like to have a mammogram taken. Examples of the clients reflecting on their experience are highlighted in the extracts below from the introductory meetings.

> *Joy*　　*Well I just think it's uncomfortable, because the equipment is so hard. You know it's hard and uncomfortable. It's very clinical and hard, and slab like.*

> *Joy, a Client, Introductory Meeting 1, University of Salford*

Reflecting on past experiences as a group happened regularly throughout the process, as the group co-constructed knowledge surrounding the problems with the mammography equipment.

> *Liz*　　*I don't find it painful, (shakes head and looks at Jill). No. I get to the point and think Ok stop now. Ye. The underarm bit can be a bit painful actually.*

> *Jill*　　*I've had a few when I am thinking, you are actually squashing something that hard it's like you are trying to burst something.*

> *Liz*　　*Ye, Ye, you do feel like you're going to burst actually.*

> *Jill*　　*Ye it's going to actually burst or damage some tissue or something.*

> *Extract from Meeting 2, at the Nightingale Centre, Liz and Jill are both clients*

The practitioners in the group also told stories about using the equipment, sharing narratives of the issues they currently face. The extract below shows Ava, a practitioner, sharing one of the issues with the machine to the rest of the group.

> *Ava*　　*I find, because I am tall I have to sit down. I use my body a lot in the MLO position, but when it comes to actually getting the compression down I struggle with the height of the stool sometimes.*

> *Ava, a Practitioner, Introductory Meeting 2, Breast Screening Centre*

Understanding an alternative perspective

A promising finding relating to the success of the group working together was that the clients perceived they were able to understand what it was like to be a mammographic practitioner. This, they felt, was developed through the discussions where past experiences were reflected on and shared. Jill found the process gave her an understanding of the practitioner's workload, and their problems of managing the current equipment.

> *I think that really gave me a lot more understanding of the workload*
>
> *Jill, Interview 1, Client*

> *It gave me a real insight into their problems of managing this equipment*
>
> *Jill, Interview 1, Client*

Alternatively, the practitioners described this differently: rather than co-design resulting in a realisation of the other's perspective it made them readdress the other's perspective.

> *It makes you address or readdress what your initial considerations were cause we look at it from one view point and they're looking at it from a different view point*
>
> *Eve, a Practitioner, Interview 1*

The practitioners felt they already understood the client's perspective, and therefore didn't express that the process gave them insight or understanding, only that it made them readdress the viewpoint of the client through speaking in the group.

Idea Generation

All the women in the group put forward ideas to solve problems they had identified with the equipment. The way ideas were generated and put forward did differ between the client and practitioner. The practitioners expressed that they to some extent already come to the meetings with solutions to the problem in mind.

> *I had ideas in mind*
>
> *Eve, a Practitioner, Interview 1*

However, this was not always the case as Beth, a practitioner, felt her ideas had developed through sketching with the group, rather than through the solutions she had already thought of prior to coming to the group.

Have a scribble on paper that is where your ideas come

Beth, a Practitioner, Interview 1

Jill, a client, also discussed an idea that was generated through the process, she describes it as 'floating in' from the discussion.

It was one that just floated in really wasn't it? I hadn't really thought of it before that meeting

Jill, a Client, Interview 2

All of the group members commented on generating ideas, which they felt were similar in what they wanted.

I think that us and the patients had very similar ideas when it came to the equipment

Beth, a Practitioner, Interview 2

Co-design appeared to give all the women an opportunity to put forward solution ideas. None of the women described generating and putting forward solution ideas as difficult or a struggle, they all felt they had contributed. The differences in how they generated the ideas highlights that they came from lived experience and therefore were personal individual solutions. On the other hand, some ideas developed, and were co-created through discussion with the co-design group members.

Idea Elaboration

The clients expressed that they had been involved in elaborating on, or explaining, their design ideas and how they would work to benefit experience in the future.

Eve   You could do with something you can move about with you

Jill   Wireless

Eve   Ye something wireless, something you could hold in your hand.

Jill   You could have something you hold in your hand

Liz   Like something attached to you, like those things for a hospital bed

Eve   Something you can hold in your hand and type that would be nice

Eve, Practitioner, and Jill and Liz, Clients, Introductory Meeting 2, Breast Screening Centre

The extract above between the clients and practitioners displays the group elaborating on the initial idea of having something you can move about with you. The clients (Eve and Liz) help to build a picture of how the solution might work in the future on Eve's idea of constructing a more detailed description of what the solution would do/be like.

Selecting ideas

All the women felt that they had an opportunity to put forward to, elaborate on, and discuss ideas. However, the interactional demand of decision-making and of selecting an idea was perceived to be the role of the practitioner. This was viewed negatively by the clients as they felt ideas were eliminated before they could develop some of the idea suggestions. This quote from an interview with Beth shows her role as a decision-maker in the design process.

> *They had ideas and some of the ideas erm I sort of had to say well you can't really have them on the equipment*

> *Beth, a Practitioner, Interview 1*

The way in which the clients spoke about the practitioners restricting and eliminating ideas is hereby shown. This highlights a lack of negotiation or discussion surrounding the alternatives and reasons for eliminating an idea. Not discussing alternatives could be detrimental to the process of co-design. As decision-making is not shared between group members, but falls to the practitioner in the group.

> *it's just that I think we did get a bit stifled a bit sort of restricted really.*

> *Jill, a Client, Interview 1*

Explaining Professional Knowledge

Learning from the practitioners was an important part of the process for the clients, which most of the clients specified as a benefit of being involved in the group. Throughout the process the practitioners explained how the mammography machine worked, the research surrounding mammography, and the medical terminology which was associated with the machine.

> *I think they explained things quite well at the beginning and they answered questions*

> *Joy, a Client, Interview 2*

The explanation of how the mammography machine worked was used to ground their collective knowledge; this included the terminology they used for the discussion about different aspects of the machine. In the below extract Eve, a practitioner, is explaining the

terms that the practitioners use to describe parts of the equipment, giving Jill a word to use to describe an aspect of her experience which both the groups will understand.

> *Eve then moves onto the next stage of the touch point discussion. She mentions the paddle, and again Jill asks her "… and the paddle is?" Eve describes this as "what we use to squash you", Jill calls it a "plate" and Eve tells her it's "the plate that moves down". Jill repeats this, and uses her hands to represent the two plates, "so the paddle is the plate that moves down, rather than the one that is stationary".*

The practitioners, however, did reflect on the challenges associated with not having a common language to describe the equipment.

> *Yer cause it was like 'oo when we put the paddle down' and they was like 'what's the paddle?'*

> *Beth, a Practitioner, Interview 1*

This links with the clients developing an understanding of the piece of mammography equipment from a medical viewpoint. The next section of the results explores the clients' perspective on gaining an understanding of the mammography machine.

Gaining an understanding of the machine

Gaining an understanding of how the mammography machine worked, for the clients was an interesting aspect of the process, which they reflected on positively during the interviews.

> *You're learning all the time and that's what I love about it. We all learnt on the project, I felt like we all learnt together*

> *Joy, a Client, Interview 2*

Jill reflected specifically on an aspect of her learning during the interview, concerning the current mammography machine and its function.

> *Tina*, erm said something about the quality of the image it's got to go through. I thought oh gosh it's so basic that.*

> *Jill, Client, Interview 1*

(Tina is a pseudonym of one of the practitioners in the co-design group)

The clients felt they had gained from the process of co-design through learning about the function of the machine, and that this was a way in which they could contribute more to the design process. Having this understanding of the equipment and how it works made them more aware of what could and couldn't be done within the scope of the existing piece of equipment.

Visualising the machine

Visualising the machine for the clients involved trying to imagine the current equipment and how it moved throughout the mammography examination. Joy particularly found this difficult to visualise when the practitioners were explaining their current problems with the machine.

> *They were talking them through but I found it difficult to visualise them even though we had the diagrams*

> *Joy, a Client, Interview 2*

While the 2D diagrams the women were looking at helped to visualise the current equipment, there was still some difficulty in understanding how the equipment moved and

worked. Difficulties in visualising the movement of the machine made it problematic for some of the clients to associate narratives of practitioners' issues with aspects of the machine.

Benefits of involvement in co-design

The interactions which appear to be successful in co-design, in that involvement was shared between the group members, lie in co-constructing knowledge surrounding the problem area and the current piece of equipment. All the women felt they had contributed to the problem area through remembering past experiences and discussing them with the group. This allowed the practitioners to readdress the client's viewpoint, and for the clients it enabled them to develop insight into the practitioner's problems.

Another aspect which the group all felt they had contributed to was generating ideas. Although they reflected on generating them in different ways, it appears that co-design can facilitate idea generation from a range of users through discussion and the design tasks. The findings also highlighted that these users are already developing ideas through just using the equipment and therefore could provide valuable insight and ideas about how their experience could be improved.

Difficulties with involvement in co-design

The difficulties for the clients in the co-design process surrounded visualising the current equipment and taking part in idea selection and elimination. Liz describes not taking part in the process of idea selection and elimination due to her perspective being limited as she did not understand what the practitioners did.

> *I thought cause I don't know their limitations of what they need or anything so I thought I'll just put what I think and then you know? As the lay person, not knowing anything about the machine*.

> *Liz, a Client, Interview 2*

This is manifested in the way both the practitioner and client describe what their role was. The practitioner was described as '*the practical voice*', and the clients' role was described as '*to tinker around the edges*'. This highlights that although the clients were able to take part in the process through shaping the problem area and putting forward solutions in the idea

generation phases of the design process, they were not initially involved in decision-making due to what they perceived to be their lack of knowledge surrounding the current mammography machine.

What was also made apparent was that different people struggled with certain things surrounding what they currently knew. For example, the clients expressed some concern with not being able to visualise the machine during discussion. Two of the aspects of 'doing' co-design that were specifically only linked to the clients in the co-design process were perceived negatively by the group. These included trying to visualise the current piece of equipment and not taking part in the idea selection and elimination.

Who does what in co-design? The role of the client and the role of the practitioner

The role of the client included the majority of interactional functions associated with understanding the problem area. However, they did not perceive their role to include some of the interactional functions that the practitioners specified in the interviews. These interactions included solution-driven interactions such as idea selection and elimination. The role of the client also included gaining an understanding of clinical knowledge, which was taught to them by the practitioners in the group.

When the women described their role in the co-design process the clients clearly linked their input, or contribution, to the group based on their past experiences and therefore the experiential knowledge they could add to the group.

> *What our main contribution, if you like, is this is what it feels like to be and have a mammogram with the equipment.*

> *Jill, Interview 1, Client*

> *I think that if it had just been me I could go on with about how uncomfortable it would be and suggest the possible solutions but my perspective is fairly limited because I am the end user*

> *Joy, Interview 2, Client*

Alternatively, the practitioners expressed their role as the practical voice in the group, to make sure things worked in practice. Highlighting their role was not only to bring

experiential knowledge, but clinical knowledge of how the mammography machine worked in practice.

Yer to make sure it worked in practice.

Kate, a Practitioner, Interview 2

The practical voice in the group

Beth, a Practitioner, Interview 2

The interactions identified that were solely the responsibility of the practitioner, which included explaining clinical knowledge and selecting and eliminating ideas, point towards the practitioners using clinical knowledge as a way of controlling the decision-making in the group, through explaining reasons why the equipment wouldn't work. Knowledge as an influencing factor in co-design involvement is discussed in detail in the chapter 5, on the key themes.

A change in involvement over time

What appeared to be missing from the women's description of the design process and taking part in design was any discussion of argumentation or negotiation. In fact, the clients expressed that they felt there was no room for negotiation on some of their design ideas, particularly when it came to selecting ideas and eliminating ideas. Although there was some frustration for the clients in not being able to take part in the idea selection and elimination, a number of the women commented on how the group dynamics changed over the course of the process. As an example, Jill's description of negotiation in the group is presented, highlighting how she felt the dynamics had changed allowing for more discussion and challenges.

I felt some of the ideas we had where thrown out really or abandoned erm, without really letting us have a good talk about it

Jill, Interview 1, Client

In the second interview Jill did comment on how the dynamics changed by the final meeting, highlighting that time may be a factor which influences involvement in co-design.

I felt I could challenge her more, and she didn't seem to object to it.

Jill, Interview 2, Client

Time as a factor for change in the group is discussed in detail in the chapter 5, on the key themes.

Summary of what it means to be involved in co-design

The group allowed women to co-construct a joint understanding of the problem area through sharing past experiences of mammography. For the practitioners this allowed them to readdress the clients experience and combining these perspectives to gain a more complete picture of the problem area of the mammography machine. For the clients, on the other hand, they gained an understanding of the practitioner's perspectives. Being in the collaborative group also facilitated learning on the part of the client, as they developed an understanding of the clinical terminology and knowledge associated with the use of the mammography machine.

From this analysis of the women's perspectives on what their role and functional interactions were in the design process it became clear that there were a number of factors that influenced the involvement of clients and practitioners in the co-design process. Firstly, knowledge; secondly, power; and finally the influence that time spent within the group had on their dynamics and interactions as part of the co-design process.

These three concepts of knowledge, power, and time within the group provide a theoretical framework for understanding involvement in medical equipment co-design. The literature on these three concepts is referred to in the next chapter. Empirical data supporting the generation of these themes is also presented.

Chapter 5: Key Themes

Key Theme: Knowledge

Grounding *Knowledge* as a key theme

EBCD is founded on humanistic beliefs (Wright & McCarthy, 2010) and theoretical perspectives from phenomenology (Merleau-Ponty & Smith, 1996; Schutz, 1967) and ethnography (Geertz, 1982, 1994) which are used to access and explore experience (Bate & Robert, 2006). The aim is to understand experience from within the cultural perspective of the user, in this case from both the mammography practitioner and client. From a phenomenological perspective, experience is considered in this sense to be a subjective, immaterial phenomenon that can only be accessed through the words and language people use when they look back over it and try and describe it (Bate & Robert, 2006). After this knowledge has been captured the design process should be centred on the experience of the user through their cultural and social perspectives. Knowledge of experience was a key factor in bringing together clients and practitioners into a co-design process as both are experts of their own different subjective experiences of mammography machines. While the clients will have experienced having had the machine used on them, the practitioners will have experiential knowledge of physically using the machine. To use subtle-realism's ontological terminology, each of the women involved will have their own representation of the mammography encounter, having been directly being in the experience at some point of their life.

The argument for experience being included in design is not based on its truth, but on the appropriateness or usefulness to the design process. Many believe that experience can be integrated into the design process (Cain, 1998). The clinical knowledge of the practitioners is built through their professional education and their experience as qualified mammographic practitioners. This knowledge was shared by the practitioners at various stages of the co-design process. The practitioners explained terminology and jargon to the clients as well as more detailed knowledge relating to operation and theory behind mammography machines.

The initial analysis and findings highlighted a distinction between what the clients and practitioners believed they could 'do' with certain types of knowledge. For example, the clients felt that they could not be involved with idea selection and elimination based solely

on experiential knowledge which highlights that they themselves doubted the validity of experiential knowledge.

Knowledge-sharing and knowledge-construction are theoretically different things, the latter being associated with the socio-cultural theories which underpin the development of collaborative design outcomes (Glăveanu, 2011b). Knowledge-sharing is considerably less useful to the generation of ideas, however it is vital to the early stages of co-design wherein the group are required to share their experiences of a service. van Aalst (2009) makes a useful distinction between knowledge sharing and knowledge construction. Knowledge-sharing refers to the transmission of information between people. As a social practice, knowledge-sharing activities involve the introduction of information and ideas *without* paying particular attention to their interpretation, evaluation, and development. Knowledge-sharing, then, is linked with the epistemic view of naïve-realism wherein data speaks for itself and ideas shared are not modified by the sharing interaction (van Aalst, 2009). On the other hand, knowledge-construction refers to processes wherein the group construct an understanding of complex concepts which are central to solving the problem of redesigning the mammography machine (van Aalst, 2009). Knowledge construction involves more than sharing narratives, but includes explanation-seeking questions and evaluating new information to create new concepts (for example, the women should be reflecting on their own understanding of the current problem, and all of the concepts that are discussed in the group in order to create a new, collaborative understanding of how the problem can be solved).

This study focuses on equipment design, which perhaps differs from service re-design in that the focus is somewhat technical. This faces the stakeholders in co-design with difficulties regarding the epistemological arguments for different types of knowledge. The standard by which we make decisions regarding technical, functional pieces of equipment is based within positivist paradigms and standards of judging truth (Nordin, 2000). This implies that the more objective technical knowledge presented by the practitioners may have more influence over the experiential knowledge put forward by the clients. The validity and practical usefulness of the client's experiential knowledge in decision-making has been questioned in health (Caron-Flinterman, Broerse, & Bunders, 2005), and the users in the

design sciences (Von Hippel, 1988). However, it is often considered that their input into framing the problem area, is both useful and necessary towards developing a design (Shah & Robinson, 2008). Through accessing the patient's knowledge of their experience, the things we as researchers produce, study, and recommend, will be more in line with their needs and beliefs. However, within the scope of EBCD, the aim is not only to capture the clients and practitioners needs but to engage and empower them to develop solutions for themselves and to co-construct a solution that will best meet the needs of both, hence the process being labelled as collaborative and a partnership.

The theoretical underpinnings for knowledge as a theme concern:

- EBCD suggests that experiential knowledge should be understood and shared to build an understanding of the problem area and solution and guide the design process. Therefore, a representational space of experience should be constructed through interactions and communication within a group.
- Validity and usefulness of experiential knowledge may be disputed based on cultural and social beliefs surrounding objective vs subjective knowledge
- It is not clear how other types of knowledge are integrated and used in the design process and how learning about clinical knowledge might influence the users' voice.

This section presents the key theme of knowledge. The perceptions of women towards their own knowledge together with their experiences of sharing and learning in the co-design group are explored. Firstly, the women's account of their experiences in sharing and developing knowledge throughout the co-design process is discussed. Secondly, this section looks at how knowledge was used in the co-design process. The findings of this study revealed the type of knowledge impacted on its perceived usefulness in the co-design process. This section will present the women's perspective of two different types of knowledge identified through the analysis: experiential knowledge and clinical knowledge. The analysis in this section highlights how experiential knowledge was perceived to be less useful than clinical knowledge.

The sharing of narratives and experiential knowledge is discussed first in this section, before discussing its impact on the rest of the group. Clinical knowledge, and its impact on the group, is then presented.

The practitioners' experience

The practitioners shared aspects of their experience of using the mammography machines throughout the discussion of the user journey. Through sharing their narratives of using the machine, the practitioners built an understanding of the issues they face with the contemporary mammography machine.

> *Ava* *You could do with a step sometimes that the women could stand on. I mean I use the stool a lot, to save my back*
>
> *Eve* *It's my thumbs but that's changed since we don't have film anymore. It was terrible, erm, but you change your technique to fit in with the equipment I think. Cause if you hurt yourself doing it once.*
>
> *Ava* *I've done that a few times, I've caught my. As I have been leaning a lady in, and my hand has just been stuck between the lady, the detector and the rib-cage if you will. It goes really quickly and it really does hurt your fingers because you get really trapped, but that that again that's a positioning thing*

Eve and Ava, Practitioners, Introductory Meeting 2, Breast Screening Centre

In the extract above, Ava and Eve are talking about what it is like for them using the equipment and some of the problems they face. Ava ends by concluding that the touchpoint, which needs to be readdressed, concerns the positioning of the women in relation to the machine.

Within the group, the practitioners communicated their current issues with the equipment, asking questions to see if other had had the same problems. In some ways, this validated their problems with the equipment. In the extract below Ava and Eve, both practitioners, demonstrate reflecting on the problem areas with the machine and establishing what they both know about their past experiences. Ava ensures that Eve is also aware of the problem she has.

> *Ava* *Does yours automatically go to an angle?*

Eve   *It goes to the last angle that was used*

Ava   *Right, we've got one which goes to the last angle and that's a lot better but some people don't use the same angle that we use*

Eve   *Ye I change mine*

Ava   *I change mine a lot but I base, it on 50. But some of my colleagues do it at 45. So*

Eve   *I was somewhere yesterday and their machine, it was really hard to get to a specific angle so you would press it and it would shoot over and it would go back past.*

Discussing problems in the group also helped the clients to gain an understanding of the problem area, although they did not have the same representation of the issue as the practitioners. Jill, a client, associates the problem the practitioners have with her sewing machine and Liz agrees.

Ava   *And our foot peddle doesn't always register when you go down so you're just stood there pushing your foot down thinking why it is not going first time, because it should register because you are still pressing it. Same with the compression, all of a sudden it moves and you're just like "where's that come from"*

Eve   *Hmm ye, there's a bit of a delay between them*

Jill   *It reminds me of a sewing machine*

Liz   *Ye! ((laughter))*

Jill   *When I'm doing my hems.*

Eve and Ava, Practitioners, Liz and Jill, clients, Introductory Meeting 2, Breast Screening Centre

I have learnt from that too, from their perspective, like that has been a learning curve for me.

Joy, A client, Interview 2

The clients were surprised by the practitioners' narratives of their experiences and the problems the practitioners faced when using the mammography machine. In the co-design meetings, the practitioners told the clients about the repetitive strain injuries, back problems, time constraints, and other areas of their experience which needed to be addressed as part of redesigning the mammography machines. The clients specified that a benefit of the co-design process was how they had gained an understanding of the practitioner's problems when working with the equipment.

That would have been a big thing for me to realise it wasn't just the women who were having the mammogram but the radiographers who had problems too.

Jill, a Client, Interview 1

For the clients, gaining an understanding of the practitioners' experience when working with the equipment had changed their own perspectives of the clinical environment. Like Springham and Robert (2015), the clients felt that the experience of co-design allowed them to see a more human and less distant side of the staff.

Because my experience of radiographers is you go into somewhere and they sort of they it can be a very cold clinical environment, because, and now I have seen it from their perspective I will now go to my next mammogram and see it in a completely different light I think.

Joy, A client, Interview 1

The way the clients interacted with the practitioners during the exchanges when practitioner problems were being discussed highlighted their interest in finding more out about the problems and issues they faced. The clients took an 'interviewer' role in the group asking questions and trying to visualise what it was like to be a practitioner. In the extract below from a design meeting Joy highlights the interview's role, as she asks questions and

106

aims to establish a shared understanding of the problem practitioners have when positioning the breast.

> Joy is it just your fingers? Or your shoulders and your wrists and things?
>
> Kate it's your shoulders and your back
>
> Tina So you try to adapt your technique to change
>
> Joy So do you have to come across then with your arm?
>
> Tina so I think that's a big thing for the equipment
>
> Joy Is it just your arms or your backs as well
>
> Kate yer it's the lower back, but now we have got stools so you can sit down
>
> Joy so what is it about the equipment is it because it's heavy or?
>
> Tina well you've got that big bulky head and you're trying to get to the lady and you're like this

Joy, client, Tina and Kate, practitioners, University of Salford,

Taking this role Joy, asks a lot of questions, trying to get a further understanding of problems that the practitioners face. She tries to visualise their experience as she brings her hand over her face to try and re-enact the movement that might result in RSI's and she asks to see an image of the machine to get an idea of what is causing the problems.

> *You know in some ways there problems were more significant because they had to do it day in day out.*

Jill, A client, Interview 1

Hearing the practitioners' experience was an important benefit of being involved in the co-design process for clients, it allowed them to develop a shared understanding of what it was like to use the machine. Sharing experience of being a professional user appeared to influence the goals of the client; it made them address their initial ideas of what needed to

be changed. Their involvement as the expert of their own experience altered, as they became more knowledgeable about what the practitioners went through.

It is an unusual situation for health professionals to share their problems and issues with patients and clients. In this study, this appeared to result in a change in perspective towards mammographic practitioners as well as influence the aims and goals of the clients, highlighting the importance of sharing experience in co-design. This however was not always the case. Liz, a client, mentioned in the interview that she had considered the problems the practitioners faced prior to the meeting

> *Even I before I even came to your group I always wondered when we went for mammograms these mammographers don't half have to more around. You know? Doing that day in day out I used to always think that anyway so I did understand their point of view.*

> *Liz, A client, Interview 1*

> *It's good talking through the experience, because you go and have your mammogram and you might mention it to a friend and then that's it*
>
> *Joy, client, Introductory Meeting 1, University of Salford*

When talking about their previous experience of having a mammogram taken, the clients described being uncomfortable and in pain. It was clear that the clients at first struggled to access aspects of their experiences, as they only have a mammogram every three years. Initially the women were quite vague regarding the aspects of the machine that were uncomfortable.

> *I mean I was lucky because I had only had a mammogram 2 weeks before*
>
> Joy, a Client, Interview 2

> *I just wonder if that experience hadn't been recent I don't think I would have been able to give such an input.*
>
> *Jill, a Client, Interview 1*

Unlike patients' interactions with services, which can extend weeks, months, or years, clients' interactions with medical equipment are often short, lasting minutes or possibly hours. Within the context of screening, interactions with equipment tend to be short. In mammography, practitioners are only permitted between 5 – 6 minutes to assess each breast in two positions, the CC and the MLO. If the client is having a routine screening then they will only experience this once every 3 years. Therefore, their narrative is likely to be short when retelling their experience of mammography machines.

The practitioner, although using the equipment every day for however many years after they have been qualified, will do the same 5 -6 minute procedures on each woman. They do, however, alter their technique depending on a number of factors relating to how they were taught, the individual who is being screened, and the piece of equipment they had used.

Eve   Yes. Well it is such a short time. And it's only every three years.

Ava   It's over like that (she clicks her fingers)

Transcript from Nightingale Meeting

The length and infrequency of the experience of mammography machines was expressed by the women as an issue in the process. The clients struggled to remember aspects of the machine which caused discomfort or pain during their experiences of having a mammogram. However, this appeared to be helped by the retelling of the experience in a group. As the group built up their story of what it was like to interact with the mammography machine, the women 'remembered' and retold what they at first struggled to vocalise. Through making their experience of mammography machines explicit, the user groups confirmed and extended their knowledge. This highlights the importance of sharing experience of equipment interactions within a group rather than through individual interviews, some of the details of experience may not have been told without having the others in the group. This finding resonates with the focus group literature, as group processes can help people explore and clarify their views in ways that would be less easily accessible alone (Kitzinger, 1995).

It is not to say that a more dominant voice of the clients came forward during the meetings who steered the discussion. The women disagreed with each other's experiences and put forward their own.

The practitioners also made reference to the clients' experience as being 'hazy' and differentiated their experience as being "as natural as brushing your teeth" and "daily", and the clients who "didn't remember all the bits" or "didn't acknowledge everything to do with the machine".

> *You know … a patient couldn't give you that kind of experience coz you don't have it. And you don't have the day in day out, you know.*
>
> *Joy, a Client, Interview 1*
>
> *they only have it once every three years, so you're not gonna really remember much.*
>
> *Beth, A practitioner, Interview 1*

However, the perspective of the practitioners perhaps implies that they believed their version of the experience was more valid than that of the client because they wouldn't remember everything to do with a mammogram and the mammography machine.

Unlike other studies (Bowen et al., 2013a; Dewar et al., 2010), the practitioners did not experience hearing the clients' perspective as helping to see through their eyes, but the process did help to bring to the forefront issues they were already aware of. Bringing the clients' experiences to the forefront had a wider impact resulting in practitioners reflecting on their own practice to be more considerate around clients.

> *Now as a practitioner I am a lot more patient with the people that I am X-raying because I know it's not nice and I know it sticks in your arm and all the rest of it.*

> *Kate, a Practitioner, Interview 2*

> *We didn't really understand the patient's point of view and their sort of perspective*

> *Beth, A practitioner, Interview 2*

Impact of hearing the client's experience

> *It was nice having them there cause you can see what they wanted changing and what their perspective was, as well as the practitioner's perspective.*

> *Kate, a Practitioner, Interview 2*

Like the study of Vennik et al. (2015), the practitioners felt much of the experience the clients shared they were already aware of. This appeared to have lessened the impact of hearing the client's previous experiences of mammography as the practitioners' aims and goals were not altered in changing and developing a more woman-friendly mammography machine. Hearing the clients experience of mammography changed the practitioners approach to practice. The practitioners also found it useful to see what the clients wanted from the machine. However, they did not feel that it changed their aims of the co-design process. This highlights that the experiential knowledge of the client did not have as much of an influence on the practitioners, as the practitioner's experiential knowledge had on the clients.

It makes you address or readdress what your initial considerations were because we look at it from one view point and their looking at it from a different view point so I think it's important to remember it's not just us using this machine

The client's experiential knowledge does not appear to have influenced the design process when considering the practitioners' view of their design goals and aims. This has important implications for the actual impact and involvement of the clients in the process of design.

Recognising subjective representations of experience

Outlined by the quote taken from the introductory meeting held at a clinical setting, the practitioners recognised that there may be a difference in the experiential knowledge of the client and the practitioner. Both, Eve and Ava are practitioners. On several occasions during the meeting when describing the procedure, the practitioners explained why they did something in relation to the impact it should have on the experience of the women.

Eve says "It's interesting this, you tell us what happened and we will tell you what we think happened." And Ava Laughs.

Introductory meeting 2, Breast Screening Centre

The practitioners in the group recognised that their training and experience in mammography does not always result in the same objective experience.

Like a large number of the studies presented earlier in the literature review (Dewar et al., 2010; Grocott et al., 2013; Tollyfield, 2014), the women who took part in the study reflected on their learning during the process. Both clients and practitioners learnt about each other's experiences of having a mammogram taken and of using the mammography machine.

Having outlined experiential knowledge that was shared and constructed in the group, this section will explore clinical knowledge. Specifically, knowledge which was shared relating to the mammography machine brought into the co-design discussion by the mammographic practitioners.

> Joy   *I think if you're working with other practitioners it can push you out of your comfort zone sometimes like the structure of the foot and all the rest of it, but you're learning all the time and that's what I love about it. We all learnt on the project, I felt like we all learned together*
>
> Sam   *Hmm, Yer*
>
> Joy   *we actually all gained from it*
>
> Sam   *Ye*
>
> Joy   *Which I thought was incredibly – that was one of the hidden benefits.*

Joy, A client, Interview 2

The analysis highlighted the emphasis that the clients placed on their learning as part of the co-design process. They had learnt a certain amount of clinical knowledge relating to the field of radiography, how x-rays were produced and the mechanical operation of the machine, such as the materials the compression paddle needs to be made of.

The practitioners also reflected on the value of clinical knowledge in the process. It was important to the practitioner to share their clinical knowledge of mammography to ensure that the whole group had an understanding of how the machine worked. The practitioners

113

attached a lot of importance to sharing their clinical knowledge of mammography, and the clients often reflected on learning as a major benefit of the process.

> Kate   think they were quite surprised how technical it is and it's not just put a boob on a plate and squash it there is more to it than that and I think they erm. I think it was a good experience for them as well as for us to be able to talk about that.
>
> Sam   Hmm, Yes.
>
> Kate   I think they learnt a lot from being there.

Kate, A practitioner, Interview 2

As the clients developed an understanding of clinical knowledge they move away from being the expert of their experience to being involved in the group as someone who has more input than just their experience, but can present their newly learnt knowledge relating to the operation and use of the machine.

Clinical knowledge was not shared while the group were developing an understanding of the problem, referred to in the literature (Burkhardt et al., 2009; Détienne et al., 2012b; Paulus, 2000) as grounding and coding what we know. This came into the co-design workshop wherein ideas were put forward. This creative phase was influenced by clinical knowledge, expressed by both the clients and practitioners. The exploration and evaluation of ideas was done using clinical knowledge rather than experiential knowledge.

Beth a practitioner brought up about how she used her clinical knowledge in the co-design meetings during her first interview. Her knowledge of mammography and the existing equipment meant that she was able to make decisions in the group about what could and could not be added to the equipment.

I sort of had to say well you can't really have that on the equipment because it will get in the way or it won't work and things like that.

Beth, Practitioner, Interview 1

Here Beth alludes to two types of knowledge which informed her decisions in the co-design process to stop ideas going forward. Firstly, she brings up her experiential knowledge of the

equipment. She infers from her previous skills and capabilities of using the machine that something couldn't go forward because it would get in the way. Secondly, she touches on her clinical knowledge with the theory that if this design idea she is discussing was to be made it may not work.

Summary: Knowledge as a key theme

This section has highlighted what was shared within the group and the influence that it had on the women involved. While experience was viewed as meaningful to the women and necessary to share, hearing the practitioners experience appears to have had more impact on the clients than the other way around. This may be an important finding in relation to each of the user group's involvement in the co-design process. Clinical knowledge was also shared between the group members; the practitioners shared their understanding of the function of the machine, taking a teaching role in some stages of the design process to educate the group members on their discipline specific knowledge. Again, this also may have influenced the involvement of each group member. As the client's contribution to the group was their own subjective experience and they learnt and were influenced by the practitioners, on a level which did not appear to be the same for practitioners, this may have 'muted' their voice as experts of their experience.

Key Theme: Power and Empowerment

It's all very well complaining about it but it needs something like this for women to actually say, well this is what we want.

Eve, Practitioner, Interview 1

Grounding *power and empowerment* as a key theme

Many definitions of what power exist and fall within different worldviews (e.g. Lukes, 1986; Foucault, 1982). In this study power will be viewed as an explanatory concept, one which has been used to help see why things are done a certain way and not otherwise. This view is similar to that of Bratteteig and Wagner (2012), they argue that in participatory design projects power concerns having a voice and a say in the decisions which constitute the final artefact. Therefore by studying power relations we can get a better understanding of the involvement of different parties in co-design projects, to understand how power may influence the collaboration and decision-making of different types of user. Organisational theories of power (Clegg, 1989; Lukes, 1986) and secondly, notions of power by Foucault (Foucault, 1977, 1982) are discussed.

The organisational theories on power take a fairly positivist approach in that power can be held by somebody or a group and can be used to control or influence something. This view of power is useful for understanding and explaining why and how certain things influence the design process and the group. In order to begin the analysis on the expressions of power within this group – both positive and negative – some useful distinctions about power can be made. The organisational theories of how power operates in groups includes both the ability to control others and the ability to accomplish one's goals (Holmes & Stubbe, 2015). Dahl (1961) examined the power one group or person has over another. Dahl explained power as a force in which a person (A) has power over another (B). A is able to make B do something that will benefit themselves but not B. In this form power is seen as a win-lose relationship (VeneKlasen, Miller, Budlender, & Clark, 2002), and has many negative associations such as coercion, and discrimination. Within the co-design group this facet of power may result in one user group or individual being coerced into decisions. This power over another is thought to originate from a number of variables associated with A. Expert power is central to the argument presented in this thesis, is based on the perception that A has some special knowledge or expertise (French, Raven, & Cartwright, 1959).

Within the literature on medical power, uses of power concern the bases laid out by French et al. (1959). Hewitt-Taylor (2004) discusses the challenge of changing the balance of power, highlighting that uses of power include coercion or persuasion, which can be achieved by clinical knowledge (Hewitt-Taylor, 2004). Although, the situation in co-design differs from the clinical encounter it is important to consider the variables associated with knowledge as a form of power. Therefore it is important to consider Foucault's view on Power/Knowledge.

To Foucault power was not fixed, but knowledge production results in constant alterations of power relations (Wellard & Bethune, 1996). Power/ knowledge was a term he used to signify that power is constituted through accepted forms of knowledge, scientific understanding and truth (Foucault, 1982). Knowledge informs power in that we tend to believe certain forms of knowledge over others and we take them as the 'truth'. Therefore, it is what we take to be the truth which reinforces who has power. Foucault's view of power/knowledge therefore links both the theme of knowledge and how the different types are used and viewed as being more or less useful with the observable power struggles that may exist within the group.

Taking power to be an explanatory concept, both the organisational conceptions of power and Foucault's Power/knowledge assist in understanding the relationship between power and knowledge. The organisational theories highlight reasons why certain user groups may have more influence over another. Foucault's theory asks that researchers go beyond thinking of power as fixed and look at the social and cultural understanding of different institutions of power (Foucault, 1982).

Empowerment is believed to be positive and closely intertwined with power. Like power, empowerment takes on different forms in different contexts (Bradbury-Jones, Sambrook, & Irvine, 2008). Central to the motivation behind involving lay people in the design process is the ideology view of empowerment; through giving the user a space to redesign we are empowering them to take action and make decisions about things and services that impact their lives. In this way empowerment represents a handing over of power from one group or person to another. Empowerment is generally thought of as both power 'to' and power 'with'. Power 'to' refers to the unique potential of every person to shape his or her life, when based on mutual support, it opens up the possibilities of joint action, or power 'with'

(VeneKlasen et al., 2002). People or groups gain power 'to' through learning, or gaining more resources, or having a voice where they previously may have not. Power 'with' refers to establishing a common ground and a collective strength within a group. It could be in the form of support, solidarity, and, particularly relevant to co-design, collaboration (Bradbury-Jones et al., 2008).

The theoretical underpinnings for knowledge as a theme concern:

- Power may be manifest in co-design groups as control and influence of one group over another.
- It is important to consider how this may be both a benefit and a negative of co-design, we can look at this through further assessing the perspective of the women involved and non-decisions.
- Clients viewed practitioners as having expert power.
- Power is not fixed, but operates in institutions therefore the wider clinical relationship should be considered.

By incorporating the various forms and theories of power outlined above, a view of power is presented. Power in this instance relates firstly to involvement within the group. Therefore, the aim is to analyse the women's involvement in the group in terms of their influence over other members of the group to explore power in the group. Beyond this, the analysis will also embed these power relations in institutes of power operating within the group, such as the health systems and the existing client-practitioner relationship as well as making links to the accepted forms of knowledge and truth. It is important to note that Foucault's conception of power/knowledge and truth was not considered prior to analysis however when going back to the literature it resonated with the findings that were unfolding and was then applied to the analysis to support and develop an understanding of how the group functioned as well as give a critical dimension to the analysis of the findings.

Knowledge, role, and power and empowerment are all linked concepts developed through the analysis of the co-design group. The role of each user type has been defined in terms of the women's involvement in the group. The role the women played in the group suggests a close relationship with power and ultimately the empowerment of each member. Here I will explore power and empowerment through the voices of the women involved, and through the analysis of observational data.

Power

Power issues between the group members were identified in the interviews with the clients; they highlighted that in some cases the practitioners where able to exert influence on the way decisions were made. Here knowledge and power are explored with a focus on the relationship between knowledge types, role, and decision-making in the group.

> Kate   *as much as we want to change it we want it to work, and we do want it to change for our patients, as much as we want to improve it it has to work for 50 women a day. 70 women a day, and we have to be able to clean it. Hmm ye we had the practical role.*

> *Kate, a Practitioner, Interview 2*

Knowledge of experience has been described as the clients and practitioners sharing their previous experiences of mammography and was characterised by their personal narratives. Clinical knowledge on the other hand can be coded in respect to knowledge of radiography and mammography. This included areas such as stating results from surveys and research, describing and explaining how aspects of the machine works, and scientific facts, such as how x-rays are produced. Basically, this type of knowledge makes up the other two aspects of 'good design' as described by Burken and used by Bate & Robert (2006) to base their foundation for including the user in the design process; engineering and function.

> Jill   *It's not the edges it's the shape, so the flat. So if the paddle was that shape*

> Liz   *Concave*

> Jill   *Concave so your ribcage was here, are you with me.*

119

Eve   *In the older days of film, that wouldn't have been a practical because of the cassettes coming in and out so it would be difficult with it being a different shape, but you wonder now it is just a detector*

Ava   *Ye*

Eve   *It's a patch work detector anyway you should be able to do something with the shape. It would work in the CC, I just don't know how it would work in the Lateral. ((Looks towards the clients)) because you might miss this vital bit of breast tissue ((moving hand across her ribs and under arm))*

Jill   *Of course*

Eve   *Perfect for the CC. But then when you go to the sideways picture*

Liz   *Well can you just, does it have to be a one size fits all? Could you not change it? But you have got your time constraints haven't ya.*

Ava   *Well ye, because of the mechanics behind them*

Eve   *The detector its self is £60,000 just for that detector so we try to discourage people from*

Jill   *Changing it. So the detector is on the base plate isn't it?*

Ava   *Ye*

Eve   *Ye that's the one*

<div align="right">Co-design workshop July, University of Salford</div>

Clinical knowledge was initially identified by the clients as a positive; they wanted to learn the aspects of the mammography machine in order to contribute to the design process. Interestingly this clinical knowledge was expressed by both the clients and the practitioners, and when the group were speaking and interacting with the using the voice no conflict or issues emerged. However, when experiential and clinical knowledge were in contention with each other conflict between group members arose leading to differences on the perceived goals of the project and the aims of the task. The voice each of the women took during the meetings impacted their role within the group, and in turn their influence in involvement. The voice of clinical knowledge was perceived as having a higher value in the group and therefore had more power in decision-making during the process, which in turn resulted for more impact on involvement. Although the voice of experience was considered to be useful and meaningful to the group, it had less power in the group therefore did not

result in the involvement and empowerment of clients previously found in other studies on co-design. On the other hand, the clients felt as if they did learn during the co-design process and because of this were able to make decisions which are often cited as a source of empowerment during client and practitioner collaboration.

There are a number of issues this study has highlighted. These relate specifically to the role of knowledge and the role of the user in terms of power and empowerment.

Eve   *I teach positioning, and there are certain things we cannot change, but there are certain things we can do to adapt what we are already doing to make it better. It's like loads of things, there is only one way we can turn a tap on, there's only one way you can turn your car on*

Joy   *There is more than one way to turn a tap on*

Liz   *Ye, you could have sensors*

Eve   *There are some things, they are what they are. And when it comes to positioning for mammograms we have to get the breast on the detector, by hook or by crook, we have to do it in the 2 views that we've got. Unless we start looking at reams and reams of research and trying to change positioning techniques that we are going to use.*

Co-Design Workshop, ranking touchpoints, Eve is a practitioner, Liz and Joy are clients.

Eve starts this discussion by asserting her role as a teacher; this makes it difficult for even the practitioners to challenge her. Her voice here is of clinical knowledge, I – the teacher of mammography, she is not talking about her experience but what she knows of radiography. The clients, Liz and Joy, do challenge one thing she said relating to their only being one way to turn a tap one, but they do not challenge her clinical knowledge as a teacher of mammography. Clinical knowledge is used her to restrict the scope of the design process, highlighting its power and control over involvement in the design process.

As identified in chapter 4 on the initial findings and the role of group members, there was a

lack of negotiation and argumentation between the women in the co-design group. Thus, this results in scope of the design outcomes being limited or restricted. A clear exercising of power between the clients and practitioners arose in the form of non-decisions that is the practitioners were able to put restrictions or limitations on the scope, or focus, of the design process as expressed by Jill a client.

> *Although I think at that point I started to feel that the radiographers because they are so used to the equipment where putting limitations on what, what was possible to do.*

> *Jill, a Client, Interview 1*

> *abandoned without really letting us have a good talk about it*

> *Jill, a Client, Interview 1*

Non-decisions or control over the scope of the design process was also observed where the practitioners eliminated touchpoints for further development by deciding on whether they were or weren't important.

Change was identified as a category within the theme of empowerment. Both groups discussed how the process encouraged a change in the existing ways things are done. The practitioners particularly felt that the process allowed them to have a say, where they would otherwise would have not due to the way manufacturers and companies work.

Eve reflected on the barriers to change, which are further influenced by the existing ways in which medical equipment is bought. She reflects on the power that people above have in the buying of equipment without informing people who will be using it. She reflects on when users and manufacturers are brought together it is normally only after there has been an incident.

> *We keep buying it as it is and don't say anything about it we just buy it and use it they have meetings and stuff but only when something goes wrong or there's an incident and then they get the manufacturers and the users together*

> *Eve, Practitioner, Interview 1*

These extracts highlight the feeling of a change in the power relations between the manufacturer and the user. The clients and practitioners in this sense felt empowered as they had been given a platform and a voice to have a say, where they would not have normally done so. Co-design then, from the women's perspectives, moved them from powerlessness through the covert stage – i.e. they were considered as valuable in making decisions.

However, the way in which they made these decisions and were influenced by their existing beliefs and values moves beyond this singular dimension of power to highlight how latent power and control might have been an issue within the group, rather than from external groups (such as manufacturers).

Power 'with' the group

On the whole the group felt empowered through being given the opportunity to have a say in what they wanted from the equipment. The women reflected on their role in the group, and often emphasised the importance of being in a multidisciplinary group as enabling them to do more than they could alone. The clients identified that they couldn't have done it without the practitioners and the practitioners couldn't have done it without them. For the

123

clients, having the practitioners in the group gave the group more power to do something, to create designs and to produce a new piece of equipment. This extract from Joy's second interview highlights this feeling of power 'with' the group.

> *Joy   You see we couldn't have done that without the radiographers.*
>
> *Sam   Yer*
>
> *Joy   And the radiographers couldn't have done it without us. And you couldn't have done it without any of us.*
>
> *Sam   Hmm*
>
> *Joy   So as a group we were much stronger really.*

<div align="right">

Joy, Client, Interview 2

</div>

When asked about her contribution to the design, Joy expressed that as a group they were able to do things they wouldn't be able to do individually. Other clients expressed the same feelings towards working in the group. This statement, along with others interpreted through the analysis of interview transcripts, highlights the perceived collective ownership of the final designed ideas.

The process of co-design appeared to represent moving away from complaining and into action. The process encouraged a change in that the women could say what they wanted, moving from the saying to the doing aspect of design. It appeared to be about taking power away from the manufacturers and those in high positions and giving it to the end-user, whether that was to the client or the practitioner in an arena to give ideas.

> *It's all very well complaining about it but it needs something like this for women to actually say, well this is what we want. There's never been any forum to say this is what we want from our machines.*

<div align="right">

Eve, Practitioner, Interview 1

</div>

Two of the clients discussed breast cancer as a reason for taking part in the process. Due to their family history or personal history of breast cancer, it was therapeutic for one to discuss their experiences; while another felt it was their duty to get involved in the process. The other client that was interviewed wanted to get involved because she had an interest the equipment and how it was designed.

> *The first things was my mother had breast cancer so she had a double mastectomy and several other family members had, and it made me in a vulnerable group and I always make sure I attend mammograms and a few years ago I had a scare following a mammogram and I was at the Nightingale for a biopsy and so on so that really makes you aware.*

> *Joy, Client, Interview 2*

> *Something about having had that, my work history and my mammogram, my own personal experience of the breast cancer it's been. It was nice, it has been nice for me really, it's been a thing I have thought about and enjoyed doing and been happy to participate in it.*

> *Jill, Client, Interview 2*

Change for the mammographic practitioners

The practitioner highlighted change as an important aspect of the co-design process. During the meetings and interviews, the traditional way of designing equipment was often challenged and as the quote from the interview with Eve highlights that this process was an opportunity for her to have a voice in the design process, where she hadn't had one before.

> *It's all very well complaining about it but it needs something like this for women to actually say, well this is what we want. There's never been any forum to say this is what we want from our machines.*

> *Eve, Practitioner, Interview 1*

In summary, this section has explored the various facets of empowerment in the co-design process, highlighting the benefits to the individual, the user groups, and the group as a

whole. For a number of the women the process was empowering as it gave them a voice, and encouraged action. For the group as a whole, the women appeared to feel a sense of power 'with', in that they were able to do more in a multidisciplinary group than they would alone. However, there were also some issues of power between the group members and external influences.

Key Theme: The group over time

Something changed. The dynamics changed in that 3rd meeting

Jill, a Client, Interview 2

Grounding *time* as a key theme

A large number of studies explore how groups develop over time (Gersick, 1988; Wheelan, 1990), following a sequential pattern of qualitatively different stages. Groups develop from their formation to their dispersion (Tuckman, 1965; Tuckman & Jensen, 1977; Wheelan, 1990; Wheelan & Mckeage, 1993).

In 1965 Tuckman brought together and reviewed the group dynamics literature to propose a theory of group development. Tuckman's theory follows the stages of forming-norming-storming-performing-adjourning (Tuckman & Jensen, 1977). The stages are separated into two streams, the task-related and the socio-emotional, or relationship aspects. More recently, Wheelan (1990) proposed an integrated model of group development that was developed through a systematic review of the various existing models that had previously been offered. In contrast to other models of group development, Wheelan's integrated model has been validated through a number of different methods in different contexts (Wheelan, 2009; Wheelan, Davidson, & Tilin, 2003; Wheelan & Hochberger, 1996). She states that there are commonalities among proposed models regardless of the type of group: the length they are together, and other variants. The phases of Wheelan's (1990) integrated model are: dependency and inclusion, counterdependency and fight, trust and structure, and work and termination.

Phase 1: Dependency and inclusion. This phase is marked by high anxiety among members, as well as uncertainty and politeness. Team members are concerned with issues such as being accepted, reducing uncertainty and setting boundaries, therefore tend to defer to the leader.

Phase 2: *Counterdependency and fight.* This phase is marked by the presence of conflict, power struggles, search for identity, and definition of roles among team members.

127

Phase 3: Trust and structure. As conflicts are resolved, mature negotiation process occur at this stage. The team show the presence of team goals, structure within the team, procedures, roles and division among labour. Ideas and feedback are exchanged openly.

Phase 4: Work and termination. This phase is marked by team members feeling comfortable with sharing information. There is a good sense of where the knowledge and expertise lie within the group.

In 2009, Wheelan investigated whether group development over time was a reality by studying 26 work groups who had been together differing lengths of time (Wheelan, 2009). Using the Group Development Observation System, GDOS (Wheelan & Hochberger, 1996), a meeting of each group, which lasted on average 45 minutes, was transcribed and coded. The GDOS organises interactions into eight categories which sit within the four phases. Participants were also asked to complete the Group Development Questionnaire (Wheelan & Hochberger, 1996). The study found that the younger the group the more fight statements were observed, and the older the group the more work statements were observed. An interesting outcome of this study was that the participants' perceptions of the group were linked to their verbal interactions. This study highlighted that groups do indeed follow a similar pattern to the stages highlighted by Wheelan, therefore researchers studying groups should take into the account the level of development as it is likely to influence the findings in studies on group decision making and action as the groups method of making decisions will alter over time.

The empirical findings presented under this theme heading, consist of observational and interview data. Organised chronologically, observational data are presented from each of the meetings to support or contrast against the women's perceptions of the group to give a more in depth understanding of the group's dynamics during each stage.

My role in the process was to facilitate the group discussion, guide the group through the tasks involved in the design process as well as organising and scheduling meetings. Therefore, I will have influenced the group's development and interactions throughout the stages of the design process (Miranda & Bostrom, 1999). Reflective entries on my role in the

process are also included in this section as an important aspect of both the group's dynamics and Wheelan's model (Wheelan, 1994).

When the co-design group first met …

Type of Task	Specific Tasks	Stage in the Process	Summary of what was involved
Exploring and elaborating	Discussing the user journey and experiences	Stage 1	A step by step narrative discussion of the use of mammography machines from both mammographic practitioners and mammography clients

During the first stage, which spanned over two similar meetings, the women discussed what they had experienced when having a mammogram or taking a mammogram. The focus of this proportion of the meetings was for the women to share their narratives of their experiences with each other (Bate & Robert, 2006). Sharing experience is a central feature of the co-design process. This task involved all the women, clients and practitioners, talking through interactions with the mammography machine.

Two user journey co-design meetings took place, as explained in the description on design. Two were held to ensure that all the women in the group had a chance to express their personal experiences with other users. One was held at the University of Salford, wherein two practitioners (Tina and Kate) and one screening client (Joy) attended. The other meeting was held at the Nightingale Centre, a breast screening facility in Manchester, wherein different women attended. In attendance at the Nightingale meeting were two practitioners (Eve and Ava) and two clients (Liz and Jill).

The women expressed feelings of uncertainty towards the project before attending the first meeting. Joy (a client) and Eve (a practitioner) both commented on not knowing what to expect from the other group members.

> Eve   *because it's your first time you don't really know each other or what I guess you want*

> *Eve, a Practitioner, Interview 1*

The uncertainty in the group appeared to come from not knowing each other or what to expect from the other type of user in the group. Joy described feeling more comfortable once she had an understanding of where the practitioners were coming from.

I thought that went really well, I thought that after we'd done the introductions and we knew who was who and where people were actually coming from which is sometimes tricky because trying to see somebody else's perspective

Joy, A client, Interview 1

The uncertainty in the group is mitigated by developing an understanding of the other group members and what their goals are for the redesign process. In this study this occurred quickly as the group began to discuss their own experiences. The women appeared to feel confident in their experiential knowledge, having understood this was the focus of the first meeting they were able to comfortably put forward their own ideas and opinions. As highlighted by, Morrow, Cotterell, Robert, Grocott, and Ross (2013), the co-design process allowed the clients to validate their experiential knowledge by sharing it with others.

Eve   Yer once everyone got going I think ideas started to come out quite easily from people everyone definitely had their own opinions of what should and shouldn't be part of the equipment that came out quite clearly

Eve, a Practitioner, Interview 1

Apart from feelings of uncertainty expressed by a few of the women prior to attending the meeting, the interviews highlighted that the group felt comfortable during the user journey co-design meetings. The women described the first group meeting as comfortable, and there was no clear distinction between the client and the practitioner group.

It was nice erm it was very very comfortable and I think we chatted away, without being conscious of the different groups we were from.

Jill, a Client, Interview 1

Both, Jill (who attended the Nightingale meeting) and Joy (who attended the meeting at the University of Salford) felt the atmosphere in the group when discussing their experiences was comfortable and open. Worchel, Coutant-Sassic, and Grossman (1991) argue that the

first stage surrounds forming a group identity, wherein the group is based on the 'norm of equality' and little distinction is made between members. This was evident in the way the clients described the group, and their experiences of being part of the group.

The clients appeared to have a positive view of the initial introductory meeting and sharing their experiences with each other.

> *What I really like was the very open discussion and very positive*

> *Joy, a Client, Interview 1*

The women felt the group were considerate and good listeners. Politeness in this sense relates to a low amount of relationship conflict (Jehn & Mannix, 2001), which is thought to permit the group members to become more familiar with each other (P. P. Shah & Jehn, 1993).

> *You know they were very good listeners they were very open minded.*

> *Joy, Interview 1*

This appeared to work well in the group, making the clients feel as though their experiences were heard and suggestions were valued by the clients as they got to know each other.

The group also displayed politeness towards each other; the extract below from the Nightingale meeting highlights this. Liz suggested an idea to focus on as part of the design, the practitioners in the group then put forward a number of reasons that the idea might not work. As practitioners, Ava and Eve fight the idea of having a mammography machine that you can lie down on, due to cost, time, and space. Both, however, end the discussion by trying to ensure that Liz does not feel as if her idea has been thrown out. Ava tells her it is a good suggestion, and Eve, tells her it is something they would definitely want to think about.

Ava	You would struggle to get in breast tissue that way as well
Liz	Would ya?
Ava	Ye
Eve	Cause the arm
Ava	It's a good idea, it's a good suggestion

Eve   It's certainly something we might want to think about

Liz   Ye

This was an interesting finding as the same suggestion is presented for a second time in the following meeting, where it was received differently by the group. The idea of lying down is discussed again in the next section on the co-design process, to show how the group's dynamics developed around evaluating and discussing an idea.

Like participants in Locock et al.'s (2014) study, the women appreciated each other for listening to their experiences, perspectives, and beliefs towards mammography. For the clients, they felt it was important to be heard and that this aspect of the process gave them a voice. They believed it to be the most important part of their role was to bring and discuss their experiences. During this stage, the group appeared to feel empowered as they were given a voice and a platform to have their say.

There was also a feeling of power 'within' the group in that the women didn't differentiate between the two user groups which made them more cohesive as a group as they recognised that they had a common goal, to improve the mammography machine.

Having this forum, or space, to move away from 'complaining' and into action also seemed to empower all the women in the group. They spoke about change and the importance of having these meetings together. Task-orientation can take place in the initial stage of group development, where the group discuss how they will approach the task. Due to the nature of the task, the group did not display any orientation as the rules had been outlined by me.

In the words of both the practitioners and clients the first meeting was comfortable and open. This is a positive aspect of the process. The observational data assists in confirming that the group were at ease with each other and felt comfortable to discuss intimate information regarding their breasts, previous diagnoses of cancer, and other worries they had regarding mammography. The meeting at the Nightingale showed a lot of laughing and joking between the group members. The clients often shared jokes about their own breasts. The practitioners also felt comfortable enough to share jokes about their own clinical practice.

Eve   Then you put the paddle on and you've got it set up

Jill   ((Hand rested on her chin, leans in looking at Eve)) and the paddle is?

Eve   What we use to squash ya

Jill   Is actually the plate?

Liz   The plate

Jill   The bit that comes down as opposed to the bit that is stationary?

Eve   Ye. (1.5) Make sure you have a range of paddles anyway ((Leans forward and looks towards Ava))

Ava   ((unfolds arms and leans into the table slightly to look towards the clients)) Ye that you have a range of paddles

Jill   Do you have different shapes and different sizes?

Eve   We have two

Ava   We have a mini one for small breasts ((puts hands in front of herself, in parallel, quite close to each other)) a medium one for normal, like smaller, breasts ((moves hands slightly further apart, but still in parallel)) and a larger one ((moves hands further apart still))

Liz   ((Leans into Ava)) I think I have the heavy duty ((Looks around to Jill, who is laughing with her head tipped back.

((Eve, Ava, Liz, Jill, and Me are laughing))

The extract above from the user journey discussion highlights the sharing of knowledge surrounding the mammography machine and its different component parts. The clients worked towards gaining an understanding of the machine and Joy feels comfortable enough to continue interrupting the discussion by asking a number of questions to reduce her uncertainty in the group. The extract ends with Liz joking about her own breast size, which is well received by the group. The group all laugh at Liz's joke about her breasts and the rest of the group also start laughing. Holding their hands to their faces, can seem as blocking during

interactions (Mahmoud & Robinson, 2011). Where the hand is used as a guard in the conversation, however, the women were not covering their mouths, and the position of their hands, showing interest or evaluation which occurred to Pease and Pease (2008) in their definitive book on body language. Therefore, this did not seem to be blocking of any kind as the women still did this when they were relaxed and laughing with the rest of the group. They moved from serious subjects to humour interspersed with their learning about the machine and seemed generally interested.

My Role in the Introductory Meetings

The practitioners often looked at me and told me what they wanted changing. Within the first minute of the meeting at the University, a practitioner had directed a statement at me as to what she wanted me to develop on the mammography machine. This may have been due to a lack of clear definition of role, however I had provided information sheets and gone over the stages and what was involved. Another reason for this could be due to the women's uncertainty in the process, therefore by asking me questions or passing over some of the task responsibilities to me they were reducing the uncertainty of the task.

Tina	*We would do the QA first thing in the morning so you have to make sure the QA tester is clean.*
Sam	*((Writing on the Flipchart paper and looking down)) Hmm, OK*
Tina	*Actually ((points her finger towards me and waits until I have lifted my head up to speak again)), you might want to look at how the QA's done. Whether there is some sort of integral alarm or alert.*
Sam	*OK ((looks down and writes idea on the piece of flipchart paper))*

Both Wheelan's (1999) and Tuckman's (1965) models of group development characterise the first stage of group development as dependence, which can be observed through a dependency on existing status rules and through conforming statements. The observations of the initial meeting highlighted, to some extent, that the group appeared to be dependent of existing status beliefs. The way the group interacted with me at the beginning of the meeting highlighted this. Knowing that I was a mechanical engineer by background, they may have directed suggestions to me, rather than discussing them as a group. This could

have also been due to my specifying the ground rules in the information sheet. Therefore, I had to some extent established control over the group.

Summary of the user-journey co-design meeting

In summary, the user-journey co-design meeting wherein the clients and practitioners shared stories of their previous experiences was open and comfortable and there was little relationship conflict between the two user groups. The group members, although uncertain about the project before attending the meeting, seemed relaxed enough to ask questions and tell jokes about themselves and their own practice. There was little distinction between the user groups and no inter-group conflict was observed in the video data or expressed by the women in their interviews.

The co-design workshop

The co-design workshop took place over the course of a day. When interviewed, the women felt a change in dynamics took place as the workshop progressed. The extract from Jill's mid-process interview highlights how she felt that the practitioners had begun to influence decisions '*at a point*' following this first discussion.

> *I found the free flowing discussion at the beginning very helpful and very useful, erm although I think at that point I started to feel that the radiographers because they are so used to the equipment where putting limitations on what, what was possible to do.*

> *Jill, Client, Interview 1*

It was clear from the interview that the clients felt there was some tension within the group during the second meeting; they specified task-related tension and quite emotional responses to this during the co-design workshop that had not been present in the first meeting.

> *Liz   Because I personally felt like my ideas weren't worth as much as somebody else's ideas.*

> *Sam   When did you feel that?*

135

> *Liz   Hmm, not at the very beginning meeting or anything but I don't know when*
> *we were doing the design bit definitely definitely.*

<div align="right">

Liz and Sam, Client and Researcher, Interview 1

</div>

During the interview I had asked Liz how she found the second meeting. She then went into detail about how she felt quite upset following this meeting as her ideas were not given enough thought or discussion. This indicates, a lack of consideration and negotiation surrounding the design ideas at this stage of the process. This negotiation is referred to as task-related conflict and is thought to be helpful in group situations and can improve performance if managed correctly (Jehn et al., 1999; Van Knippenberg et al., 2004). If members of the group confront the difference in perspective, more information is exchanged as ideas are evaluated leading to a better considered idea. However, if the group choose to avoid task-related conflict, the potential benefits of having the diverse perspectives in the group may not be realised (Van Knippenberg et al. 2004). The next section explores each of the tasks which took place during the co-design workshop in chronological order.

Type of task	Specific tasks	Stage in the process	Summary of what the meeting involved
Decision-Making	Ranking touchpoints	Stage 2	Discussion between group members to identify specific moments which caused problems and associate these with features of the machine. These are then ranked in order of what needed to be addressed.

The workshop began with a discussion of the previous meetings to identify and rank the experience touchpoints. These touchpoints were then ranked by the positive and negative impact they have on both the user's experiences. This involved a more direct discussion wherein decisions had to be made about which problems were prevalent and which were not. After the discussion of previous meetings' minutes to recap, the group were required to label an aspect of the machine that caused discomfort that could be developed to reduce any issues with the machine.

It was during this task that the women in the group began to further elaborate on their experiences and begin to challenge each other's preferences for change and negotiate what the focus of the design process would be. The task involved decision-making rather than sharing stories, therefore the group dynamics and approach to the task appeared to change. The differences in involvement lead to more conflict between the women in the co-design group. In the interviews the clients identified selecting and ranking touchpoints as an aspect of the process wherein the practitioners had a more powerful voice in the group members decision-making.

Unlike the user journey meeting, there was more differentiation between the client and practitioner group. The role of the users as two separate groups became evident during this task. The practitioners took a more task-related role by defining the problem and leading the discussion surrounding what could and couldn't go forward.

Jill   Yes it's once you're in position it's the squeezing there

Liz   [We are] talking this bit? ((*Points to the diagram*))

Jill   Yer, Yer

Liz   [The front] and the corner and then the top

Sam   I will just split them up

Liz   You're still gonna get squashed tho aren't ye?

Anne   Well

Joy   we were talking

Anne   if you think that the squashing you can't do anything about the compression
       if you can make everything else more comfortable. Surely it could be better

Liz   Oh yer yer definitely

Co-design Workshop, University of Salford, July 2015

The clients expressed feeling unsatisfied and restricted by the practitioners, who were making decisions about what could and couldn't go forward. The extract above from the co-design meeting highlights Anne, a practitioner, making the decision that the group could not change the compression, only make it more comfortable. This decision limits the ideas and designs that the people in the group can put forward, therefore the exchange of ideas and knowledge around new and novel ideas become restricted. Although the decision was not challenged by anyone in the group, the clients reflected on these types of decisions as dismissive. Therefore, indicating that a recommendation needs to be in place to ensure that all group members are encouraged to comment on their feelings towards decisions made during the co-design process.

Type of task	Specific tasks	Stage in the process	Summary of what the meeting involved
Creativity-Tasks	Affinity Diagram	Stage 2	Structured Brainstorming around the touchpoints identified in stage 1, and ranking earlier in the co-design workshop.

The purpose of the affinity diagram was for the all the women in the group to contribute ideas for each of the ranked touchpoints. Four touchpoints were kept on the board which couldn't be solved through discussion. For example, the position of the women's feet was an area which was a problem, but the group agreed that this could be solved with a line across the floor so the client knows where to put their feet. This was not kept for the affinity diagram as the group felt they had come up with a solution to this issue. The different mammography machine touchpoints and the ideas added to the affinity diagram are in Appendix 8.

The affinity diagram appeared to work well. All the co-design group got up and added ideas to the touchpoints. Most of the women remained silent during this time, writing on their post-it notes and getting up to put them on the board. This was also confirmed in the interviews with the practitioners and clients, who felt it was a good aspect of the process, as they got to express their individual ideas.

> *I think it's a good idea; it's just a chance for everybody to express themselves individually*

> *Beth, A Practitioner, Interview 1*

The group were polite during this stage, and made an effort to encourage others if they felt they couldn't contribute to the different touchpoints identified.

> *Joy   Well I think that is hard because I don't know the component parts. Because you had the opportunity to ((Looking at Jill)). You saw the equipment*

> *Jill   Yes we saw all the equipment*

> *Joy   So you can step back then and look at it.*

Eve   Well look at the picture there ((Pointing at the screen with a picture of a current mammography machine on)).

Joy   Ye

Eve   What can you see on that machine where you think, oh ye, I want to change that, and maybe then you can try and visualise it.

Joy   Well you know you were talking about

Eve   When you're confronted with that in the room, what would you think? Well you want to get rid of that that and that because that looks really horrible and that does work for me

After ideas had been put forward the group split into smaller groups of both clients and practitioners to sketch some of the designs which had been suggested in the affinity diagram stage.

Following the affinity diagram, the group had some concerns about which of the touchpoints stayed and which didn't. This may indicate that the group had either reflected on these, following putting forward ideas, or felt they couldn't specify these earlier in the meeting when they were discussing and ranking touchpoints. Joy felt that certain aspects of the experience had been lost by separating the narratives into components of the machine and expressed this to the group. However, there was a clash of perspectives between her and the practitioners.

Joy   One of the things I think you're missing Sam, is you are losing the piece of equipment as a whole ((lifts and raises both arms to highlight the whole machine)).

Sam   On the whole?

Joy   Sometimes by looking at the component parts ((moves her hands in various directions to highlight the different bits of the machine we have discussed)) you lose oversight don't you.

The rest of the group, however, do not seem to be interested in the piece of equipment as a whole part. Eve leans back and puts her hand behind her head and yawns. Then the group start to go in another direction surrounding what they are talking about. Joy tries to pull the conversation back to the whole machine.

Joy   *((Leans back in her chair and moves her hands across her body in a defensive positon)) If we are trying to be radical I think we need to stop thinking about what we have already got*

Eve   *((Leans over the table, across Joy, to point to a sketch in front of her)) I bang my head on that all the time, but I can't change that because that's where the x-rays come out of*

Anne   *((Laughs))*

Eve   *So there are certain aspects of it that we can't*

Joy   *You could put foam on it ((Joy has a serious expression here))*

Eve   *((Laughs and leans back, making eye contact with Beth another practitioner))Hmm ye ((They both chuckle))*

Jill   *Well, then, does that need changing in its shape? Or are all those things been done*

Eve   *Ye it's where the generator, it's where the x-ray generator is.*

Extract from co-design workshop, Jill and Joy are clients, Eve and Beth are Practitioners.

At the beginning of this section on the co-design workshop the quotes from the interviews highlight that the clients felt there was some tension between the clients and practitioners. This tension centred on the lack of negotiation surrounding the development of creative ideas. Dismissive was a word used a lot by the clients when describing the interactions of the practitioners of their ideas at this stage. This indicates that the task-related conflict was somewhat avoided by the clients as the practitioners eliminated ideas without argumentation or negotiation which led to emotive responses from the clients as well as having an influence on the performance of the group and the design outcomes.

The practitioners also commented on a change in the second meeting. Interestingly, Kate only began to feel comfortable by the second meeting.

I think we were more comfortable with each other after the first meeting. I think we could kind of say and be more honest about what we thought.

Kate, Practitioner, Interview 2

This indicates that the practitioners felt more comfortable when they were in control. As commented on earlier, the practitioners made the majority of decisions in the co-design workshop as they expressed clinical knowledge as reasons that ideas couldn't go forward.

The second meeting: Being Creative – Group Sketching

Type of task	Specific tasks	Stage in the process	Summary of what the meeting involved
Creativity-Tasks	Group Sketching	Stage 2	Splitting into smaller groups, of 3, to focus on specific touchpoints. Ideas from the affinity diagram where used to drive the group sketches. Each small group was given a minimal 3D representation of the existing affinity diagram to sketch on (see Appendix 8).
			The last stage of the co-design workshop was for the group to all get back together and discuss their sketches.

The co-design group separated the touchpoints into two sections, they decided on the Detector and Free-Arm position as one category to be looked at, and the other touchpoints, buttons and displays, and the paddle where separated into another group. The two groups where Joy, Anne, and Eve who focused on the buttons and displays and the paddle. The other small group was made up of Jill, Liz, and Beth who focused on improving the detector and Free-Arm position.

The group of six who came to the co-design workshop then separated into two smaller groups of 3. They selected these groups based on where they were sitting. The tables where moved so that the smaller groups had their own space to discuss the two touchpoints they had and to sketch the design ideas.

Each of the smaller groups took ideas from all of the women involved in the co-design process, this lead in part to ideas being eliminated or misunderstood between group members that were later interpreted by the clients as their ideas being dismissed without discussion. For example, an idea which had been put forward by Jill to do improve the paddle was to make it like a 'nail bed'. Although the small group who are sketching the paddle ideas try to understanding the idea of a paddle being telescopic, the group end up bundling the idea with other concept for improving the paddles design.

> Anne   So we're on the paddle now. ((She reads off the post-it note to the rest of the group.)) Shape changes similar to a nailbed, like a hand print.

> Eve   Flexible ((She then writes this down on the sketch))

> Anne   ((Looks off into the distance, rather than at the other women, as if trying to understand an idea.)) Ye so somebody was saying, because ((touches her chest wall)) your breast is thicker at the back ((long pause, she is still looking off and squinting slightly as if trying to visualise the machine.))

> Joy   So it sort of bends at the back?

> Eve   They already do this ((shows the sketch that she has been drawing)) They already flex like this ((uses her pen to show the way the paddle flexes)) Because we can't have it too wobbly or you aren't going to get the compression are you? ((Looks at Anne))

In this extract, it is clear that Anne and Joy are both trying to visualise the idea of the paddle being like a nailbed. However, in the end the idea gets written down as a nailbed rather than further considered or discussed. Once Eve had said to Anne and Joy that the paddle is already flexible they move onto the next point.

During the time, sketching the discussions got more in-depth about the operation of the machine as the group members evaluated ideas before putting them down on the drawing.

A specific point during the course of the project saw the group as a whole deconstruct and eliminate one of Liz's ideas which made her feel ridiculed and as if her ideas weren't as good as other peoples. During this point in the process, the practitioners began to tell Liz and the other clients why the idea could not go forward. This eventually saw the other clients agreeing with the practitioners and joining the discussion to evaluate and eliminate Liz's idea. Pre-existent knowledge of radiography and objective facts became more dominant in the group than in previous tasks.

> Jill   Free hanging really was the idea

> Anne   Free hanging ((laughter))

Liz   The angle of the dangle haha

Jill   Low hanging fruit

Joy   You might need a sling for some people

Eve   That's the thing because you have got quite small breast and all the padding from the thing you are lying on and the detector can only go up so high so you have got quite a gap between the chest wall and where the detector is so you miss out quite lot of the back of the breast. It's all very well with the biopsies cause you can move and manipulate the lady to get into position but if we are doing the bog standard screening you can see the entire breast

Anne   And you would have to go very high up for the radiographer to go underneath it

Liz   It was just a thought ((laughter)) it's not my baby don't worry

Eve   The tables do go quite high and you wheel yourself underneath on a stool

Joy   Oh right, I can image trying not to fall off

Anne   Ye for someone who is frightened of heights

Joy   I am just thinking about the amount of time it would take to get a, a client in the lying down position as opposed to

Jill   And that's why you just use them for biopsy's

Liz   You just asked me to put my thoughts on paper

Sam   No, no it's good

Joy   It gives you the impression of when you take your car to the garage and it gets lifted up with the mechanic's underneath

Anne   You need a pit in the mammo- room, that's right a pit

Joy   That's right a pit ((Anne, Joy, and Eve are laughing))

Co-design Workshop, University of Salford, July 2015

In this extract the women were discussing the idea of lying down on a table so that the breasts hang down rather than be compressed. This was Liz's idea put forward on the affinity diagram. As this conversation between the women unfolded, what was interesting was the way the other clients in the group spoke through the voice of the practitioner. Half

way through the extract Joy (client) eliminates the idea because of the time it would take to get a client on the machine. As a client, this was surprising as her concerns were focused around how altering the equipment in this way would impact the practitioner without considering how it would influence her own experience or that of other clients.

This extract is particularly interesting, as outlined in the findings from the first meetings. Liz puts forward the same idea of having a machine where the woman lies down. In the first meeting, the women were polite in their evaluation of the idea using supportive statements following the evaluation. Here, however, the women appear to have stopped trying to be polite to individual members and are much more focused on the task than on maintaining interpersonal relationship. This highlights a change in group dynamics.

Liz described the way her ideas were evaluated as leaving her feeling as if she had been ridiculed. The way she uses humour in the above co-design workshop extract highlights how it was used as a defensive strategy as well as a way to put down ideas and suggestions by other women in the group. Liz says her idea 'wasn't her baby or anything' and laughs, therefore putting herself and her own idea down. Further along in the conversation, Joy also makes a joke about the idea, but it is at Liz's expense as it is her idea. Although some of the women laugh at the joke, Liz smiles but breaks her eye contact with the group and looks down. These are subtle uses of humour and jokes, which may seem like the group are getting along to most members, however it was clear in the interview that Liz felt ridiculed and was made to feel silly.

In the interviews the clients commented that their ideas were dismissed without having a discussion about them. However, the practitioners felt that the meeting had been more open and that there were no overwhelming or forceful personalities in the group. The observational data did not highlight that ideas were dismissed, but it did show how some ideas were rejected by clinical knowledge. The group did talk about each of the suggested ideas, therefore dismissive may not be a correct word to describe how ideas were discussed, but rather a reflection on how the clients felt when their ideas were eliminated by clinical knowledge. For example, in the extract below, the practitioners are to a point putting limitations on what can and can't be done. Jill is trying to suggest changing the shape of one

aspect of the machine, and Eve is explaining that the C-Arm head needs to be that big due to the functional parts which create the x-ray being in the machine.

Jill   It's just very bulky isn't it? Has that been done to hide the wires or is it?

Eve   It's the way the x-rays are created. You have a target ((her left hand is held up and she is spinning her wrist to show how the x-rays are made)) and it shoots ((right hand is how moving quickly from the right to the left, to show the shooting of x-rays) erm, it shoots erm photons or something ((looks over to Anne, another practitioner for reassurance))

Anne   Ye

Eve   It shoots photons over to the target and then when it hits the target the x-rays shoot down ((uses her left hand to show the x-rays now moving down towards the breast))

Jill   Hmm right

Eve   So you need to have that big bulk head. It's like a car engine it all goes on in there all the whirring and the spinning. They have different targets and different filters depending on the breast size so they have got to be able to change from rodibid, er I can't even say it. ((Looks to Beth)) Rodi –Rodi

Beth   Rhodium, Molybdenum, and silver are the three main filters and targets. They have to sit up there. That's like the engine that bit ((slows down, and voices gets quieter)) can't be changed.

(silence for 20 seconds, which is broken by Liz)

Liz   Well if you're thinking really radically though, like we were talking about in that first meeting. It would be good if you could just lie on something and let your breasts hang down, and that way the women does have to do anything there at all.

Anne   Ye, like an MRI scan

> *Eve*   *((To Anne)) Ye you could do tomosynthesis. I said you could do tomosynthesis lying down.*
>
> *Liz*   *((To Jill)) Did you say you'd seen one where you are lying down.*
>
> *Jill*   *Y e when we were looking round didn't you ((pointing at Eve)) have a bed with holes in for your breasts?*
>
> *Eve*   *That's for biopsies.*
>
> *Liz*   *For me personally, I think that would be more comfortable than just lying there*
>
> *Eve*   *It is better for biopsies it's just not everyone can lie down*
>
> *Liz*   *But not everyone can stand either can they*
>
> *Jill*   *We are talking about mass screening. Because we said we are only going to concern ourselves with mass screening*

Tuckman and Wheelan's model of group development highlight that during this stage, power issues may occur as the group become hostile over who takes control of the task (Tuckman, 1965; Wheelan, 1994). This is evident in the group, however was not contested during the meeting but was felt by the clients as they expressed this during the interview. The interviews highlighted that the clients had felt dismissed when presenting ideas which has important implications for the empowerment of the women involved as well as the performance of the group.

During the first section of the co-design workshop, the women discussed the various problems and issues that had been raised in the previous meetings. It was during these discussions that the practitioners first began to take their place as leaders of the group.

What was evident from focusing on body language was the need for all the women to be in face-to-face meetings in order to explain their ideas to each other. Both the clients and the practitioners acted out different ideas as well as explanations, so that the other people in the group could understand what they were talking about. Different things around the

group were used to explain their ideas as they were not proficient sketchers and acting appeared to work well to help explain their ideas.

Summary of the co-design meeting

The ranking of touchpoints here was done through discussion, the women in the group were asked to consider each of the moments of interaction with the machine and decide which were going to be the focus of the design process. Although all of the women were involved in the discussion, the decisions on what touchpoints could be changed and which couldn't come down the practitioners.

The affinity diagram worked well in giving people an opportunity to write down their own ideas and express themselves individually. No discomfort was observed in putting forward their ideas, however when the post-it notes were further discussed at the end of the co-design meeting, following the group sketching, group members were made feel excluded and silly for putting forward creative ideas. Other group members used jokes and humour to evaluate and eliminate ideas. The guidelines currently available for co-design affinity diagramming and brainstorming suggests that the group members do not judge any ideas they deem as silly until the end of the session. These guidelines were followed. However, the use of humour to joke about people's suggestions caused relationship conflict in the group.

The group sketching helped to move the ideas from words into images, and the group discussed the ideas in more detail therefore helping to elaborate and explore suggested ideas. Some issues occurred surrounding the misunderstanding of ideas, which led to ideas being grouped together and not representing what the other women had in mind. This suggests that the move from the verbal description to an image is difficult for a group to grasp.

Type of Task	Specific Tasks	Stage during the process	Summary of what was involved
Getting Feedback on Design	Technical feasibility feedback	3	The sketches had been commented on by a medical physicist and then fed back to the group.
Decision-making	Making decisions on design developed from the previous meeting	3	Design features and ideas which were developed in stage 2 are discussed regarding what would work and what needed to be removed.

The women recognised a further change in dynamics in the third meeting, where they felt they could be more creative, challenge each other more. They found this overall to be more satisfying.

Something changed. The dynamics changed in that 3rd meeting

Jill, a Client, Interview 2

There was quite a lot of idea blocking in the second meeting

Jill, a Client, Interview 2

The clients were most vocal on this as they had moved from feeling restrained in their participation in the design project during the co-design meeting. However, the practitioners also recognised the more they met the easier it got.

The more we met the easier it got

Beth, a Practitioner, Interview 2

I think I behaved differently in that meeting. I did behave differently and that was more satisfying. I seem to recall feeling strong, feeling stronger if you like about putting my opinions and erm I came away from that meeting feeling, yes that for me had been a real change. The fact I did feel I could speak out.

Jill, a Client, Interview 1

Jill noted the change in how decisions made as more mature negotiation processes occurred within the group. Where previously members of the group had asserted their status within the group to make decisions without discussion, in this meeting the group members presented more alternatives and took more time in discussing these rather than eliminating them without discussion. By this stage the group was more deliberative, and participation, while not equal between members, was considerably more participative from the client sub-group than in the co-design workshop.

Observations of the group at this stage show that the practitioners were more open to radical ideas. There were more silences within the group which were broken with suggests or solutions to the decisions they were trying to make.

> *Eve*   *Ye, it would be very nice for the CC ((pointing at the picture to show the image)) because you get some people whose ribs are sunken and some people whose ribs are prominent*
>
> *Kate*   *Hmm ye ((leaning over the table to point to the picture))*
>
> *Eve*   *And the oblique ((silence, 2 secs)). I don't know you would have to try it. Because I can sit here and say I don't think you can get enough tissue but you don't know until you have taken the actual picture. Ye you wouldn't, hmm. You would think you are going to miss this bit of the breast here ((moves hand across the back of her breast at the chest wall)). You see this one here with the rounded corners is more practical.*
>
> *Kate*   *I think it would probably better straight*
>
> *Eve*   *I am trying to think how it would work if it had that concave cut out was there.*
>
> Co-design meeting 3, Kate and Eve (practitioners)

There was a change by the final meeting, which opened up more opportunities for discussion around earlier ideas which had been eliminated. The discussion style also led to more suggestions being put forward by both the clients and the practitioners.

Jill, a client, believed that this change had been due to reflecting on the co-design workshop in the mid-project interview. She felt she was more confident to challenge the practitioners when making decisions. However, the observational data shows that the practitioners were less dismissive in their decision-making and were open to trying and testing ideas before stopping their development any further within the group. This highlights a change across the group, both with the clients and the practitioners in the design process. The change in group dynamics appears to be due to the time spent together with the group as they have moved to the performing stage rather than a storming stage, in which there was some conflict over roles and responsivities within the group. This final meeting highlights some of the main expected benefits of conducting EBCD in medical equipment design. There is negotiation around ideas, more ideas being developed which could benefit both the client and the practitioner.

As humour was touched upon in the previous meeting, a contrasting view at how humour and jokes is used shows a different feeling within the group. Jokes are not being used at one person's expense or to show power within the group, but the feeling is that the group are now more cohesive and making jokes about the 'outgroup' in this situation which are the manufacturers.

The relationships between the key concepts

This analysis has highlighted links between equal involvement and power through co-design, which is influenced by the knowledge that individuals in the group held. Before moving on to explore these further, the concept map shown in figure 11 highlights the relationships between the three key themes
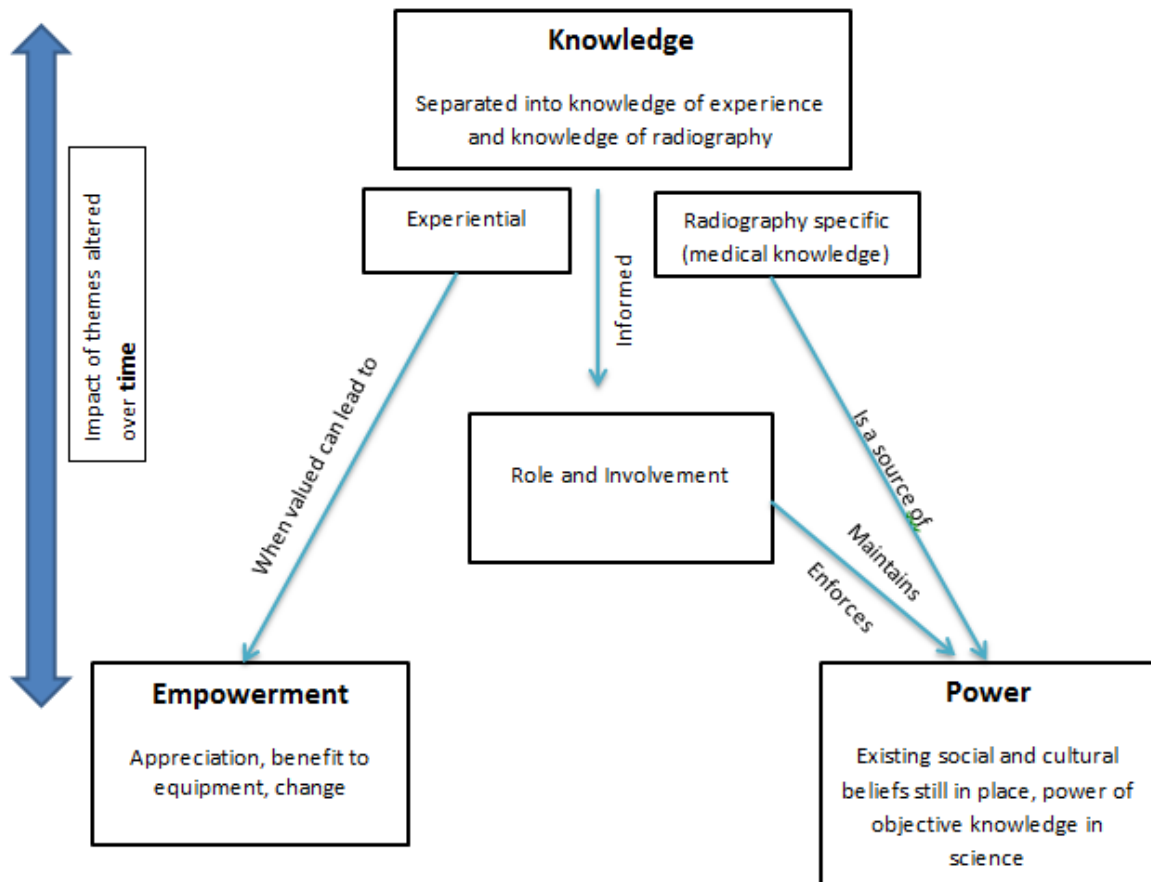

Figure 11 - The Relationship between the Key Themes

Chapter 6: Discussion

Each of the three research questions is addressed in this chapter. The first question will examine the women's experiences of co-design before exploring in more detail the factors that influenced involvement. The existing literature on co-design in health, and the demands of co-design which were brought to light in this study, are discussed. By covering the second research question, knowledge, power, and group development, and their influences on the process, are explained. Finally, recommendations for the future practice of medical equipment co-design are suggested.

Question 1: What are women's experiences of co-design?

The term involvement has been positioned in this thesis as playing an active role in the design process. That the process should be designed by the users rather than with them is a key factor for using a process such as EBCD, therefore involvement in the group should represent the design by the user. This section discusses what design by the users meant in this group. Exploring the roles and responsibilities of the users in this co-design highlights the key aspects of involvement.

In the interviews, the women described, from their experiences of EBCD, what they did during the design process. A number of interactional functions were identified for the role of being a co-design group member. The way the women described and represented their role and involvement in co-design highlighted a number of benefits and challenges to becoming a co-designer.

EBCD, when applied to the development of medical equipment, had a number of benefits in terms of engaging different users in the design process. All of the women involved added to the group discussion by reflecting on past experiences, understanding an alternative perspective, and generating and elaborating on ideas. The theoretical perspectives on designer-like thinking usually separates interactions into the various stages of designing (Bevan et al., 2007; Détienne et al., 2012b; Shah & Robinson, 2006). For the purpose of this discussion the interactions are separated into the first and second phase of designing; the problem and the solution (Piper et al., 2012). Piper et al. (2012) describes the initial phase identifying and diagnosing problems, then the later phases of the process as 'collaboratively designing' improvements and solutions. The theories surrounding what it means to think like a designer (Bevan et al., 2007; Détienne et al., 2012b), which support the rationale for EBCD, describe an early stage in the process surrounding the development of a shared understanding of the problem area through discussion and reflection on past experiences and knowledge. This first stage involves defining the problem area. In terms of the interactions required, Bevan et al., (2007) states that the individual members must be involved in reflection, analysis, diagnosis, and description. Through description the users are able to ground their collective knowledge (Détienne, 2006). The findings presented in this study highlighted that the interactional features associated with defining the problem were

successful in the design process. These included reflecting on one's own past experiences and understanding an alternative perspective. This, for the women, involved reflecting on and remembering their own previous experiences to co-construct the touchpoints, and also learning and readdressing the experience of the other to co-construct a detailed picture of what it feels like to have a mammogram and what it feels like to use a mammography machine. This highlights that the current co-design process facilitates communication process such as grounding (Burkhardt et al., 2009).

The women experienced learning as part of the co-design process. Like Dewar et al (2010), learning about experience arose from hearing narratives. Like others, the women in this study experienced reflecting on their past experience and discussing it in a group as a successful part of co-design (Farr, 2012; Morrow et al., 2013; Tsianakas, Maben, et al., 2012).

However, unlike the majority of studies (Bowen, 2012; Boyd, 2012; Dewar et al, 2010) the client group were the only group to reflect on learning. Learning was particularly important to the clients, who reflected on learning about a number of aspects of the practitioner's knowledge, surrounding both the function of the mammography machine and what it is like to have a mammogram taken. The first feature that the focus on experience is supported by the epistemological arguments put forward by Bate & Robert (2006) in their rationale for focusing on experience. The approach to developing an understanding of experience through sharing narratives appears to have worked throughout this thesis, as the communicative function of grounding which is stressed in the design literature (Détienne et al., 2012b).

The clients and practitioners also discussed grounding of other types of knowledge, such as more medical objective knowledge relating to the function of the machine. This finding differs from others in co-design, as the research is based predominately in the service redesign literature rather than equipment design. EBCD, however, did not facilitate this from the early stages of the design process, as the focus is solely on experience rather than scientific objective facts. The majority of co-design studies currently in the base of literature are in the field of service redesign (Farr, 2012; Iedema et al., 2010; Locock et al., 2014). In

the service redesign processes, experience is vital to both understanding and improving how a service feels, and therefore how it is perceived and judged by people.

This thesis studied the co-design of imaging equipment design. It was found that this differed from the literature on service redesign as the focus is more technical. Therefore, this faced the women in the group with difficulties regarding the epistemological arguments for different types of knowledge. Typically, the standards by which we make decisions regarding technical knowledge are based within positivist paradigms and judging truth (Nordin, 2000). In service redesign, more subjective approaches to judging and assessing a service are perceived to be more effective. This has in turn driven the design processes such as EBCD in the service redesign arena.

My findings suggest that although a design process where experience is the focus is used, the overall perspective from the women in the group was that clinical knowledge had more value and power in making decisions. This finding goes directly against the focus on experience of the co-design process. Captured in the theme of 'knowledge', the women in this study highlighted that their role was limited by the scope of their mammography-specific knowledge. Both the clients and practitioners reflected on how hearing each other's experiences was interesting and eye opening. However, they felt learning about the clinical knowledge was more valuable to the decision-making and evaluation of developed designs.

However, the views on why the user input is useful resonate with the findings in this study. In the more technological field of medical device design, the focus on experience is not as prominent. Medical equipment is more generally judged by how well it does its job. In this case, how well the mammography machine operates. This would suggest that our social and cultural perspectives of how something, in this case medical equipment design, should be done influences the groups beliefs surrounding how they should value and judge input from others and the decisions that are being made.

This finding has a number of implications in terms of the future of co-design in more technological settings such as imaging equipment design. Firstly, the benefit to the final design outcome may not achieve what was hoped by whoever initiates a co-design process. That is, the design outcome may not improve experience of the users involved in the

process. Secondly, the users who are involved may not be empowered through being involved. The group which was studied in this thesis replicated more standard ways of making decisions in that they viewed technical knowledge as more useful, therefore replicating existing ways of designing and developing medical equipment. Although the women in my group often discussed how the co-design process gave them a voice in the process which they had never had before, they were reluctant to let their experiential knowledge drive the process. As this is why they were involved, they may not fully be empowered to have a voice in a new and influential way.

This highlights that ECBD, needs to be tailored for medical equipment design to facilitate the grounding of all types of knowledge to some extent to ensure that the representational space in which the group are co-constructing the problem and developing the solutions is established (Glăveanu, 2011b). However, it has been argued that this learning can cause the client to lose their credibility as a representative of 'true' health clients and patients (Vennik et al., 2015).

In their study, Tsianakas et al. (2012) give four characteristics of the EBCD process which are key to its successful implementation: patient involvement, patient responsibility and empowerment, a sense of community, and a close connection between their experiences and the subsequent improvements. Each of these key characteristics has been supported by other studies into the process of EBCD when applied to medical equipment design.

From my observations of client and participant interactions during the co-design process, I identified both the collaborative construction of the problem and creative solutions were put forward. However, the emergence of solutions was rarely observed.

For the majority of co-design projects, the initial phase is established in order to understand the problem from the perspectives of all those involved. The literature review identified this to be a benefit of the co-design process, both to the people involved and to the design and development process.

> *Everyone definitely had their own opinions of what should and shouldn't be part of the equipment that came out quite clearly.*

> *Eve, A practitioner, Interview 1*

Through discussion the group were able to develop an understanding of one another's perspectives and views of mammography, therefore widening the representation of the problem area. However, the women identified differences between their perceived roles in the design process. This was particularly manifested in clients not perceiving their role to evaluate or select developed ideas. In this way, functional interactions of the design process falls into different tasks. Tsianakas, Robert, et al. (2012) found through interviews with participants in co-design that a key feature was high levels of patient involvement from the onset and throughout the project. However, this study highlighted that involvement for the patients, or in this case clients, was not applicable in all of the interactional functions required towards becoming a co-designer. What was identified through this analysis was that all members were able to co-construct the problem area and put forward ideas based on their experience. This supports the rationale for co-design, and goes some way to explaining its success. However, creative ideas are unlikely to emerge if there is not more constructive conflict between the two groups to elaborate and reanalyse initial ideas.

Although patients/clients are supposed to be involved in all aspects of the design process (Morrow et al., 2013; Tsianakas, Maben, et al., 2012), this presented some difficulties for the women in this group. The clients within the group struggled to develop ideas and make decisions on the ideas that did and did not go forward.

However, a secondary factor was also identified which is that the clients were excluded from the elimination and selection of ideas. Therefore their role was unequal to that of the practitioner in selecting ideas. This may explain Bowen et al.'s (2012) study in which the client's felt as if they weren't *doing the designing*.

Certain design interactions are described as essential for creative groups with diverse perspectives on a problem, such as argumentation and negotiation. As features of design, these were rarely observed and the clients recognised that for the early stages of the process there was little to no discussion surrounding decisions, and labelled the way decisions were made as dismissive. It is thought that high creativity is facilitated by cognitive stimulation factors such as conflicts and divergent styles (Paulus, 2000). Constructive conflict can allow further elaboration of ideas, resulting in reanalysis of solution ideas that could lead to important and new insights (Detienne, et al, 2012). The women identified this

as both a negative and positive feature of the group; they recognised that the lack of argumentation resulted in a good social feel about the group and the relationships that were built. However, they felt this impacted on the task-related aspects of the group. They, therefore, were at odds as to how to handle aspects of co-design which involved argumentation and challenging of ideas, as they wanted to keep the comfortable environment, but also wanted a space to express their ideas.

While the women in the group where able to come up with ideas, they felt that their input in design evaluation was limited. Highlighting that there is a need to focus on ways in which this aspect of the process can be improved allowed group members to come to collaborative decisions.

In summary, women's involvement in co-design differed in terms of their role and perceived responsibilities in the design process. This highlights barriers to equal involvement in the co-design process as well as highlighting that processes important to collaborative design are not being undertaken due to cultural and social factors. Task interactions, including negotiation and argumentation, were bypassed by the group in the early stages of the design process which led to negative feelings of the clients towards the solution development stages of design. From my review of the literature aspects of co-design which were identified to contribute towards its success lie in a close connection between experience and the solution (Tsianakas, Robert, et al., 2012). Enabling this close connection relies on a number of different factors. Firstly, it relates to the genuine involvement of all parties, wherein involvement is more than simply being in the group, or being considered as part of the group, but as having an active role in defining the problem and the solution (INVOLVE, 2010). The clients, or patients, within a co-design group are asked to take part because of their individual specialist knowledge of their experiences. Therefore, to be actively involved (as per the INVOLVE definition), their experiential knowledge should be considered equal to any other knowledge in the group and should be valued in both the problem and solution phases of design.

There were a number of factors which appear to have influenced the involvement and role of the user in the co-design process. These have been identified as knowledge, power, and time with the group. These are explored further in the next section before discussing the

recommendations which could be put in place to facilitate more equal involvement in design and allow more constructive design interactions and processes, therefore leading to successful creative solutions.

Question 2: What factors influence involvement in design?

In this study knowledge emerged as a key factor which influenced involvement in design. Although experience is stressed as the centre of the design process by Bate & Robert (2006), the women expressed concern in viewing their knowledge as valid enough to move forward with design.

Knowledge

Co-design is founded on collaboration between various stakeholders who bring with them different perspectives, skills, and knowledge bases which are considered to be useful to the design process. Socio-cultural theory of design states that in a collaborative situations individuals use symbolic resources intrinsic to their system of knowledge, and through communication generate new and useful artefacts (the design solution) within the representational space of the group (Glăveanu, 2011b). As stated earlier, this implies that the group co-create knowledge surrounding the solution. The co-creation of the solution develops through discussion of the group member's individual knowledge. In EBCD, the key focus is experience (as the title Experience-Based Co-Design suggests).

Sharing experiences with the group validated their experiential knowledge. As highlighted by the findings, the group felt their experiences were valuable when constructing the problem.

The findings highlighted the value which the clients put on the practitioner's narratives of their experience which allowed the clients to see a human side to the practitioners (Springham & Robert, 2015). An important aspect on the impact of sharing experiential knowledge in the group is that when the clients heard the practitioner's narratives, they influenced their aims within the design process. This highlights the value the clients placed on the perspective of the others, as well as how they felt they understood the practitioners, which is similar to a number of findings of Piper (2012), who found that the co-design process leads to an understanding of the 'other' perspective which can lead to a change in mind set and possibly behaviours (Piper et al., 2012). How the findings differ relates to the practitioners view on the clients experiential knowledge. The practitioners reflect on hearing the clients' experiences as meaningful, however they did not influence the

practitioners' aims or ideas for the design process which could mean that the ideas for redevelopment were not collaborative.

However, the value and usefulness of experiential knowledge was doubted by the co-design group, therefore leading to them making decisions based more on clinical knowledge than experiential knowledge.

Knowledge therefore informs the role of the people involved in the design process. Rather than a reconfiguration of roles being a difficulty, we need to look at ways in which we can make users appreciate their experiential knowledge over clinical knowledge, and their social and cultural beliefs surrounding how things are done within the institutions associated with the design of medical equipment; namely, the National Health Service and Manufacturing companies.

Both the clients and practitioners share experiential knowledge with the group in co-design, they have all previously experienced mammography and have different representations of it. However, the practitioners bring another type of knowledge surrounding mammography – clinical knowledge. The practitioners also have knowledge of the function and structure of the equipment, developed through education towards gaining their postgraduate qualification in mammography and becoming qualified. Mammographic practitioners, along with all health professionals, also gain knowledge of the practice and procedures specific to their area of expertise.

EBCD can improve staff and patients' thinking about not only their experience and the aesthetics of something but also how it operates and functions (Piper et al., 2012). Experiential knowledge was shared at some point in the process by all of the women involved in the co-design group under study. Although the power of experiential knowledge has been explored and highlighted elsewhere, there is little published literature surrounding how more technical aspects of the design process are brought into the process and how group members value this. The decision to use clinical knowledge as the voice to make decisions may be why some people have doubted whether clients and practitioner can be collaborative together (Farr, 2012). The lack of value we place on experiential knowledge as a quality with which we can redesign medical equipment is echoed in the medical

equipment literature as Martin, Norris, Murphy, and Crowe (2008) found. Manufacturers felt that there was no point in involving people who don't design the equipment to put forward ideas.

A key feature should be that there is a close connection between their experiences and the subsequent improvements (Tsianakas, Robert, et al., 2012), however this may be influenced by the medical and more technical knowledge that is associated with medical equipment, therefore causing the co-design group to become restricted by their social and cultural beliefs about how equipment should be developed.

The power of knowledge and existing hierarchy structures

Boyd et al, (2012) suggest that people using co-design should attempt to try things out of your comfort zone. Design tools, such as sketching and affinity diagrams, can change ways of thinking and challenge existing ideas (Boyd et al, 2012). However, it has been suggested that changing ways of thinking may be difficult to achieve due to the deeply ingrained beliefs about what constitutes valid knowledge for the design and development of medical equipment.

Power has been highlighted as an issue within the co-design process (Farr, 2012; Bowen, 2011; Tsianakas, Robert, et al; 2012), with some authors calling for the types and facets of power operating in the setting to be studied as the workshops based on equality and equal contribution are difficult to establish. Without a critical understanding of power and the influence of power, subtle forms of oppression may begin to appear in the groups (Donetto et al., 2015).

This study has aimed to unpack power within co-design groups. Power appears to be intrinsically linked with knowledge and our belief and values towards knowledge. The more knowledgeable (in a certain area) are able to exert more power, without resistance from those who are less knowledgeable. It is often stated at the beginning of a paper that EBCD was selected as a method design and development as it gives all stakeholders an equal voice (Piper et al., 2012). Considering the client-practitioner relationship in light of Luke's (1974) 3 faces of power goes some way to explaining how power operates in co-design. The first face of power refers to overt power between A and B and is usually described in terms of influence. This is viewed negatively. This form of power, first put forward by Dahl (1957),

has been used to describe the existing relationship between the client and practitioner in a medical situation, such as the mammography encounter where to some extent the client is obedient and the practitioner has influence over where the (half naked) client stands, how much compression is applied to the breast, etc. However, this relationship of overt power was required to change in the collaborative partnership which was part of the design process. It was found that, to some extent, the clients were obedient in that they did not contest any of their ideas which were dismissed by the practitioners. They allowed them to make decisions and the clients based their rationale for this on the expert power they believed the practitioners to hold. This therefore resulted in some cases reverting back to the old relationship in the medical encounter wherein the practitioners exercise their expert knowledge of mammography. It is important to acknowledge that power does not just go, or move, in one way, but that the practitioners were also subjected to power from the existing hierarchy, and in some ways the clients. Where clients asked probing questions regarding the practitioners' mammographic practice and questioned their motivation for change, there may have been some power in terms of coercive power whereby the clients could have judged them.

The second face of power refers to covert power (Bachrach & Baratz, 1963). Bachrach and Baratz (1963) argued that power is more than getting B to do something A wants them to do, but it also includes stopping B from doing something in the first place. This covert power has been described as non-decisions, where an individual or a group determines what is and what isn't important, and what does and doesn't get included. This was again highlighted in the group. Through determining the scope of the design process, the practitioners enforced which of the touchpoints would go forward and which would not. When covert power is in operation power conflicts don't arise due to our vested beliefs and values that one group should have power over the other. The group would struggle to change their values and beliefs surrounding who decides what is important and what is not, without making transparent peoples beliefs surrounding this and therefore ensuring that their roles are readdressed throughout the project.

Clinical knowledge appears to have had more control, and power over the design process, than any individual. The practitioners recognised that, although they were trying to be

creative, the group were unable to move past clinical knowledge to believe that they could do whatever they want. In Foucault's theory of knowledge and power he argues that we should look at other areas which have reimagined power relations to highlight how this can be changed in the future.

The empowering users

Having identified power as a factor which can influence equal involvement and contribution to the design process, it is worth considering ways in which this can be mitigated to ensure that the experiential knowledge of both the client and the practitioner is at the forefront throughout all stages of the design process. The majority of studies have highlighted that the problem development stage is empowering for a number of reasons. It can give the people involved a sense of responsibility as they get to have a say in a more realistic way than patient surveys.

Another source of empowerment stated in the current literature rests on having the multidisciplinary group together (Piper et al., 2012; Tsianakas, Robert, et al., 2012). Tsianakas, Robert, et al. (2012) found that being together in a mixed group gave them a sense of empowerment as they felt they were actually able to make changes and were aware that their voices were being heard. Therefore empowerment was gained through responsibility in the group. Piper et al. (2012)'s study also identified that responsibility for the work was an important aspect of co-design that they felt was necessary for the work being successful. When participants were interviewed following EBCD they found that the process gave them an opportunity to work meaningfully together (Piper, et al, 2012).

The group over time

One feature of the interactional data which sheds some light on the change in the group dynamics over time is the use of humour within the group. Jokes were told throughout the co-design meetings by both the clients and the practitioners. The analysis of humour has been used to study organisational cultures by analysing how individuals from different levels of hierarchy interact with one another in terms of their humour usage (both the production and the reaction) (Holmes & Stubbe, 2015; C. Robert & Yan, 2007).

Humour in this study refers to a social phenomenon which is shared in a group situation, therefore the definition provided by Cecily Cooper (2005), as "any event shared by an agent

166

with another individual that is intended to be amusing to the target and that the target perceives the intentional act" has been the one used in this study. Humour can unveil power relations between individuals and groups who perceive themselves to be of a different status.

Although generally perceived as a positive aspect of relationships, humour dynamics can facilitate or detract from the formation of new relationships (Cecily Cooper, 2008). Throughout the study I observed humour as a method to manage the relationships between group members in the co-design group. This allowed me to make assumptions about the developing relationships between the clients and practitioners in the group.

Humour and jokes were used in the first meetings to bring the group together across the boundary of the client and practitioner. However in the second meeting humour appeared to have been used to distract from what one person felt was an error, or to move the conversation onto a different topic. It was also used to dismiss or dissuade a person from using an idea, therefore leaving them feeling as if they had been ridiculed. Humour may have kept the group feeling that their interpersonal relationships were healthy and positive between members. However, there were instances were humour was used to destruct an idea, leaving Liz feeling ridiculed. This usage of humour highlighted power changes and tensions within the group at the different stages of the group's development.

Through analysis of the way the women described the group at different stages and observations of their interactions, it was shown that the group dynamics change and developed over the course of the process. The group was initially characterised as comfortable. The group appeared to be cohesive and open and group members felt comfortable to share their stories of past mammography experiences. The following meeting, wherein the women took part in design tasks, was separated into different stages which the women recognised as impacting their development and dynamics. At the start of the co-design workshop the group was comfortable and open, allowing for useful discussion, however it was during this meeting wherein an area of task-conflict was felt by the women, but not observed- the clients were dissatisfied with the way the meeting went although no obvious arguments were noted. The final meeting was described as more

rewarding, as more negotiation was both observed and described by the women in the interviews.

The time spent together allowed the group members to develop an understanding of the social and relationship boundaries of the group and therefore gave them more of a space to challenge each other. A number of small group researchers have studied this topic with the view that time together on a task can impact both the task-related and relationship-related interactions of a group. A large number of studies have been conducted to explore how groups develop over time (e.g. (Gersick, 1988; Wheelan, 1990), with very few contesting that groups remain the same in dynamics over time.

The process of group development which was identified fits well with that of Wheelan and Mckeage (1993). Wheelan and Mckeage (1993) describe a linear process of development through a number of stages, the first of which is labelled dependency and inclusion. This stage is characterised by high anxiety, politeness, and uncertainty, which leads the group to be dependent on the leader for support and advice in completing the task. When the group first met, there was some uncertainty of their role and the co-design process as a whole. Both politeness and uncertainty were observed during the initial stage of the group meeting. Politeness seems to have been a positive in this meeting. The group were respectful when listening to each other's stories, and no one challenged narratives of mammography experiences, therefore resulting in the meeting being comfortable and open, which is important to allow people to share personal information (Mauthner & Doucet, 2003).

As the group were comfortable and able to share their narratives, they built cohesion through a commonality of experiences. This is similar to the findings of Bowen et al. (2013a) and Dewar et al. (2010), who found that co-design groups develop relationships due to a reflection on similar experiences. It is fair to say that this may not have occurred with people who did not have the common experience of mammography and therefore a strength of this stage of co-design is having the stakeholders together without any outside influence other than the facilitator, for example designers and manufacturers.

As the facilitator, I found in the first meetings I held more power in the meetings as I controlled the agenda and the group looked to me for confirmation of ideas and opinions. As Wheelan (1990) describes, the group in the first stage of development, can become dependent on the leader as they come to understand their individual roles. The group in this stage of development are more likely to follow suggestions made by the leader and generally demonstrate a desire for direction from others (Wheelan et al., 2003). In this study, as facilitator, I found that taking a scribing role and reiterating what the women had stated as problems assisted in avoiding making suggestions which might influence the women's stories, narratives, and discussion. However, any suggestions I made in terms of how the tasks were carried out and who did what resulted in the group relying on me for guidance and advice, in regards to this first stage.

It is, however, important that the group come through the first stage of group development by the co-design workshop and co-design meeting phase. The way the group described themselves in the first stage highlighted their cohesion as one group, rather than being separated into user subgroups. It is therefore reasonable to assume that the group were in the first forming stage of group development, wherein they are still trying to identify their group identity.

The sensitive nature of discussing past experiences of their healthcare experience with each other did not appear to influence the group dynamics. It did in fact appear to make the group more cohesive as they bonded over a common problem. As Bowen et al. (2013) found, the commonality of experiences contributes to group cohesion. Like Boyd et al. (2012) this study has highlighted the importance of involving patients early in the design process. Most design processes, regardless of the specific method, will begin by establishing a representation of the problem from the perspectives of various stakeholders. In this group the women found this particular aspect of the design process to be the most rewarding and easy to be involved in.

The second meeting highlighted that some group members did feel disrespected, which is a similar finding to Bowen et al. (2013), who highlighted that the co-design group's cohesion did not follow in a linear pattern. The analysis of the co-design group studied in this thesis highlighted that this seemed to occur due to the group moving through a stage of conflict,

which was characterised by the group members coming to recognise their place in the group and the roles they might undertake.

The fact that the practitioners did not recognise that there was an area of conflict shows that the clients did not attempt to argue or negotiate roles, but accepted the way the meetings went. This may then be an important finding, as when the group go through this stage it may be that the role description and responsibilities of each group member needs to be readdressed.

In other co-design studies researchers, have found that strong relationships can be built between patients and staff over time, as the group start to feel like a team as they come to understand and respect each other's perspectives (Tsianakas, Maben, et al., 2012). Although in regards to this co-design group they felt they recognised and understood each other's perspective, they did not feel or begin to interact like a team who understood each other's roles and mutually contributed to the task until they had developed and negotiated their roles as co-designers in the design process. Power differences between members are not obviously present during this stage in that the practitioners do not try to coerce or influence the clients towards what they believe to be a better outcome. Neither the clients nor the practitioners felt they were in control of this first meeting, they offered evaluations of opinions and ideas but did this in a polite manner.

EBCD projects typically take 12 months with a 6 month discovery phase (Locock et al., 2014). In Wheelan's integrated model of group development, uncertainty is included in the first stage. She describes the first stage of a group coming together as marked by high anxiety among members, however none of the clients or practitioners reported having high anxiety in the meetings. Although the women identified feelings of uncertainty prior to introductions, the group appear to have felt comfortable enough to share opinions and thoughts after a reasonably short amount of time.

There did appear to be underlying power relations as the clients became somewhat dependent on the practitioners for answers and for providing most of the information for the task. Participation was not equal between the two different user types as the practitioners provided more detail. Tuckman (1965) explains that this initial phase, the

forming phase, the group tend to rely on existing hierarchies or status structures. This was the case in this study, as the clients and practitioners at times reverted back to a traditional client-practitioner relationship, relying on the practitioners to answer questions which related to medical knowledge.

Question 3: What recommendations regarding medical equipment co-design can be put in place to facilitate involvement?

Power issues were found to occur within the group. Group members had power due to their existing relationship and the belief that different forms of knowledge are more valuable than others. In a medical encounter, such as having a mammogram taken, professional knowledge is used to have control over the client. Therefore the group members are required to renegotiate their existing roles to ensure equal contribution in the co-design process (Robert et al., 2015). The recommendations are based on ensuring that the co-design group members are involved in the way they want to be, and that they have control and ownership over the process and to allow group members to be actively, rather than passively, involved. The recommendations should ensure that the group members are satisfied with the process and their input, and are therefore, able to work effectively.

Recommendation – Facilitation

Not being a client or practitioner is recommended for the facilitator and is notable both from my findings and the literature (Schwarz, 2002). This study has shown that there were issues that the clients raised in the interviews whereas in the meetings they avoided conflict. Therefore if the group facilitator was a practitioner the clients may not have had a say. From the findings presented in this study, I would recommend that the facilitator is familiar with the EBCD process and the creative tasks rather than being a client or practitioner. As the group's facilitator, I explained the tasks prior to taking part in them and answered any questions which were asked about what was required from the task. However, as the aim was to study the group's communication, I remained fairly passive and did not intervene throughout the process when the group were making decisions or when issues arose. In future co-design processes it is recommended that the facilitator assists the group to understand the process and the aims of the creative tasks, as well as ensuring that the group members are satisfied and have as equal a voice as possible. The rest of the recommendations should be considered by the facilitator in the group.

The group needs a facilitator whose role will change over the course of the project, from initially leading the group as the members feel uncertain about the process to supporting

the group members later in the process. However, their aim should remain to diagnose and intervene to help the co-design group identify and solve problems as they arise.

Recommendation – Who does what? The group member's roles and responsibilities

The most dissatisfaction with the co-design process came from being unhappy about what the women thought they should be doing in the group, and what others were supposed to be doing. In other words, this could be described as a lack of norms and agreement surrounding the roles and responsibilities of different user types and members of the group. A recommendation to limit this dissatisfaction with the design process is to make sure that the group members are aware of the demands of co-design and agree their own roles and responsibilities.

Both the clients and the practitioners stereotyped themselves by their existing role and relationship as health service user and health service provider. Therefore, positive reinforcement of what the members can do should be expressed prior to deciding the roles and responsibilities with each other. The co-design group members all felt like they had ideas, and each member contributed ideas to the process. However, decisions were made quickly without exploring many alternatives. A facilitator, or group lead, should encourage elaboration on ideas. During this study the aim was to explore alternatives through the use of brainstorming and affinity diagrams, however this was not done in detail as the group did not discuss each idea face-to-face. This was due to a distinction in what the group believed their roles and responsibilities to be for each of the creative tasks and stages of the design process. It is important that the group list out and mutually agree on what the members within the process on.

Through first establishing the roles and responsibilities of each of the group members they will have a better idea of the challenges they might face. The process has to be established prior to starting, including the design tasks which are going to be employed to foster creativity and their specific rules, such as the affinity diagram. The goal is not well defined in design, however the process should be.

The second recommendation to arise from this study's findings surrounds establishing ground rules for the communication and conduct in the co-design meetings. Explicit ground rules can improve working relationships, group member satisfaction, the quality of decisions and increase the commitment of members to the group (Schwarz, 2010). Previous studies such as that of Tsianakas, Robert, et al. (2012) established ground rules prior to the process. Although the rules established were not published, the aim was to ensure that the patients had equal voices. The findings of this study have highlighted knowledge as a source of power within the group, therefore it is suggested that this finding be integrated into the development of ground rules prior to the process. While the ground rules provided by Schwartz (2010) are aimed at all groups, the recommendation for ground rules suggested in this section will be explained in the specific context of medical device design.

Schwarz (2010) suggests that ground rules should be based on four core values: valid information, free and informed choice, internal commitment, and compassion (Argyris & Schon, 1974). The assumptions that underlie the ground rules are 1) that the group members have some relevant information 2) each of the group may see people others may not 3) differences are opportunities for learning and creativity and 4) people are trying to act with integrity given the situation.

The first core value and associated ground rules which should be considered surround the sharing of information and knowledge within a group. Groups need all the relevant information to effectively solve problems and make decisions (Schwarz, 2010). Whether the information shared in the group is valid or not should relate to its specificity – 'do they know enough about it to add the information to the discussion?' Rather than use the terms validity for knowledge, we will use specificity. As a term associated with quantitative research, validity is not appropriate for assessing people's personal subjective experiences. When the clients in the group felt that the group fully discussed and were able to eliminate ideas through group discussion they felt the process had worked well. Therefore, the first ground rule should be based around what is shared and this is judged by the people involved. Some suggestions for this are given by Schwarz (2010) and from the findings are:

Ground Rule 1 – Test assumptions and inferences

Ground Rule 2 – Share all relevant information (including how you are feeling about the conversation and group).

Ground Rule 3 – Use specific examples and agree on what important words mean

Ground Rule 4 – Explain your reasoning and intent

In this group, it would have been beneficial to consider what information would inform choice.

The second core value rests on how decisions are made within the group, if there is free and informed choice between group members. This means that the group make the decisions on the information they had made valid in the group, not due to pressure from people inside and outside of the group (Schwarz, 2010). This should be specifically discussed with the group in relation to the wider social and cultural beliefs associated with how medical equipment is designed. This discussion should help the group move past their initial thoughts and feelings that their experiential knowledge is not valuable enough for the redesign of medical equipment.

Recommendation – Provide Scaffolding for group members

Another feature important to any group, particularly the co-design group, is the feeling of internal commitment. Internal commitment is defined as each member feeling personally responsible for the decision and is being willing to support the decision, given his or her role (Schwartz, 2010). For this design group there were no feelings that group members had not contributed to the end designs. They felt responsible and that the designs were their own. This may have been due to the lack of design professionals and academics in the group. Bowen et al. (2013) found that people did not feel like their designs were their own. It would then be recommended that if designers are part of the co-design process, their role should not be to design but to assist with the design process. Most design processes encourage design professionals to be involved with the design process. However, the recommendation here is that design professionals should be involved to 'scaffold' the design process. That is, to make sure that the group have the creative tools and space

(Sanders & Stappers, 2008), rather than to lead them in any way towards a solution which they will not feel any commitment too.

Recommendation - Include a technical feasibility stage in the EBCD process

The adaptation to include a technical feasibility stage, where the group members received feedback from a specialist in mammography machine function was positive in this study. Another important adaptation was the removal of designers from the process to allow the group to 'control' the design process. This enabled me as a researcher to explore the interactional demands that users find difficult without support. Although EBCD is often tailored for practitioners to undertake the process themselves, designers may not necessarily always be part of the co-design group. It would also allow a facilitator to conduct these early stages of the concept development process without costly input from designers and manufacturers. Interestingly, the interactional demands of co-design which the group found difficult did not include shaping the problem area or putting forward solutions, but it concerned how ideas were developed, negotiated and selected.

Including the feedback from the medical physicist was viewed positively by the women in the group as their ideas for design were validated, giving them confidence in their ability to come up with design ideas. However, the clients felt an engineering/ manufacturing input would have given them more scope to be creative. On the other hand, the practitioners felt this would have restricted them in what they would have said as they would have felt that they were being judged by others with more clinical knowledge surrounding the function and operation of the machine. To balance power and to empower people, it is suggested that the technical feasibility stage is beneficial to the co-design process. Once people have already had a chance to develop and select ideas and are confident enough to argue or explain how their new ideas would improve their experience then negotiation between viewpoints can take place on a more even basis.

Recommendation – Agree on how decisions are made

Larkin et al. (2015) felt that qualitative methods of coming to a group consensus were more appropriate than more formal methods in 'unmixed' groups. They also argue that this method of making decisions is more suited to underpinnings of EBCD. However, they

recognise that they do not fully know if consensus was reached or not as they did not audio record meetings to see how the discussion developed. As I found, a false sense of consensus may occur at the decision-making stage of co-design when non-decisions and covert power is used to decide what is and is not said.

There are a number of different decision-making rules that can be used in groups. The aim of co-design, like other partnerships, is for the decision making in the process to be as democratic as possible. In democratic decision making, the full group discusses the issues and is involved in making the decision. A decision is then made when the majority of the group agrees to make the decision. The group may also choose to make decisions by consensus decision making, in which, like democratic decision making, the whole group are involved in the decision. Consensus, however, means that all of the group members must agree and can support a decision.

The co-design group avoided any face-to-face conflict during the second meeting, however the clients were unsatisfied with how the meeting had gone and there was a distinction between how the clients and practitioners viewed the task. While the clients felt the affinity, diagram was to be as creative as possible, the practitioners felt they had to eliminate some of the ideas if they believed they would not work practically.

A formal decision making rule where the group members are encouraged to take more time on decision making and ensure that everyone in the group has had a say in the decision may give everyone a more equal voice. Consensus and democratic decision making rules may also make the group consider their decisions more carefully. More discussion could allow for a better evaluation of ideas. It is therefore strongly recommended that the way the co-design group makes decisions are discussed with the whole group prior to the process and that a rule is selected and followed throughout.

Recommendation - Revisit the ground rules and roles and responsibilities with the group members individually

Once ground rules and roles and responsibilities have been established and agreed by the group, they need to be revisited with group members to see what is and is not working and how the group feel they are progressing. In this study, the interviews that were used as part

of the evaluation allowed the group to reflect on their past experiences. Therefore it is recommended that a facilitator of a co-design group takes time to speak to both the clients and practitioners individually. Jill felt the interview gave her confidence to challenge ideas as it allowed her to reflect on how the meeting wherein the clients had been dismissed. As the interviews which were done as part of this project were not design data, or an existing part of the design model, the feedback from the interview was not fed back into the process by myself. However, this is good practice guidance as provided by INVOLVE (INVOLVE, 2012).

Chapter 7: Conclusion

To conclude this thesis, the key findings are summarised. This will capture the main messages which have been developed over the course of this study. It is hoped that future co-design practitioners consider the key messages before devising and implementing an EBCD project. Finally, the study limitations and the suggestions for further research are presented.

The key findings

The key findings of the study are outlined in four points. It is urged that each of the points are considered before conducting the co-design of imaging equipment, or any other technological based collaborative design wherein the group consists of both clients and practitioners of health. Without considering the messages outlined in this study the co-design process may not produce the outcomes which are central to co-design, as the empowerment of the user may be limited or restricted.

1. Experiential knowledge is harder to accept in the design of technology

The first finding provides the novel contribution to the knowledge base. Experiential knowledge is harder to accept when the focus of the design process is technological in nature. The majority of co-design studies identified in the literature are in the field of service redesign (Farr, 2012; Iedema et al., 2010; Locock et al., 2014). In the service redesign processes, experience is essential to both understanding and improving how a service feels and, therefore, how it is perceived and judged by people.

This thesis studied the co-design of imaging equipment. This study differed from the literature on service redesign as the focus is more technical. Therefore the women in the group were faced with difficulties regarding the epistemological arguments for different types of knowledge. Typically, the standards by which we make decisions regarding technical knowledge are based within positivist paradigms and judging truth (Nordin, 2000). Whereas with service redesign, more subjective approaches to judging and assessing a service are perceived to be more effective (Caron-Flinterman et al., 2005). This has in turn driven the design processes such as EBCD in the service redesign arena.

My findings suggest that even though an experience centred design process was used, the overall perspective from the women in the group was that clinical knowledge had more value and power in making decisions. This finding goes directly against the focus on experience of the co-design process. Captured in the theme of 'knowledge', the women in this study highlighted that their role was limited by the scope of their mammography-specific knowledge. Both the clients and practitioners reflected on how hearing each other's experiences was interesting and eye opening, however they felt learning about clinical knowledge was more valuable to the decision-making and the evaluation of developed designs.

This finding has a number of implications in terms of the future of co-design in more technological settings such as imaging equipment design. Firstly, the benefit to the final design outcome may not achieve what was hoped by whoever initiates a co-design process. That is, the design outcome may not improve experience of the users involved in the process. Secondly, the users who are involved may not be empowered through being involved. The group which was studied in this thesis replicated more standard ways of making decisions in that they viewed technical knowledge as more useful, therefore replicating existing ways of designing and developing medical equipment. Although the women in my group often discussed how the co-design process gave them a voice in the process, they were reluctant to let their experiential knowledge drive the process. Therefore they may not fully be empowered to have a voice in a new and influential way.

Failure to recognise that clinical knowledge takes precedence in co-design could limit the value of involving the client user group in the co-design process.

2. **Co-design promotes learning and shared understanding**

Learning and developing a shared understanding was a key factor which was perceived positively by the group members. This finding concurs with the literature and did not differ due to the difference in design focus.

The clients learnt about the experience of being a practitioner and heard the practitioner's restrictions in terms of time constraints, difficulties with the machine, staffing issues, and work related injuries. Through this, they reflected in a change of perspective towards

radiography and in particular mammography practitioners. This was viewed as a benefit of the co-design process and the clients expressed that they would change their behaviour towards practitioners and the mammography examination in the future. The practitioners also learnt from the clients, reflecting on how the process has made them more patient around women who are having a mammogram after hearing their experiences.

The setting of co-design differs from a normal practitioner and client relationship, and talking to each other in this group lead to a change in perspective and behaviour in both. Therefore, although there are many challenges to implementing co-design of medical equipment, the benefits associated with having a forum and space to express their experiences both as clients and practitioners should not be under-valued.

3. **Challenges of co-design lessen over time with the group**

The Wheelan (1990) model of group development has been applied to the group's changing dynamics over time. The review of the literature has highlighted that there are variations in the way in which a group of practitioners and clients interact over time (Bowen et al., 2013; Larkin et al., 2015). Bowen's interviews with group members following the co-design process highlighted that the group did not become more cohesive in a linear fashion. This finding differs from others who focus on the end feelings towards each other rather than the ongoing processes of the group's dynamics (Piper et al., 2012).

This study found that the group moved through a number of stages through which they became a functioning team. The first phase as described by Wheelan (1990) was dependency and inclusion. During this stage the group were polite to each other and there were feelings of certainty to the tasks of co-design. From my analysis of the group interactions over the course of the process it was identified that the group avoiding the management of task related conflict. However, the analysis of interviews identified that the group did feel there were issues with how decisions were made. This stage is identified by Wheelan (1990) as a struggle for power as group members come to terms with their roles.

4. Changes need to be put in place to allow the successful EBCD of medical equipment

Having identified that there are issues with the current EBCD process and its application to medical equipment, a number of recommendations have been made. Each of the recommendations is aimed at giving all of the women within the group an equal voice in the co-design group and the design process. Having identified that knowledge informs role, and that experiential knowledge was not considered as useful as clinical knowledge, it is important that these recommendations are put in place.

EBCD has been tailored to a number of specific services including emergency departments (Iedema et al., 2010; Piper et al., 2012), lung and breast cancer services (Tsianakas, Robert, et al., 2012) and mental health services (Larkin et al., 2015; Springham & Robert, 2015). Each of these studies has reported both benefits and challenges to implementing a process of design and improvement which is both based on experience and collaboration. This study has explored the process when adapted and applied to the design of medical equipment, specifically mammography machine design.

The recommendations for using the co-design process, EBCD, on medical equipment that have arisen from this thesis are:

1. Have an impartial trained facilitator

2. Discuss and Decide on all group members' roles and responsibilities

3. Establish ground rules

4. Provide scaffolding and creative tools for users' to design for themselves

5. Include a technical feasibility stage in the EBCD process

6. Agree on a method of decision-making in the group

7. Revisit the ground rules and roles and responsibilities with all the group members individually.

Limitations

Due to the nature of the group, there are a number of considerations that have resulted in study limitations. These considerations should assist the reader in assessing the relevance of the key findings presented in this study to other similar studies.

The lack of diversity, other than user type, may have had an impact on my study and needs to be acknowledged. All of the women who agreed to take part in the study were white British in ethnicity. This may have impacted the group's communication and developing relationships. The perspectives on co-design only represent those of women white British in ethnicity. Piper et al. (2012)'s paper highlights the lack of underrepresented populations in research, and that the majority of people who take part in research are white British. This is an issue that should be addressed in future co-design projects. The reason for the limited diversity in terms of economic background, ethnicity and race appears to be due to the recruitment method used in this study.

Appropriateness addresses the identification and use of participants who can best inform the research question. Appropriateness, in some cases, can be improved by using online and internet recruitment strategies (Hamilton & Bowers, 2006). Researchers can locate specific groups who have online communities that may be difficult to reach without the internet. Therefore, it is still a strategy that may be useful for designers and researchers to use with EBCD. For example, for a medical device which was specific to a rare disease it might be that there is already an established online community of people with the rare disease.

However, a second principle guiding recruitment in qualitative research is adequacy (Hamilton & Bowers, 2006), which means that there is enough data collected to develop detailed, rich descriptions of the phenomenon under study (Morse & Field, 2002). In this study, the phenomenon under examination was collaboration between diverse user groups which was achieved with the co-design group. However, there are other aspects of diversity which are important to both the process and outcomes of the design process. Socio-economic and ethnic diversity may have meant that the women had different experiences of mammography and therefore would have resulted in different designed outcomes. This type of diversity would have also influenced the process of EBCD, the interactions between

clients and practitioners and the design tasks. For example, the status differences between the professional practitioners and the clients could have been more apparent.

Another way of improving recruitment may have been to involve the clients in the recruitment strategy. Joy, a client, asked me about how I had recruited and, as a patient representative on a number of different panels across the North West, gave me some suggestions for future studies. It therefore would be a recommendation to involve clients who come forward to be involved in the early stages of the design process to aid with recruitment. This approach to recruitment is advised in Patient and Public Involvement in research by INVOLVE (INVOLVE, 2010), however was not found in the design literature but may be a method of recruiting more people into the design process. Graham, Milner, Saul, and Pfaff (2008) found that the effectiveness of online recruitment advertisements depended on their tone and placement. There were issues with the placement originally only being on the internet and only on websites which people who wanted to be involved in research studies visited. The women who were able to locate the advert had access to computers and to the internet. Secondly, the women who responded are likely to have had some previous experience in research and being involved as a research participant. This could have possibly resulted in a group who were not diverse in terms of their experience in research.

In the future, it is recommended that those wishing to recruit people use a variety of approaches to recruitment. Targeting already existing groups such as local religious groups and churches, or patient groups that are already set up, is recommended. Social media may also be a method of recruiting people who are perhaps less likely to have seen and been involved with previous research. A range of recruitment strategies and inclusion and exclusion criteria that ensure a diverse group in terms of user type socio-economic background and ethnicity would allow for new research questions and discussions surrounding diversity and co-design, as well as ensuring that minority groups are considered.

Another issue relating to the composition of the group is that some of the group members knew each other prior to taking part in the study. Both Jill and Liz were from the same choir group and knew each other prior to the co-design process. As they already had an existing

interpersonal relationship, this may have influenced their behaviour towards other group members and impacted the development of the group (Rockett & Okhuysen, 2002). It is likely that within a co-design group there will be some familiarity between the practitioner group and the client group. The literature suggests that familiarity with a person prior to joining a group can result in members working more closely with those persons than the rest of the group (Okhuysen & Bechky, 2009; Rockett & Okhuysen, 2002). Although this did not become evident throughout this thesis, it is important for others to consider how to ensure that the group is cohesive and that cliques do not form. In this study the first stage of the design process, wherein the group members all shared aspects of their own personal experiences, led to feelings of familiarity with the whole group. This therefore mitigated possible issues where members had relationships prior to joining the group.

The final limitation related to this study is that the design ideas where not turned into a product. In a typical co-design process, the design outcomes will be a modified service, or a redeveloped object (in this case a mammography machine). Throughout the study, the whole group were aware that the final design outcomes would be concepts rather than a piece of equipment. The concepts were developed 3D sketches and models of what the women would hope for in a new piece of equipment. This may have impacted, to some extent, their behaviours towards developing the design outcomes. However, it is unlikely that this would have had an impact on the interpersonal relationships between the group members and the communicative interactions as the group moved through the stages of design. The influence of knowledge and external judging of ideas may have been greater if the developed concept sketches were moving through the next phases of redeveloping a product, as manufacturers, engineers, physicists, and other people external to the group would have been involved in considering the feasibility of the design ideas.

Future research

Equal partnerships in the delivery and design of healthcare in PPI is encouraged across the NHS (NHS England, 2014). It will therefore be important to consider the conceptual framework developed here in other areas, wherein the diversity of users is broader than two different user groups.

This conceptual model has been explored in the context of collaboration between health professionals and clients. A similar setting where diversity is a factor, and where there may be technological settings, is PPI in research. It is suggested that it would be beneficial to explore the influence of knowledge, power, and time in these groups in order to optimise PPI in the research process. As PPI is becoming a more standardised practice, it may be important to explore how other groups with a larger range of stakeholders, for example, with the added aspect of the academic influences the process.

Summary

The process of co-design when applied to the development of medical equipment has been explored in this thesis. Through the analysis of individual interviews with members of a co-design group and analysis of video recorded observational data, this study has shown that power and knowledge are both contributing factors to equal partnership and involvement of practitioners and clients in collaborative projects, wherein the focus is a technological object or machine.

This is the first piece of research to explore and produce findings on how the process of experience-based co-design works when applied to medical equipment. Although this study only focused on one small group throughout the process, this is the first to highlight that, when applied to medical equipment, power relationships between users exist due to cultural and social beliefs about the value and usefulness of different knowledge types. The key unique finding is that experiential knowledge is harder to accept in technological settings than that of service redesign. Suggestions for recommendations have been put in place that aim to balance the power of clinical knowledge which was identified as an influencing factor on the impact of client involvement in the co-design of medical equipment.

References

Archer, M. S. (1995). *Realist social theory: The morphogenetic approach*: Cambridge university press.

Argyris, C., & Schon, D. A. (1974). *Theory in practice: Increasing professional effectiveness*: Jossey-Bass.

Bachrach, P., & Baratz, M. S. (1963). Decisions and nondecisions: An analytical framework. *American political science review, 57*(03), 632-642.

Bak, K., Macdougall, L., Green, E., Moody, L., Obarski, G., Hale, L., . . . Devitt, D. (2014). Hindsight is 20/20: Lessons learned after implementing experience based design. *Patient Experience Journal, 1*(2), 12-19.

Baker, M. J. (1999). Argumentation and constructive interaction. *Foundations of argumentative text processing, 5*, 179-202.

Barcellini, F., Prost, L., & Cerf, M. (2015). Designers' and users' roles in participatory design: What is actually co-designed by participants? *Applied Ergonomics, 50*, 31-40.

Barnard, A. (2002). Philosophy of technology and nursing. *Nursing Philosophy, 3*(1), 15-26.

Baron, R., & Kerr, N. (2003). *Group Process, Group Decision, Group Action 2/E*: McGraw-Hill Education (UK).

Bate, P., & Robert, G. (2006). Experience-based design: from redesigning the system around the patient to co-designing services with the patient. *Quality and safety in health care, 15*(5), 307. doi:10.1136/qshc.2005.016527

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The qualitative report, 13*(4), 544-559.

Bevan, H., Robert, G., Bate, P., Maher, L., & Wells, J. (2007). Using a Design Approach to Assist Large-Scale Organizational Change "10 High Impact Changes" to Improve the National Health Service in England. *The Journal of Applied Behavioral Science, 43*(1), 135-152.

Bjerknes, G., & Bratteteig, T. (1995). User participation and democracy: A discussion of Scandinavian research on system development. *Scandinavian Journal of information systems, 7*(1), 1.

Board, H. C. (1998). Standing Group on Health Technology. *Health Technology Assessment, 2*(15).

Bovaird, T., & Loeffler, E. (2013). We're all in this together: harnessing user and community co-production of public outcomes. *Birmingham: Institute of Local Government Studies: University of Birmingham, 1*, 15.

Bowen, S., McSeveny, K., Lockley, E., Wolstenholme, D., Cobb, M., & Dearden, A. (2013). How was it for you? Experiences of participatory design in the UK health service. *International Journal of CoCreation in Design and the Arts, 9*(4), 230-246. doi:10.1080/15710882.2013.846384

Boyd, H., McKernon, S., Mullin, B., & Old, A. (2012). Improving healthcare through the use of co-design. *NZ Med J, 125*(1357), 76-87.

Bradbury-Jones, C., Sambrook, S., & Irvine, F. (2008). Power and empowerment in nursing: a fourth theoretical approach. *Journal of advanced nursing, 62*(2), 258-266.

Bratteteig, T., & Wagner, I. (2012). *Disentangling power and decision-making in participatory design.* Paper presented at the Proceedings of the 12th Participatory Design Conference: Research Papers-Volume 1.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology, 3*(2), 77-101.

Brudney, J. L., & England, R. E. (1983). Toward a definition of the coproduction concept. *Public administration review*, 59-65.

Bruner, J. (1991). The narrative construction of reality. *Critical inquiry, 18*(1), 1-21.

Burkhardt, J.-M., Détienne, F., Hébert, A.-M., Perron, L., & Leclercq, P. (2009). *An approach to assess the quality of collaboration in technology-mediated design situations.* Paper presented at the

European Conference on Cognitive Ergonomics: Designing beyond the Product---Understanding Activity and User Experience in Ubiquitous Environments.

Cain, J. (1998). Experience-Based Design: Toward a Science of Artful Business Innovation. *Design Management Journal (Former Series), 9*(4), 10-16.

Caron-Flinterman, J. F., Broerse, J. E., & Bunders, J. F. (2005). The experiential knowledge of patients: a new resource for biomedical research? *Social Science & Medicine, 60*(11), 2575-2584.

Carson, D., Gilmore, A., Perry, C., & Gronhaug, K. (2001). *Qualitative marketing research*: Sage.

Casakin, H., & Badke-Schaub, P. (2013). The psychology of creativity: mental models in design teams. *Psychology of Creativity*, 167-180.

Cavanagh. (2013). *Guidance on screening and symptomatic breast imaging*

Chida, K., Komatsu, Y., Sai, M., Nakagami, A., Yamada, T., Yamashita, T., . . . Zuguchi, M. (2009). Reduced compression mammography to reduce breast pain. *Clinical Imaging, 33*(1), 7-10. doi:http://dx.doi.org/10.1016/j.clinimag.2008.06.025

Clegg, S. R. (1989). *Frameworks of power*: Sage.

Cooper, C. (2005). Just joking around? Employee humor expression as an ingratiatory behavior. *Academy of Management Review, 30*(4), 765-776.

Cooper, C. (2008). Elucidating the bonds of workplace humor: A relational process model. *Human relations, 61*(8), 1087-1115.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage publications.

Dahl, R. A. (1957). The concept of power. *Behavioral science, 2*(3), 201-215.

Dahl, S. (2004). Intercultural research: The current state of knowledge.

Darses, F., Detienne, F., Falzon, P., & Visser, W. (2001). A method for analyzing collective design processes: DTIC Document.

Davies, & Cleary, P. D. (2005). Hearing the patient's voice? Factors affecting the use of patient survey data in quality improvement. *Quality and safety in health care, 14*(6), 428-432.

Davies, H. T., Nutley, S. M., & Mannion, R. (2000). Organisational culture and quality of health care. *Quality in Health Care, 9*(2), 111-119.

Denzin, N. K., & Lincoln, Y. S. (2011). *The SAGE handbook of qualitative research*: Sage.

Détienne, F. (2006). Collaborative design: Managing task interdependencies and multiple perspectives. *Interacting with computers, 18*(1), 1-20.

Détienne, F., Baker, M., & Burkhardt, J.-M. (2012a). Perspectives on quality of collaboration in design. *CoDesign, 8*(4), 197-199.

Détienne, F., Baker, M., & Burkhardt, J.-M. (2012b). Quality of collaboration in design meetings: methodological reflexions. *CoDesign, 8*(4), 247-261. doi:10.1080/15710882.2012.729063

Dewar, B., Mackay, R., Smith, S., Pullin, S., & Tocher, R. (2010). Use of emotional touchpoints as a method of tapping into the experience of receiving compassionate care in a hospital setting. *Journal of Research in Nursing, 15*(1), 29-41.

DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. *Medical education, 40*(4), 314-321.

Donetto, S., Pierri, P., Tsianakas, V., & Robert, G. (2015). Experience-based Co-design and Healthcare Improvement: Realizing Participatory Design in the Public Sector. *The Design Journal, 18*(2), 227-248.

Donetto, S., Tsianakas, V., & Robert, G. (2014). Using Experience-based Co-design (EBCD) to improve the quality of healthcare: mapping where we are now and establishing future directions. *London: National Nursing Research Unit, King's College*.

Dong, A. (2004). *Design as a socio-cultural cognitive system.* Paper presented at the DS 32: Proceedings of DESIGN 2004, the 8th International Design Conference, Dubrovnik, Croatia.

Doyle, C., & Stanton, M. (2002). Significant factors in patient satisfaction ratings of screening mammography. *Radiography, 8*(3), 159-172.

Duncan, E. A., & Nicol, M. M. (2004). Subtle realism and occupational therapy: An alternative approach to knowledge generation and evaluation. *The British Journal of Occupational Therapy, 67*(10), 453-456.

England, N. (2013). *Transforming Participation in Health and Care*

Farr , M. (2012). Collaboration in public services: can service users and staff participate together. *Critical Perspectives on User Involvement*.

Farr, M. (2012). *Understanding participation and power within collaborative processes: Jointly involving staff and citizens in changing public services.* University of Bath.

Finlay, L., & Ballinger, C. (2006). *Qualitative research for allied health professionals: challenging choices*: John Wiley & Sons.

Foucault, M. (1977). *Discipline and punish: The birth of the prison*: Vintage.

Foucault, M. (1982). The subject and power. *Critical inquiry, 8*(4), 777-795.

French, J. R., Raven, B., & Cartwright, D. (1959). The bases of social power. *Classics of organization theory*, 311-320.

Fund, T. K. (2016). Improving NHS culture. Retrieved from http://www.kingsfund.org.uk/projects/culture

Gale, Hunter, Lawton, & Purdy. (2007). *ERGONOMIC ASSESSMENT OF MAMMOGRAPHY UNITS*. NHS Cancer Screening Programmes.

Gale, N. K., Heath, G., Cameron, E., Rashid, S., & Redwood, S. (2013). Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *BMC medical research methodology, 13*(1), 117.

Geertz, C. (1982). The way we think now: Toward an ethnography of modern thought. *Bulletin of the American Academy of Arts and Sciences*, 14-34.

Geertz, C. (1994). Thick description: Toward an interpretive theory of culture. *Readings in the philosophy of social science*, 213-231.

Gersick, C. J. (1988). Time and transition in work teams: Toward a new model of group development. *Academy of management journal, 31*(1), 9-41.

Gillespie, A., & Cornish, F. (2010). Intersubjectivity: Towards a dialogical analysis. *Journal for the Theory of Social Behaviour, 40*(1), 19-46.

Glăveanu, V. P. (2011a). Creativity as cultural participation. *Journal for the Theory of Social Behaviour, 41*(1), 48-67.

Glăveanu, V. P. (2011b). How are we creative together? Comparing sociocognitive and sociocultural answers. *Theory & psychology, 21*(4), 473-492.

Goethem, M. V., Mortelmans, D., Bruyninckx, E., Verslegers, I., Biltjes, I., Hove, E. V., & Schepper, A. D. (2003). Influence of the radiographer on the pain felt during mammography. *European Radiology, 13*(10), 2384-2389. doi:10.1007/s00330-002-1686-6

Graham, A., Milner, P., Saul, J. and Pfaff, L., 2008. Online advertising as a public health and recruitment tool: comparison of different media campaigns to increase demand for smoking cessation interventions. *Journal of Medical Internet Research*, *10*(5), p.e50

Grocott, P., Blackwell, R., Currie, C., Pillay, E., Clapham, J., Graham-King, P., . . . Snelson, K. (2013). Woundcare research for epidermolysis bullosa: designing products with the users. *Dermatological Nursing, 12*(1), 30-35.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research, 2*(163-194).

Gustavsson, S. M. K. (2014). Improvements in neonatal care

using experience-based co-design. *International Journal of Health Care Quality Assurance, 27*(5), 427-438. doi:10.1108/IJHCQA-02-2013-0016

Hafslund, B. (2000). Mammography and the experience of pain and anxiety. *Radiography, 6*(4), 269-272. doi:http://dx.doi.org/10.1053/radi.2000.0281

Hammersley. (1992). Deconstructing the qualitative-quantitative divide.

Hammersley. (2000). The relevance of qualitative research. *Oxford Review of Education, 26*(3-4), 393-405.

Hammersley. (2013). *What's wrong with ethnography?* : Routledge.

Hammersley, & Campbell. (2012). *What is Qualitative Research* (1st ed.): Bloomsbury Academic.

Hamilton, R.J. and Bowers, B.J., 2006. Internet recruitment and e-mail interviews in qualitative studies. *Qualitative Health Research, 16*(6), pp.821-835.

Heath, C. (2011). Embodied action: video and the analysis of social interaction. *Qualitative research*, 250-270.

Heath, C., Hindmarsh, J., & Luff, P. (2010). *Video in qualitative research*: Sage Publications.

Hewitt-Taylor, J. (2004). Challenging the balance of power: patient empowerment. *Nursing Standard, 18*(22), 33-37.

Hogg, M. A. (2001). A social identity theory of leadership. *Personality and social psychology review, 5*(3), 184-200.

Holmes, J., & Stubbe, M. (2015). *Power and politeness in the workplace: A sociolinguistic analysis of talk at work*: Routledge.

Houghton, C., Casey, D., Shaw, D., & Murphy, K. (2013). Rigour in qualitative case-study research. *Nurse researcher, 20*(4), 12-17.

Hunt, J. (2015). *Culture change in the NHS* www.gov.ul/government/publications: OGL

Iedema, R., Merrick, E., Piper, D., Britton, K., Gray, J., Verma, R., & Manning, N. (2010). Codesigning as a discursive practice in emergency health services: the architecture of deliberation. *The Journal of Applied Behavioral Science, 46*(1), 73-91.

INVOLVE. (2010). Payment for involvement: A guide for making payments to members of the public actively involved in NHS, public health and social care research *INVOLVE, Eastleigh*.

INVOLVE. (2012). Briefing notes for researchers: involving the public in NHS, pulic health and social care research. *INVOLVE, Eastleigh*.

Jehn, K. A., & Mannix, E. A. (2001). The dynamic nature of conflict: A longitudinal study of intragroup conflict and group performance. *Academy of management journal, 44*(2), 238-251.

Jehn, K. A., Northcraft, G. B., & Neale, M. A. (1999). Why differences make a difference: A field study of diversity, conflict and performance in workgroups. *Administrative science quarterly, 44*(4), 741-763.

Johnstone, B. (2000). The individual voice in language. *Annual Review of Anthropology*, 405-424.

Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundations and practice. *The Journal of the Learning Sciences, 4*(1), 39-103.

Kitzinger, J. (1995). Qualitative research. Introducing focus groups. *BMJ: British medical journal, 311*(7000), 299.

Koch, T. (1999). An interpretive research process: Revisiting phenomenological and hermeneutical approaches. *Nurse researcher, 6*(3), 20.

Lantolf, J. P., Thorne, S. L., & Poehner, M. E. (2000). Sociocultural theory and second language development.

Larkin, M., Boden, Z. V. R., & Newton, E. (2015). On the Brink of Genuinely Collaborative Care: Experience-Based Co-Design in Mental Health. *Qualitative Health Research, 25*(11), 1463-1476. doi:10.1177/1049732315576494

Littleton, K., Miell, D., & Faulkner, D. (2004). *Learning to collaborate, collaborating to learn: Understanding and promoting educationally productive collaborative work*: Nova Science Publishers Inc.

Locock, L., Robert, G., Boaz, A., Vougioukalou, S., Shuldham, C., Fielden, J., . . . Pearcey, J. (2014). Using a national archive of patient experience narratives to promote local patient-centered quality improvement: an ethnographic process evaluation of 'accelerated' experience-based

co-design. *Journal of Health Services Research & Policy, 19*(4), 200-207. doi:10.1177/1355819614531565

Lukes, S. (1986). *Power*: NYU Press.

Mahmoud, M., & Robinson, P. (2011). *Interpreting hand-over-face gestures.* Paper presented at the International Conference on Affective Computing and Intelligent Interaction.

Martin, J. L., Norris, B. J., Murphy, E., & Crowe, J. A. (2008). Medical device development: The challenge for ergonomics. *Applied Ergonomics, 39*(3), 271-283.

Mattessich, P. W., & Monsey, B. R. (1992). *Collaboration: what makes it work. A review of research literature on factors influencing successful collaboration*: ERIC.

Mauthner, N. S., & Doucet, A. (2003). Reflexive accounts and accounts of reflexivity in qualitative data analysis. *Sociology, 37*(3), 413-431.

Mays, N., & Pope, C. (2000). Assessing quality in qualitative research. *British medical journal, 320*(7226), 50.

Mercer, Hogg, P., Szczepura, K., & Denton, E. R. (2013). Practitioner compression force variation in mammography: A 6-year study. *Radiography, 19*(3), 200-206.

Merleau-Ponty, M., & Smith, C. (1996). *Phenomenology of perception*: Motilal Banarsidass Publishe.

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education. Revised and Expanded from" Case Study Research in Education."*: ERIC.

Mertens, D. M. (2014). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods*: Sage Publications.

Miller, W. (2005). Definition of design. *Trimtab, Buckminster Fuller Institute*.

Miranda, S. M., & Bostrom, R. P. (1999). Meeting facilitation: process versus content interventions. *Journal of Management information systems, 15*(4), 89-114.

Morrow, E., Boaz, A., Brearley, S., & Ross, F. (2011). Concepts *Handbook of Service User Involvement in Nursing and Healthcare Research* (pp. 18-35): Wiley-Blackwell.

Morrow, E., Cotterell, P., Robert, G., Grocott, P., & Ross, F. (2013). Mechanisms can help to use patients' experiences of chronic disease in research and practice: an interpretive synthesis. *Journal of Clinical Epidemiology, 66*(8), 856-864.

Murphy, F. (2006). The paradox of imaging technology: a review of the literature. *Radiography, 12*(2), 169-174.

Murphy, F., & Yielder, J. (2010). Establishing rigour in qualitative radiography research. *Radiography, 16*(1), 62-67.

Myklebust, A. M., Seierstad, T., Stranden, E., & Lerdal, A. (2009). Level of satisfaction during mammography screening in relation to discomfort, service provided, level of pain and breast compression. *European Journal of Radiography, 1*(2), 66-72. doi:http://dx.doi.org/10.1016/j.ejradi.2009.09.003

NHSBSP. (2006). *Quality Assurance Guidelines for Mammography including Radiographic Quality Control*

NHSBSP. (2013). NHS breast screening: Helping you decide In K. s. H. Partners (Ed.).

Nordin, I. (2000). Expert and non-expert knowledge in medical practice. *Medicine, Health care and philosophy, 3*(3), 295-302.

Okhuysen, G. A., & Bechky, B. A. (2009). 10 coordination in organizations: an integrative perspective. *The Academy of Management Annals, 3*(1), 463-502.

Olson, G. M., Olson, J. S., Carter, M. R., & Storrosten, M. (1992). Small group design meetings: An analysis of collaboration. *Human–Computer Interaction, 7*(4), 347-374.

Page, S. E. (2008). *The difference: How the power of diversity creates better groups, firms, schools, and societies*: Princeton University Press.

Paulus, P. (2000). Groups, teams, and creativity: The creative potential of idea-generating groups. *Applied psychology, 49*(2), 237-262.

Pawson, R., & Tilley, N. (1997). *Realistic evaluation*: Sage.

Peart, O. (2005). *Mammography and Breast Imaging* McGraw-Hill Medical.

Pease, B., & Pease, A. (2008). *The definitive book of body language*: Bantam.

Perry-Smith, J. E. (2006). Social yet creative: The role of social relationships in facilitating individual creativity. *Academy of management journal, 49*(1), 85-101.

Pike, K. L. (1954). Language in relation to a unified theory of the structure of human behavior.

Piper, D., Iedema, R., Gray, J., Verma, R., Holmes, L., & Manning, N. (2012). Utilizing experience-based co-design to improve the experience of patients accessing emergency departments in New South Wales public hospitals: an evaluation study. *Health Services Management Research, 25*(4), 162-172.

Popay, J., & Williams, G. (1996). Public health research and lay knowledge. *Social Science & Medicine, 42*(5), 759-768.

Poulos, & Llewellyn, G. (2005). Mammography discomfort: a holistic perspective derived from women's experiences. *Radiography, 11*(1), 17-25. doi:http://dx.doi.org/10.1016/j.radi.2004.07.002

Poulos, McLean, D., Rickard, M., & Heard, R. (2003). Breast compression in mammography: how much is enough? *Australasian Radiology, 47*(2), 121-126.

QIT(13660). (2015). *Culture Change in the NHS – applying the lessons of the Francis Inquiries:*

Equality Analysis.

Ram, M. B., Grocott, P. R., & Weir, H. C. M. (2008). Issues and challenges of involving users in medical device development. *Health Expect., 11*(1), 63-71. doi:10.1111/j.1369-7625.2007.00464.x

Ritchie, J. (2003). The applications of qualitative methods to social research. *Qualitative research practice: A guide for social science students and researchers*, 24-46.

Ritchie, J., Lewis, J., Nicholls, C. M., & Ormston, R. (2013). *Qualitative research practice: A guide for social science students and researchers*: Sage.

Ritchie, J., & Spencer, L. (2002). Qualitative data analysis for applied policy research. *The qualitative researcher's companion, 573*, 305-329.

Robert, C., & Yan, W. (2007). The case for developing new research on humor and culture in organizations: Toward a higher grade of manure. *Research in personnel and human resources management, 26*, 205.

Robert, G., Cornwell, J., Locock, L., Purushotham, A., Sturmey, G., & Gager, M. (2015). Patients and staff as codesigners of healthcare services. *BMJ, 350*, g7714.

Robinson, L., Hogg, P., & Newton-Hughes, A. (2013). The power and the pain: Mammographic compression research from the service-users' perspective. *Radiography, 19*(3), 190-195. doi:10.1016/j.radi.2013.04.005

Rockett, T. L., & Okhuysen, G. A. (2002). Familiarity in groups: Exploring the relationship between inter-member familiarity and group behavior.

Rubin, H. J., & Rubin, I. S. (2011). *Qualitative interviewing: The art of hearing data*: Sage.

Salter, K. L., & Kothari, A. (2014). Using realist evaluation to open the black box of knowledge translation: a state-of-the-art review. *Implementation Science, 9*(1), 1.

Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design, 4*(1), 5-18.

Schutz, A. (1967). *The phenomenology of the social world*: Northwestern University Press.

Schwarz, R. (2002). *The skilled facilitator: A comprehensive resource for consultants, facilitators, managers, trainers, and coaches*: John Wiley & Sons.

Schwarz, R. (2010). Ground Rules for Effective Groups. *The Skilled Facilitator Fieldbook: Tips, Tools, and Tested Methods for Consultants, Facilitators, Managers, Trainers, and Coaches*, 61.

Scott, T., Mannion, R., Marshall, M., & Davies, H. (2003). Does organisational culture influence health care performance? A review of the evidence. *Journal of Health Services Research & Policy, 8*(2), 105-117.

Shah, & Robinson, I. (2006). User involvement in healthcare technology development and assessment: Structured literature review. *International Journal of Health Care Quality Assurance, 19*(6), 500-515. doi:10.1108/09526860610687619

Shah, & Robinson, I. (2008). Medical device technologies: who is the user? *International Journal of Healthcare Technology and Management, 9*(2), 181-197.

Shah, Robinson, I., & AlShawi, S. (2009). Developing medical device technologies from users' perspectives: A theoretical framework for involving users in the development process. *International Journal of Technology Assessment in Health Care, 25*(04), 514-521. doi:doi:10.1017/S0266462309990328

Shah, P. P., & Jehn, K. A. (1993). Do friends perform better than acquaintances? The interaction of friendship, conflict, and task. *Group decision and negotiation, 2*(2), 149-165.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for information, 22*(2), 63-75.

Silverman, D. (2010). *Qualitative research*: Sage.

Silverman, D. (2013). *Doing qualitative research: A practical handbook*: SAGE Publications Limited.

Silverman, D. (2016). *Qualitative research*: Sage.

Sjöberg, C., & Timpka, T. (1998). Participatory design of information systems in health care. *Journal of the American Medical Informatics Association, 5*(2), 177-183.

Smith, J., & Firth, J. (2011). Qualitative data analysis: the framework approach. *Nurse researcher, 18*(2), 52-62.

Spencer-Oatey, H. (2005). (Im) politeness, face and perceptions of rapport: unpacking their bases and interrelationships.

Spencer-Oatey, H. (2012). What is culture? A compilation of quotations. *GlobalPAD Core Concepts*.

Springham, N., & Robert, G. (2015). Experience based co-design reduces formal complaints on an acute mental health ward. *BMJ quality improvement reports, 4*(1). doi:10.1136/bmjquality.u209153.w3970

Srivastava, A., & Thomson, S. B. (2009). Framework analysis: a qualitative methodology for applied policy research. *Joaag, 4*(2), 72-79.

Stempfle, J., & Badke-Schaub, P. (2002). Thinking in design teams-an analysis of team communication. *Design Studies, 23*(5), 473-496.

Stewart, D. W., & Shamdasani, P. N. (2014). *Focus groups: Theory and practice* (Vol. 20): Sage Publications.

Ten Have, P. (2007). *Doing conversation analysis*: Sage.

Thomson, A. M., & Perry, J. L. (2006). Collaboration processes: Inside the black box. *Public administration review, 66*(s1), 20-32.

Thorne, S. L. (2005). Epistemology, politics, and ethics in sociocultural theory. *The Modern Language Journal, 89*(3), 393-409.

Tollyfield, R. (2014). Facilitating an accelerated experience-based co-design project. *British Journal of Nursing, 23*(3).

Tsianakas, Maben, J., Wiseman, T., Robert, G., Richardson, A., Madden, P., . . . Davies, E. (2012). Using patients' experiences to identify priorities for quality improvement in breast cancer care: patient narratives, surveys or both? *BMC Health Serv. Res., 12*. doi:10.1186/1472-6963-12-271

Tsianakas, Robert, G., Maben, J., Richardson, A., Dale, C., & Wiseman, T. (2012). Implementing patient-centred cancer care: using experience-based co-design to improve patient experience in breast and lung cancer services. *Supportive care in cancer, 20*(11), 2639-2647.

Tsianakas, V., Verity, R., Oakley, C., Murrells, T., Robert, G., Richardson, A., & Ream, E. (2014). Using experience-based co-design (EBCD) to enhance support for carers in the chemotherapy outpatient setting. *Eur. J. Oncol. Nurs., 18*, S13-S14.

Tuckman, B. W. (1965). Developmental sequence in small groups. *Psychological bulletin, 63*(6), 384.

Tuckman, B. W., & Jensen, M. A. C. (1977). Stages of small-group development revisited. *Group & Organization Management, 2*(4), 419-427.

van Aalst, J. (2009). Distinguishing knowledge-sharing, knowledge-construction, and knowledge-creation discourses. *International Journal of Computer-Supported Collaborative Learning, 4*(3), 259-287.

Van de Bovenkamp, H. M., Trappenburg, M. J., & Grit, K. J. (2010). Patient participation in collective healthcare decision making: the Dutch model. *Health Expectations, 13*(1), 73-85.

Van Knippenberg, D., De Dreu, C. K., & Homan, A. C. (2004). Work group diversity and group performance: an integrative model and research agenda. *Journal of applied Psychology, 89*(6), 1008.

VeneKlasen, L., Miller, V., Budlender, D., & Clark, C. (2002). *A new weave of power, people & politics: the action guide for advocacy and citizen participation*: World Neighbors Oklahoma City, OK.

Vennik, F. D., van de Bovenkamp, H. M., Putters, K., & Grit, K. J. (2015). Co-production in healthcare: rhetoric and practice. *International Review of Administrative Sciences*, 0020852315570553.

Von Hippel, E. (1988). *The sources of innovation*: New York ; Oxford : Oxford University Press.

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*: Harvard university press.

Ward, D. J., Furber, C., Tierney, S., & Swallow, V. (2013). Using framework analysis in nursing research: a worked example. *Journal of advanced nursing, 69*(11), 2423-2431.

Wellard, S., & Bethune, E. (1996). Reflective journal writing in nurse education: whose interests does it serve? *Journal of advanced nursing, 24*(5), 1077-1082.

Wheelan, S. A. (1990). *Facilitating training groups: A guide to leadership and verbal intervention skills*: Greenwood Publishing Group.

Wheelan, S. A. (2009). Group size, group development, and group productivity. *Small group research*.

Wheelan, S. A., Davidson, B., & Tilin, F. (2003). Group Development Across Time Reality or Illusion? *Small group research, 34*(2), 223-245.

Wheelan, S. A., & Hochberger, J. M. (1996). Validation studies of the group development questionnaire. *Small group research, 27*(1), 143-170.

Wheelan, S. A., & Mckeage, R. L. (1993). Developmental patterns in small and large groups. *Small group research, 24*(1), 60-83.

Whelehan, P., Evans, A., Wells, M., & MacGillivray, S. (2013). The effect of mammography pain on repeat participation in breast cancer screening: A systematic review. *The Breast, 22*(4), 389-394. doi:http://dx.doi.org/10.1016/j.breast.2013.03.003

Williamson, T., Kenney, L., Barker, A. T., Cooper, G., Good, T., Healey, J., . . . Prenton, S. (2014). Enhancing public involvement in assistive technology design research. *Disability and Rehabilitation: Assistive Technology*(0), 1-8.

Willis, J. W., Jost, M., & Nilakanta, R. (2007). *Foundations of qualitative research: Interpretive and critical approaches*: Sage.

Worchel, S., Coutant-Sassic, D., & Grossman, M. (1991). A developmental approach to group dynamics: A model and illustrative research.

Wright, P., & McCarthy, J. (2010). Experience-centered design: designers, users, and communities in dialogue. *Synthesis Lectures on Human-Centered Informatics, 3*(1), 1-123.

Appendix 1: Stages of EBCD implemented in this study

Specific tasks	When during the process the task took place	Summary of what the task involved
Discussing past experiences to identify touchpoints	Meeting 1, UoS. Meeting 2, Nightingale Centre	A step by step narrative discussion of the use of mammography machines for both mammographic practitioners and clients to identify moments or touchpoints associated with interacting with the mammography machine.
Ranking touch points	Meeting 3, Co-design workshop, UoS.	Involved discussion between group members to identify areas of the equipment they felt caused problems and then rank them in order of what needed to be addressed.
Affinity Diagram	Meeting 3, Co-Design Workshop, UoS.	Structured brainstorming around each of the touch points identified in Meeting 1 & 2. Idea generation exercise.
Group sketching	Meeting 3, Co-design Workshop, UoS	Involved splitting into smaller groups (of 3 and sketching the ideas identified through the affinity diagram on a 3D sketch of the mammography machine).
Technical feasibility feedback	Meeting 4, UoS	The sketches were given to a medical physicist and then fed back to the group, the group then read these and made decisions about what was going to stay and what would need to be removed.
Making decisions on design ideas	Meeting 4, UoS	Design features where discussed and decisions regarding what could stay and what needed to be removed where made.

Appendix 2: Advert for client recruitment

Design Team Steering Group Advert

Members of the Public

Opportunity to members of the public to be involved with the process of mammography equipment design

You will be a member of a design team and a research steering group. Your role will be to contribute towards the design of mammography with the woman in mind – as well as evaluating the process of design itself.

I am looking for women who have had a mammogram and would be interested in contributing to the development of a method of medical equipment design which involves the public and health professionals. You will be a member of a steering group comprised of women who have experienced mammography and women who are responsible for taking the mammogram.

I anticipate we will meet as a group 3 times over the course of a year between July 2014 and July 2015. All the meetings will take place at the University of Salford, there will be two 2 hours meetings and a design workshop which will take place over the course of a day. At the first meeting I will introduce you to the project and the rest of the team and will take place at the end of July.

You will need to have experienced mammography, and have had a mammogram taken.

You do not need any experience in design or research, as support and training will be in place to ensure that you feel confident and comfortable.

For more information on the role, or to apply please get in touch with Samantha Bird, via email

s.l.bird@edu.salford.ac.uk

Appendix 3: The interview guide

Interview Guide – Mid Project

Could you tell me about your experience of

- The introductory meeting
- The design and creativity tasks during the design workshop

Do you feel that your personal experience of mammography equipment was important during the project?

Could you describe what it was like working with mammographers/clients during the project?

- Were there any conflicts?
- Was there a difference of goals between yourself and any other members of the group?
- How do you think mammographers/clients affected the process and outcomes of the designs?

Could you describe a moment during the project where you felt the group had made a breakthrough in their design?

Could you tell me about a moment you felt you might have been restricted to put forward a design idea?

Apart from this, what do you believe have been the strengths of the project?

- In terms of the tasks (during the design workshop)
- The utilisation of the skills you came into the project with
- Working with mammographers/ clients?
- The support and training

Do you believe there has been any weakness during the project?

- In terms of the tasks (during the design workshop)
- The utilisation of the skills you came into the project with
- Working with mammographers/ clients?

Do you think anything could have been altered or improved to support you in these roles?

Could you think of any improvements for the future? Regarding the weaknesses of the project?

Would you take part in another collaborative design project?

Appendix 4: Screenshots from co-design meeting video recordings

Introductory Meeting 1

Co-design meeting 1

Small co-design group (working on detector, buttons and panels)

Small co-design group (working on paddle, and free arm solution)

University of
Salford
MANCHESTER

27.05.2014

Implementing and evaluating a method in which users become designers

You are being asked to take part in a research project being led by a PhD student at the University of Salford. I am looking for female members of the public who have had a mammogram to work with me as a member of the research and design team. So you can decide to be involved or not, it is important that you understand why the research is being done and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish. Please ask me if there is anything that is unclear or if you would like more information. Take your time in deciding whether or not you wish to take part.

What would my role be in the research project?

The research project aims to implement and evaluate a method of collaborative design, in which mammographic radiographers and women who have experienced mammography work together to create innovative mammography equipment designs that combat pain, discomfort and other problems and issues that the people who use it (you) encounter.

I am looking for mammographic radiographers and members of the public to join the research and design team. These people will be a member of the research Steering Group and the mammography equipment Design Team. The Design Team Steering Group (DTSG) will be made up of approximately 5 radiographers and 5 members of the public and will be facilitated by myself. As a member of the DTSG you will be asked to comment on the research design, in particular your views on how a method of design involving members of the public and health professionals should be evaluated. You will also become a designer for the course of the project and work collaboratively with other women to create and design mammography equipment which has the woman in mind.

You do not need any experience of involvement in research or design to be a member of the DTSG as you will be supported throughout your role.

The research project is expected to run from July 2014 to July 2015. It would be helpful if you would be available to participate for the whole duration of the programme.

Why have you been invited?

You have been invited as someone who has experience with mammography equipment and the discomfort that women experience during the procedure.

Do I have to take part?

It is up to you whether or not to take part. You can change your mind at any time and a decision to withdraw or a decision not to take part will not be held against you in anyway.

What will happen to me if I join in?

I aim to have the first Design Team Steering Group meeting in July 2014 at which we can discuss such things as:

- The exact role of a member of the DTSG and your role in the design process
- What is expected from you
- How the group will work
- How I can best prepare and support you
- The evaluation of the project

At the first meeting we, as a group, will discuss the above points in more detail and answer any queries that you have.

I anticipate that there will be 2 DTSG meetings over the course of the year. The meetings will be approximately 2 hours. There will also be a design workshop, which will take place over the course of a day. Opportunities to get involved in other aspects of the project will also be available these will be discussed at the first meeting.

The meetings and workshop will be video and audio recorded in order to analyse the process of design and the workings of the group.

The aim of the project is to evaluate your experiences of the codesign project therefore there will be two interviews in which you are asked to discuss your expectations and experience of the project as it unfolds.

What are the possible disadvantages and risks of taking part?

There are no expected risks related to taking part.

What are the possible benefits of taking part?

Commonly people who take part in research studies as a research team member experience benefits to their personal development, employment skills and confidence levels. I hope that the findings will improve the way in which radiography equipment is designed, by providing a method in which manufacturers can collaborate with radiographers, patients and members of the public to improve radiography equipment.

Will my taking part in the research project be kept confidential?

All personal information which is collected about you during the course of the project will be kept strictly confidential.

Video and Audio recordings will be transcribed, however you will be kept anonymous. Only members of the researcher team will have access to any data.

All data will be stored digitally and securely at the University of Salford.

What will happen to the results of the research?

The results will be used to support the codesign of radiography and other medical equipment – and therefore improve the patient experience. The research findings will make up my thesis, and will be shared in a variety of ways including presentations and forums at the University of Salford. Articles will be published in academic journals and presented at conferences. We won't let people know of your involvement unless you want us to, for example by acknowledging you on project reports. There will be a final meeting in which we can discuss the findings and results of the project.

Who is organising and funding the research?

The study has been organised through the University of Salford.

Contact for further information

For further information please contact Samantha Bird at s.l.bird@edu.salford.ac.uk

What to do now?

You do not have to decide immediately. Take this information away and read it through with others if you wish. If you are willing to take part as a research and design team member please contact me as above.

May I thank you for taking the time to read this information sheet and for considering becoming a member of our research team.

Implementing and evaluating a method in which users become designers

You are being asked to take part in a research project being led by a PhD student at the University of Salford. I am looking for mammographic radiographers to work with me as a member of the research and design team. So you can decide to be involved or not, it is important that you understand why the research is being done and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish. Please ask me if there is anything that is unclear or if you would like more information. Take your time in deciding whether or not you wish to take part.

What would my role be in the research project?

The research project aims to implement and evaluate a method of collaborative design, in which mammographic radiographers and women who have experienced mammography work together to create innovative mammography equipment designs that combat pain, discomfort and other problems and issues that the people who use it (you) encounter.

I am looking for mammographic radiographers and members of the public to join the research and design team. These people will be a member of the research Steering Group and the mammography equipment Design Team. The Design Team Steering Group (DTSG) will be made up of approximately 5 radiographers and 5 members of the public and will be facilitated by myself. As a member of the DTSG you will be asked to comment on the research design, in particular your views on how a method of design involving members of the public and health professionals should be evaluated. You will also become a designer for the course of the project and work collaboratively with other women to create and design mammography equipment which has the woman in mind.

You do not need any experience of involvement in research or design to be a member of the DTSG as you will be supported throughout your role.

The research project is expected to run from July 2014 to July 2015. It would be helpful if you would be available to participate for the whole duration of the programme.

Why have you been invited?

You have been invited as someone who has experience with mammography equipment and the discomfort that women experience during the procedure.

Do I have to take part?

It is up to you whether or not to take part. You can change your mind at any time and a decision to withdraw or a decision not to take part will not be held against you in anyway.

What will happen to me if I join in?

I aim to have the first Design Team Steering Group meeting in July 2014 at which we can discuss such things as:

The exact role of a member of the DTSG and your role in the design process

What is expected from you

How the group will work

How I can best prepare and support you

The evaluation of the project

At the first meeting we, as a group, will discuss the above points in more detail and answer any queries that you have.

I anticipate that there will be 2 DTSG meetings over the course of the year. The meetings will be approximately 2 hours. There will also be a design workshop, which will take place over the course of a day. Opportunities to get involved in other aspects of the project will also be available these will be discussed at the first meeting.

The meetings and workshop will be video and audio recorded in order to analyse the process of design and the workings of the group.

The aim of the project is to evaluate your experiences of the codesign project therefore there will be two interviews in which you are asked to discuss your expectations and experience of the project as it unfolds.

What are the possible disadvantages and risks of taking part?

There are no expected risks related to taking part.

What are the possible benefits of taking part?

Commonly people who take part in research studies as a research team member experience benefits to their personal development, employment skills and confidence levels. I hope that the findings will improve the way in which radiography equipment is designed, by providing a method in which manufacturers can collaborate with radiographers, patients and members of the public to improve radiography equipment.

Will my taking part in the research project be kept confidential?

All personal information which is collected about you during the course of the project will be kept strictly confidential.

Video and Audio recordings will be transcribed, however you will be kept anonymous. Only members of the researcher team will have access to any data.

All data will be stored digitally and securely at the University of Salford.

What will happen to the results of the research?

The results will be used to support the codesign of radiography and other medical equipment – and therefore improve the patient experience. The research findings will make up my thesis, and will be shared in a variety of ways including presentations and forums at the University of Salford. Articles will be published in academic journals and presented at conferences. We won't let people know of your involvement unless you want us to, for example by acknowledging you on project reports. There will be a final meeting in which we can discuss the findings and results of the project.

Who is organising and funding the research?

The study has been organised through the University of Salford.

Contact for further information

For further information please contact Samantha Bird at s.l.bird@edu.salford.ac.uk

What to do now?

You do not have to decide immediately. Take this information away and read it through with others if you wish. If you are willing to take part as a research and design team member please contact me as above.

May I thank you for taking the time to read this information sheet and for considering becoming a member of our research team.

Research Consent Form

Title of Project: Implementing and Evaluating the Collaborative Design of Mammography Equipment

Ethics Ref No:

Name of Researcher: Samantha Bird

(Delete as appropriate)

➢I confirm that I have read and understood the information sheet for the above study (version 27.05.2014) and what my contribution will be.	**Yes** / **No**

➢I have been given the opportunity to ask questions (face to face and e-mail)	**Yes** / **No**

➢I agree to take part in the interviews and design/ research activities	**Yes** / **No** / **NA**

➢I agree to the interview being audio recorded and meetings being video-audio recorded	**Yes** / **No** / **NA**

➢I understand that my participation is voluntary and that I can withdraw from the research at any time **without giving any reason**	**Yes** / **No**

➢I understand how the researcher will use my responses, who will see them and how the data will be stored.

Yes	No

➢**I agree to take part in the above study**

Yes	No

Name of participant   …………………………………………………………………

Signature   ……………………………………………………………….

Date   ………………………………

Name of researcher taking consent   Samantha Bird

Researcher's e-mail address   S.L.Bird@edu.Salford.ac.uk

Appendix 7: Audit Trail and Framework Analysis

Identifying a conceptual framework

Introduction to the key concepts

An inductive approach to analysis was taken, I felt it important to progressively focus (Board, 1998) my findings throughout the analysis. Initially, I grouped the data into tasks and activities, the reasons for this are explained in the next section. However, following the stages of FA my interpretation of the data developed leading me to focus on three main themes that were present in all of the activities. Using the stages of FA as a framework I will now explain the decisions taken which resulted in the findings presented in this thesis.

Stage 1: Familiarisation

For this study, the familiarisation stage involved transcribing and reading through transcriptions of individual interview data collected at mid-point of the co-design process. As Ritchie and Spencer (2002) state often in FA data must be selected for the familiarisation stage. As with a number of qualitative methodologies analysis, begins during data collection and time constraints may not allow for the researcher to wait for all data collected to start analysis. Interview data was selected as the primary data source based on the aims of the research and to prioritise the voice of the women. I, therefore, felt it important to familiarise myself with the first set of interview data, and leave room to add themes which arose from my interpretation of the video recorded interactions during design meetings. Familiarisation occurred immediately following the collection of the first set of interviews, between co-design meeting 1 and co-design meeting 2 and resulted in a number of codes, or emerging concepts. These initial codes are displayed in figure 5.2.

Stage 2: Identifying a theoretical framework

It was at this stage a FA approach was selected, this meant that I was required to specify a draft theoretical framework. The concepts identified were grouped into themes and became the initial theoretical framework. It is important to note that this framework was only a draft, and only included data from the first set of interviews with the group members.

I focused the analysis of the interviews to the benefits of and barriers to involvement in the co-design process, as this was the aim of the thesis: to identify barriers to and benefits of professional and end user collaboration in medical equipment design.

The initial framework is displayed in figure 5.2, next to corresponding codes and extracts from the interview transcripts. Although FA is a matrix based analysis process, this stage occurs before any data has been charted into a matrix, so the initial theoretical framework is displayed as a hierarchy, highlighting the main theme names and codes identified from familiarisation which were grouped into the themes in figure 5.3.

Codes	Extracts	Theme Assignment
Agreement	All looking for a solution, on the same side, agreed on the most important things	**Benefit Agreement**
Benefits of the design process	being able to put forward ideas, outside interest, evolving ideas with others, hearing the other perspective	**Benefits Empowerment (Value of designing and designing in groups)**
Change	change, discussing action from negatives, need something like this for women to actually say this is what we want	**Benefit Empowerment (Change and Voice)**
Change in the group over the course of the process	Well … I did in that design session but not in that one; although I think at some point I started to feel that the radiographers, because they are so used to the equipment they were starting to put limitations on	**Benefit or Barrier? Development of the group over the process**

	chatted away without being aware they were from different groups, we all had the same experiences	**Benefit** **The group (cohesion)**
Cohesion		
Conflict/ disagreement	Different personalities pushing different points, feeling ridiculed, made to feel silly,	**Barrier** **Conflict between group members**
Dismissive	some of the ideas got completely dismissed, dismissive, ideas abandoned and thrown out, without letting us have a good talk about it,	**Barrier** **Conflict between group members**
Design tasks benefits	forced you to actually come up with some action, I am a doer, when you put it down on paper it actually makes more sense,	**Benefit** **Empowerment (Action and Change)**
Defending status and role in the group	I'm a forceful personality so no I didn't, I used all my skills if you like from doing applications training and being a mammographer and teaching mammography	**Benefit** **Skills and role in the group**
External influences	It's really hard to step back from those ideas because you know someone like [*Medical Physicist*] is going to waltz in and say well that's not going to work because physics won't allow that, mammographers may resist change as it will impact them more.	**Barrier** **Power & Knowledge (Resisting change)**
Hopes for designed	Feeling of anything is possible, in the first session I	**Benefits**

solution	felt that lots of things where possible and it was quite erm exciting	**Empowerment (Feelings of change)**
Interpersonal relations	Felt ideas weren't as good as other peoples, mammographers where dismissive, felt pressured to have a voice and talk when there were silences, felt ridiculed and upset, No one got touchy	**Barrier** **Conflict between group members**
Knowledge of Equipment / Technical Knowledge	Tech knowledge stopped mammographers from thinking outside the box, not knowing if something was possible made women drop their ideas, however gave women more confidence to go forward with ideas.	**Barrier to** **Lack of knowledge**
Limitations of the process	having to think about the technical aspects of the design process, practical aspects, time between meetings, Need to see the machines	**Barriers** **Knowledge (value of different forms of knowledge)**
Reflection	I came home and thought I had never really thought about what it was like using the equipment for them,	**Benefit** **Change in perspective (reflective process)**
Role of group members	Reign people in say that's gotta be that, giving a practical input, mammographers have detailed knowledge, can't have things like that, ideas crossed off as irrelevant	**Barrier** **Power between group members and**

		knowledge
Understanding the other perspective	Initial perceptions of mammographers (cold, clinical), hanged perspectives on radiographers, see it in a completely different light, that has been a learning curve for me, changed aims, you come at it for different perspectives which can make things better for everyone	**Benefit Developing shared understanding and meaning**

Figure 5.2 Initial codes derived from mid-project interview data

Codes identified before the selection of FA as a data organisation tool, through familiarisation and open coding of interview transcripts. Only including initial interview data. N.B. mammographers was kept in the extracts instead of practitioners as this is what the women choose to call them throughout the interviews.

	Theme Heading	Sub-headings
Benefits of Involvement in co-design		
	Learning	• Sharing understanding • Developing shared meaning • Change in perspective
	Empowerment	• Value of designing and designing in a group
	The group	• Agreement and cohesion
	Encouraging change	• Having a voice • Action • Aims and goals of involvement
Barriers to Involvement in co-design		
	Lack of knowledge	• Knowledge of technical equipment • Limitations of the process
	The group	• Conflict and disagreement • Dismissive

		• Control over group members
	External Influences	• Resisting Change
		• Physics/ Medical community
Other important factors to consider		Development of the group over the process

Figure 5.3 Draft theoretical framework.

Initial theoretical framework following the selection of FA, codes has been tentatively grouped into emerging themes. Only interview data was used to derive this draft theoretical framework.

At this stage of the study the feeling was that there had been some personal benefits to the people involved these generally related to learning and sharing their understanding, and this was meaningful to the women who took part in the study. Hearing the practitioner's perspective was an important part of the client's experience, however, I kept coming back to the issues of control within and between members of the group. This appeared to be linked to power between group members, and external influences, such as the medical context. By power in this instance, I refer to 'power over'. The practitioners were able to control and influence what the women could do with the designs however, at this stage I did not have an understanding of why this was the case. Lack of knowledge was another important area which seemed to restrict involvement in the design process. The clients referred to their lack of knowledge as a limitation to the design process, which I felt needed further exploration before I could understand how their lack of knowledge of the technical aspects of the equipment restricted and limited their involvement and voice in the process.

Another important aspect related to the group and the relative benefits the women perceived of being in this particular group, I gave this the tentative theme name of 'empowerment' however, wanted to explore this further in relation to the group and the process. This theme seemed to be linked with co-design as a process which encouraged change, the women spoke about how co-design, gave them a voice, encouraged action, and allowed them to reflect on their aims and goals of taking part. I wanted to explore this is relation to the themes which rather than encouraged change, restricted it. To look at power and empowerment together to get an understanding of how these impacted the individuals and the group.

Stage 3: Indexing

Using qualitative analysis software, NVIVO 10, this next stage of analysis involved setting up a number of nodes that corresponded to the codes listed in the previous stage. I, then, indexed the entire of all the interview transcripts. This involved attaching a name to sections of the transcripts. I went through each transcript individually from start to finish labelling quotes from the women according to the thematic framework specified in figure 5.2.

Throughout the process, it was necessary to rethink the names and descriptions of some of these codes in order to ensure that the thematic framework covered the benefits and barriers of the women's experiences. I used in vivo names for codes (words or phrases that had been used by the women themselves.), where possible, to keep the themes in the voices of the women. This indexing stage helped to develop the descriptions for each code as well as prioritise some of the codes into headings and subheadings.

Following indexing of the data, a second draft of the theoretical framework was developed. It became apparent through indexing that a number of the codes where not represented in the data, needed to be separated into sub-headings, or became themes of their own. I used NVIVO to track all of the changes made, and I made notes where I had moved or renamed nodes. The framework was developed through adding memos and notes to each of the nodes as they developed and I got a clearer image of what the issues were important to the women and what the analysis of the video-recorded footage showed.

At this stage, the video data was transcribed verbatim without linguistic features but including body language cues. The transcript and video footage were kept linked together on NVIVO, to keep as much of the data intact as possible, as it is inevitable that aspects of the data is lost when moving from video to transcription. I could then index the video and transcript together. Leaving the video analysis until this point was to make sure I was focusing on aspects of the women's experience that they had specified in the interviews.

The framework was grounded in the data, names of codes and categories where derived from the women's own words during interviews or through my own words on observation notes. Once the entire data set had been indexed the nodes were reviewed. At this stage, I

felt some of the nodes needed to be rearranged into different themes surrounding the requirements of co-design sharing understanding, designing, and decision-making. I regrouped these nodes into their various themes using the modelling capability of NVIVO. An example of using NVIVO to chart is found in the screenshots below.

	A : About mammographic screening practice	B : About mammography equipment	C : About the clients and practitioners experience	D : In the process	E : Towards mammographic scr both in practice and attendi
1 : Mammographic Practitio.		I think they were quite surprised how technical it is and it's not just put a boob on a plate and squash it there is more to it than that	We didn't really understand the patients point of view and their sort of perspective		I just think its just made us like *Kate said, more patie around patients. Cause we you done 25 ladies, your o 26th lady shes not coopera with you at all you do gt frustrated and your pushin against the machine and y think, right OK she is obvio nervous bla, bla, blah take bit more time.
2 : Screening Client	The idea of compression the breast within its more within its natural shape, nevertheless making as flat and as accessible to the xray and that is something I mean now there is more to tissue and this is the stuff we don't know I mean theres all this under the arm	the quality of the image its got to go through, I thought oh gosh its so basic that. Very informative having a look at all round and seeing what's out there.	It gave me a real insight into their problems of managing this equipment Because my experience of radiographers is you go into somewhere and they sort of they it can be a very cold clinical environment, because, and now I have seen it from their perspective I have learnt from that too, from there perspective, like that has been a learning curve for me.	It would be something handheld that you went to and clamped on the breast and squeezed, but then this is the stuff you don't know there is all this under the arm	I can say I know the timesl they have got for patients start to see why its like tha I will now go to my next mammogram and see it in completely different light

216

Stage 4: Charting

The aim of the charting stage is then to refine my categories by seeing the information together, and starting to develop more critical questions relating to power and empowerment identified earlier in the stages of analysis.

Seeing the data in chart allowed, helped to ground my data, and allowed me to represent what the women were saying better before moving on to making any further interpretation of the data. As I could see the data together making sure that I had not placed any data in an inappropriate theme during indexing. From seeing the data like this, I decided that when coding the data the extracts I was using were in some places too long and made seeing the data in a matrix confusing. I also started to think about how the cases should be distributed in order to make some of my conclusions.

It was here, I started to recognise changes over the course of the process and decided that the rows, cases, should be displayed in order to see differences across the tasks and requirements of co-design. An extract from my analysis journal is displayed below.
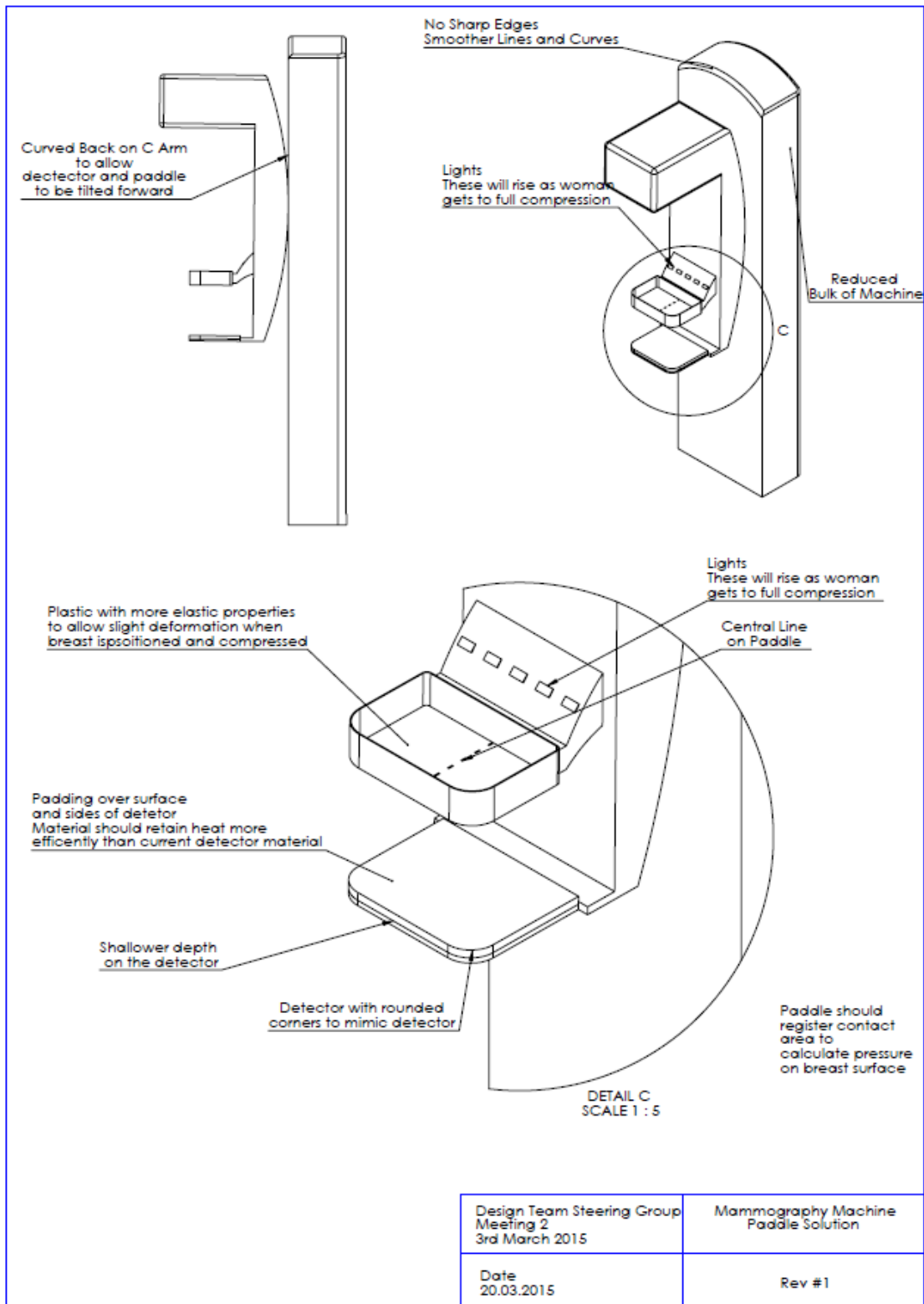
> *I, actually found that, this framework of sharing experiences, being creative (sharing ideas and developing ideas), and making decisions actually summarised a number of the nodes in data set. For example, when I went through the agreement node there were a number of quotes that highlighted the group felt they agreed with each other, but these were related to different things such as agreeing on decisions, having similar ideas, and having similar experiences – each of these is actually a different thing than solely 'agreement' but relates to how the group worked when doing different things such as sharing experiences, developing ideas, and making decisions. A lot of the literature on co-design seems to only talk about sharing experience, and doesn't go into how decisions are made by members of the group – perhaps this is why power has not been studied? Or is not fully understood in these groups? Could look at each of the themes in terms of the requirements of co-design, or tasks …*

I also considered the cases to be separate in terms of the clients and practitioners, this was not to compare them or to try and make a claim about who is more true or more accurate but, to add depth to the description of what happened in each of the meetings. I created a couple of matrices with the cases as; the client, the practitioner and the observational notes. Seeing the data in these cases allowed me to look into some of the motivations behind the behaviours of the different user groups.

Final theoretical framework and layout of matrices

| Theme Heading	Sub-Headings
Knowledge	Sharing understanding of experience
	Influence of sharing understanding of experience (on the co-design process)
	Impact of hearing others experience (on own perspective)
	Technical Knowledge of machines operation
	Influence of sharing understanding of machines operation
	Perspective on lack of knowledge and its influence on involvement
Roles of group members/ the group	Agreement and cohesion
	Conflict and disagreement
	Dismissive
Power	Resisting change
	Physics/ medical community
	Control over group members (link with knowledge and role)
Empowerment	Value of designing and designing in a group
	Change: Having a voice, Action, Aims and goals of involvement

Appendix 8: Developed Designs

No Sharp Edges
Smoother Lines and Curves

Curved Back on C Arm
to allow
dectector and paddle
to be tilted forward

Lights
These will rise as woman
gets to full compression

Reduced
Bulk of Machine

C

Lights
These will rise as woman
gets to full compression

Plastic with more elastic properties
to allow slight deformation when
breast ispsoitioned and compressed

Central Line
on Paddle

Padding over surface
and sides of detetor
Material should retain heat more
efficently than current detector material

Shallower depth
on the detector

Detector with rounded
corners to mimic detector

Paddle should
register contact
area to
calculate pressure
on breast surface

DETAIL C
SCALE 1 : 5

Design Team Steering Group Meeting 2 3rd March 2015	Mammography Machine Paddle Solution
Date 20.03.2015	Rev #1

Made from plastic for easy cleaning
Grooving inside to stop fingers from sliding
Slightly different colour so you can visually see it

Similar to shell handle
Same dimensions

Grooves to rest fingers in

D
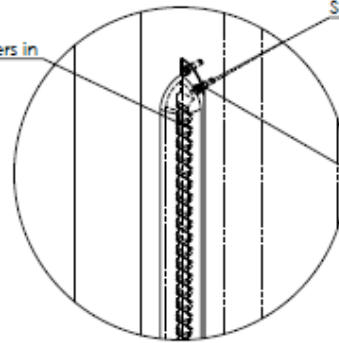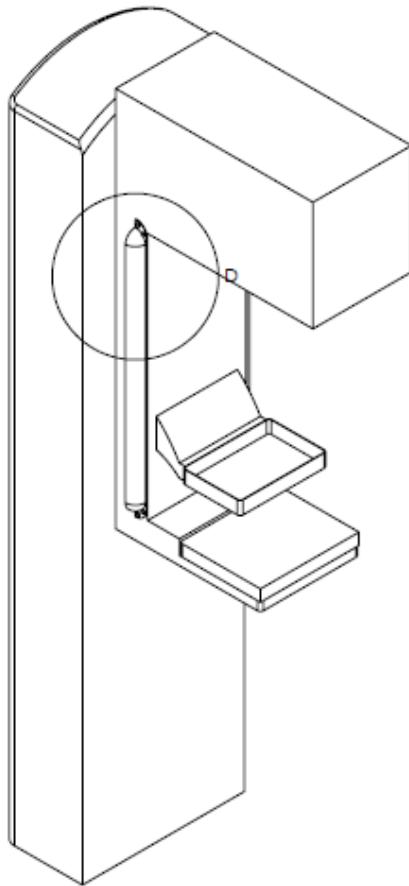
DETAIL D
SCALE 1 : 5

Handle on both sides
Length to accomodate
different women's heights

Fingers would hook
behind the groove
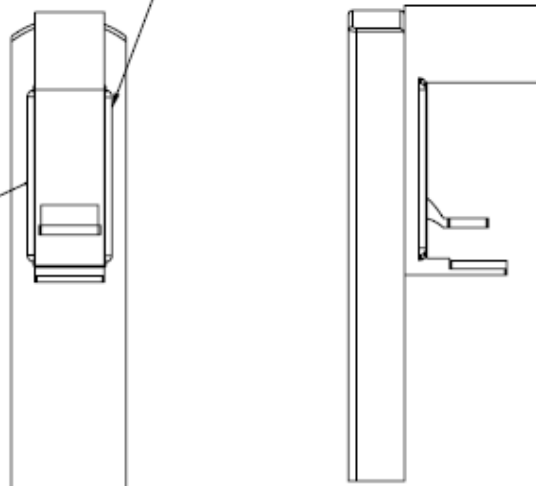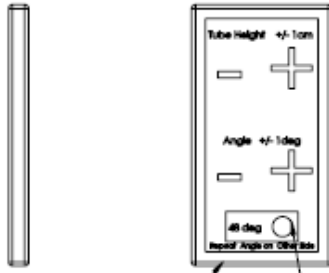
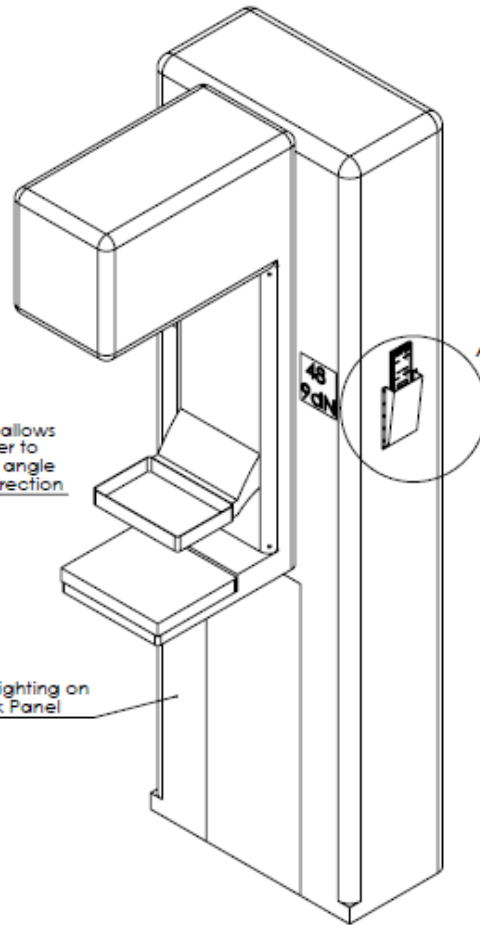| Design Team Steering Group Meeting 2 3rd March 2015	Mammography Machine Free Arm Solution
Date 20.03.2015	Rev #1

Wireless Remote
for adjusting Tube Hieght and Angle

Tube Height +/-1cm
−   +
Angle +/-1deg
−   +
48 deg
Repeat Angle on Other Side

Handheld Dimensions
130 x 70 x 10
Similar to a smart phone

Button which allows
radiogrpaher to
set the same angle
in the other direction

Mood Lighting on
Back Panel

A

48
9dN

48
9dN

48
9dN
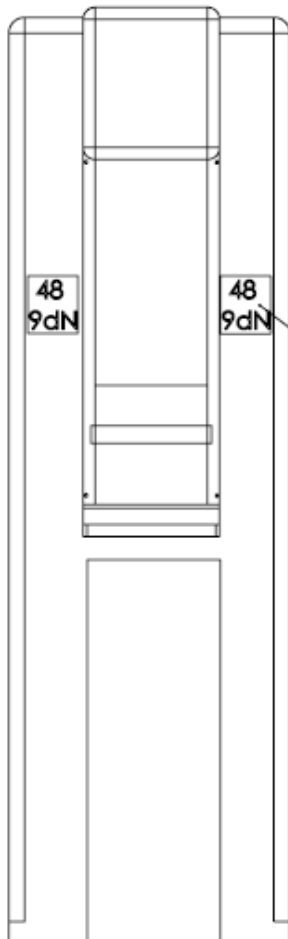
Panels on either side
these display the angle and
compression force
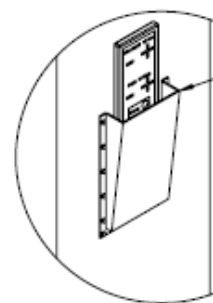
Charging Unit for
Handheld Remote

DETAIL A
SCALE 1 : 5

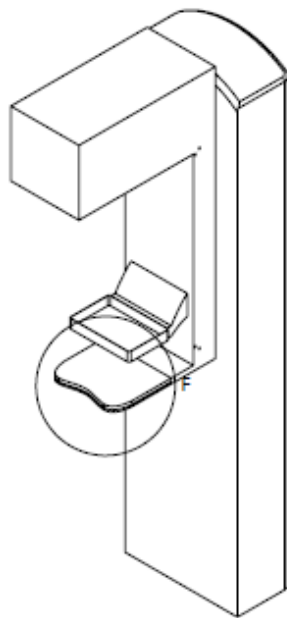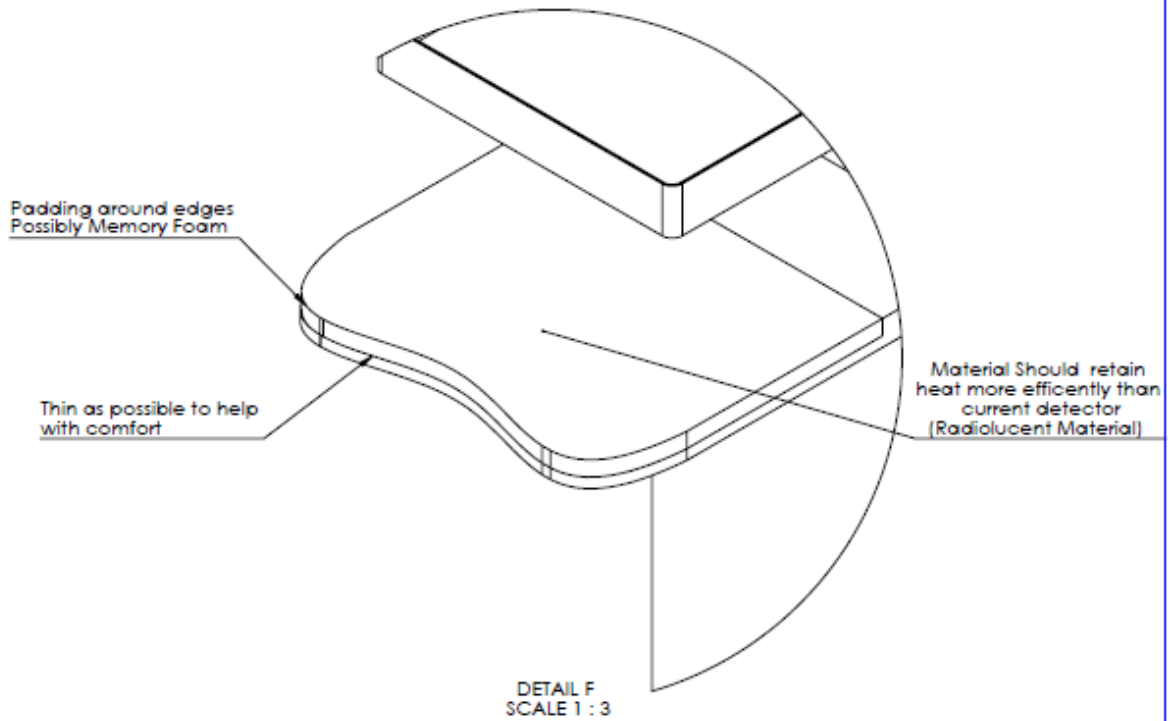| Design Team Steering Group Meeting 2 3rd March 2015	Mammography Machine With Button and Panel Solutions
Date 20.03.2015	Rev #1

Detector Solution Group

Padding around edges
Possibly Memory Foam

Thin as possible to help
with comfort

Material Should retain
heat more efficiently than
current detector
(Radiolucent Material)

DETAIL F
SCALE 1 : 3

F

Design Team Steering Group Meeting 2 3rd March 2015	Mammography Machine Detector Solution
Date 20.03.2015	Rev #1